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The Instrumentalist

Surgical knives: the scalpel

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'*From hand and mouth to sticks, stones and metal*'[1] 'man is a tool-using animal…without tools he is nothing, with tools he is all'[2]

The word 'surgeon' derives from the Greek words *kheir* (hand) and *ourgos* (work). By far the most important 'instrument' in surgery is the human hand. Historically, it is believed that teeth were used to cut before sharp instruments were developed from organic and inorganic sources (stone or wood fragments). From simple probing to controlling complex robotic machinery, it is the hand that performs surgical manoeuvres (with the assistance of pedal instruments for coagulation). They are retractors, dissectors, tweezers, dilators, haemostatic aids, curettes, lancets (fingernails once upon a time), and manipulate the specialized tools of modern surgery. All too often the origin of the tools wielded have been forgotten. This new section of *BJS* is dedicated to bridging that temporal knowledge gap.

Surgical knives: the scalpel

Primitive cutting blades were made of flint, jade, or volcanic glass (obsidian or the 'dragon glass' in *Game of Thrones*) before metallurgy developed to shape tools into metal blades with handles. The scalpel (from the Latin *scalpellum* or *scalpellus*) came in various sizes and shapes, including historical derivatives such as the lancet (short and often hinged like a pen-knife) or bistoury (French—a longer, narrow blade). Modern scalpel blades are made from hardened and tempered steel, stainless steel, or high carbon steel. In addition, titanium, ceramic, diamond, and even obsidian blades are possible. The shape altered according to need such that earlier ablative and amputation requirements were long and durable. More modern scalpels are shorter, precision-focused blades and handles (*Fig. 1*).

Steam sterilization allowed tough, single-piece, steel scalpels, but they required regular sharpening of their blades such that a technician sharpener was often in the operating theatre in the early twentieth century. They rusted and were replaced by stainless steel (incorporating at least 11% chromium) rust-resistant equivalents in the 1920s. Fixed-bladed scalpels required their blades to be sheathed or kept in racks. Pocket sets of scalpels, lancets, and other implements that folded into metal or organic (e.g. tortoiseshell) guards prevented inadvertent tissue injury and reduced damage to the blades.

Disposable blades had obvious advantages. Some early methods of attaching the blades to the handle were too intricate, but, around 1914, Morgan Parker (an American engineer) invented the two-piece blade-and-handle model still used today. This led to the founding of the Bard-Parker Company. Fenestrated blades today slide onto linear raised buttresses on the end of the handle. The British equivalent to the US firm is the Swan-Morton Company of Sheffield, founded in 1932. There are now disposable plastic polymer handles with fixed or changeable blades. The interchangeable blade system allows a large variety of well-known and favoured blade sizes and shapes. This selection permits robust or more delicate incisional or excisional work.

Today there are many advanced types of stainless steel, which may incorporate zirconium nitride, diamond and polymer coatings, which enhance the cutting edges. Gemstone-quality diamond blades are available for ophthalmic operations. As to

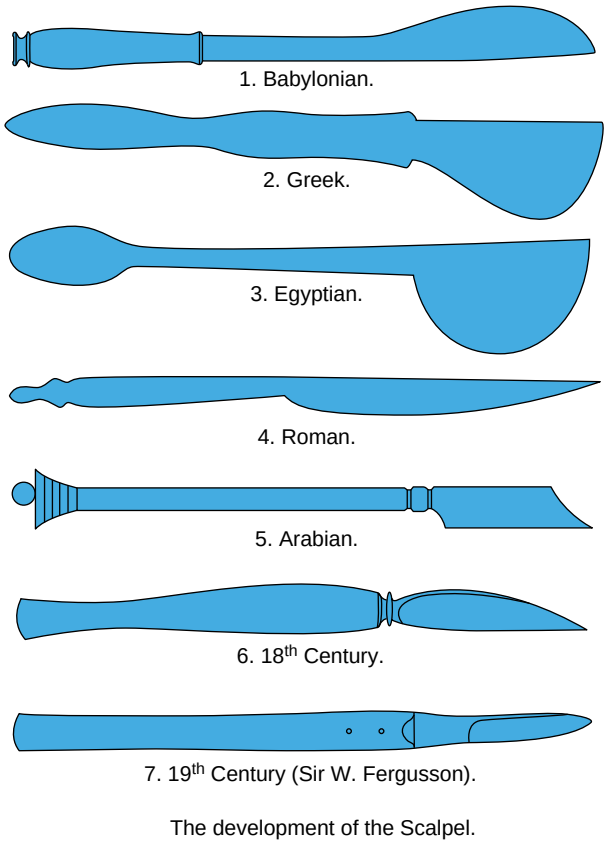

Fig. 1 The changes in format of the scalpel over time (courtesy of the Royal College of Surgeons of England)

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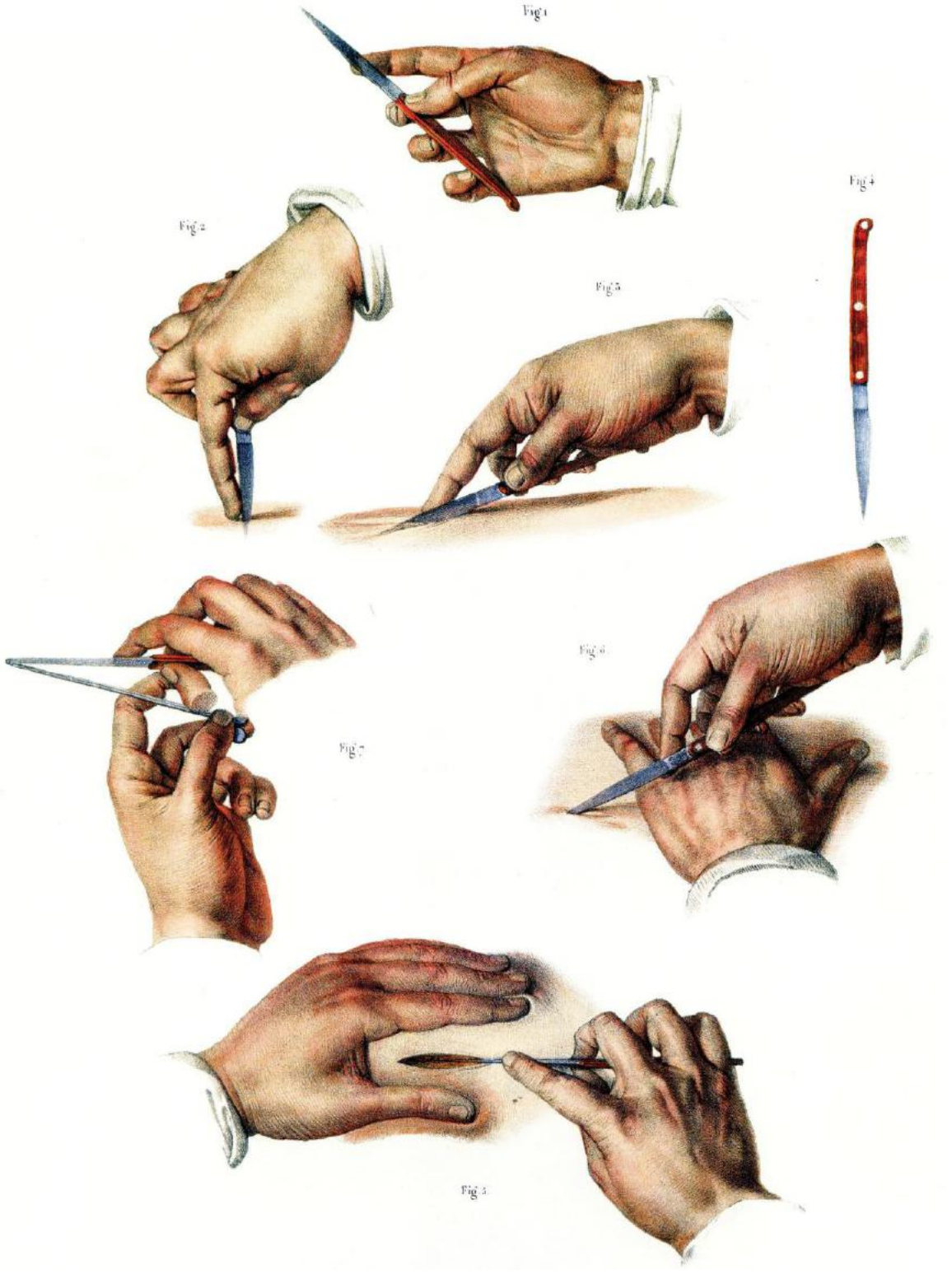

Fig. 2 Suggested methods of holding a scalpel—early twentieth century (from Bourgery and Jacob's mid-19th century *Atlas of Human Anatomy and Surgery*, Volume 6 Plate 14. Author's collection)

the use of the scalpel, we have to recall that the edge and tip of the blade is very close to the gloved hand of the surgeon, permitting accurate force, depth, angle, and shaped cutting techniques to be employed. Most frequently used for creating an initial incision, the blade is used for dividing skin, fat, muscle, and fascia, with due caution being observed when cutting near vital structures. Cutting in a firm controlled way usually at angles of 30 to 90 degrees to the tissues, necessitates holding the instrument in various ways, often placing a steadying forefinger along the back of the instrument. The tissue through which the scalpel is incising should also be steadied and put under a slight degree of tension (*Fig. 2*).

Being a cold cutting tool, various haemostatic methods need to follow an incision. Gentle pressure, diathermy or ligature is required. Scalpels may be employed inside a body cavity to sharp dissect tough or finer tissues, for example dense adhesions, or dividing gut or vascular tissue after clamping, but fine dissecting scissors often supplant the blade in deeper work. The advantage of a clean sharp division of gut or blood vessels allows for accurate apposition and suturing. Aside from unintentional cutting into important structures or injuring the surgeon's or assistant's fingers, a frequent cause of accidental injury occurs while mounting or dismounting a detachable blade onto or from its handle.

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Bone-cutting instruments

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Surgical saw

In 1837, a French surgeon observed that, under a microscope, fine scalpel blades have a serrated appearance (as do all knife blades). To divide tough cortical bone, however, strong force (delivered manually or mechanically) requires saws made of steel sheets with visible serrations or teeth. These latter may be offset individually, alternative teeth being slightly angled away from each other to create a grooved incision in the wet bone. This broader incision helped prevent the saw jamming. Often pushing the saw more strongly than equal pull-and-push allowed more careful and controlled bone division. In previous times, the strong manual measured to-and-fro movement has been supplanted by a safer oscillating power-driven cut using smaller blades. Care had to taken not to damage soft tissue and to obtain a clean excision, with little or no splintering of bone ends. Before the advent of anaesthesia, the sawing of a limb bone was reputedly one of the most painful and challenging experiences of an amputation. Saw blades became jammed between the bone ends or jerked the limb painfully with rough handling. Before the introduction of these modern instruments and over time, the tenon saw with a reinforced steel strip along its back proved more robust than bow or frame saws, whose thin blades frequently snapped (*Fig. 1*).

Many varieties and sizes of surgical saw have existed over the centuries. Notable examples are the trephine circular saw, the Gigli chain saw (Leonardo Gigli, 1863–1908, was an Italian surgeon and obstetrician), and smaller digital and osteotomy saws. The trephine circular blade cuts out circular discs of the two tables of the cranium for access and drainage purposes. Several so-called burr holes often proved inadequate and a wider cranial osteoplastic flap could be fashioned by passing the chain of a Gigli saw from one to another defect, and using to-and-fro rocking movements by alternatively pulling up the handles attached to each end of the chain. Thus, carrying out several of these joined-up incisions allowed an adequately vascularized flap to be created; the undivided base of the flap contained the blood supply. Today, small electric saws are used to create the flaps.

Complex hand-driven circular saws came into being in 1815, and the first electric powered saw was introduced by a Parisian surgeon named Eugène Doyen (1859–1916) in 1895. Contemporary ways of dividing bone use power-driven instruments which, rather than create continuously rotating circular hand or powered blades, now use straight steel blades that have either oscillating or reciprocating movements. These tend not to cause so much snag and rip. These tools may be powered by compressed air or, more usually, electric motors.

Osteotomes (gouges) and chisels

As a rule, the surgical chisel has a single bevelled edge, compared with the equal-bevelled working end of an osteotome. These instruments have been, and can be, used to amputate, divide, fashion or trim bone, for example removing osteophytes. Of note was the Macewen osteotome (*Fig. 2*). Alongside chisels and osteotomes, the surgeon requires a hammer to carefully strike the reinforced non-working end of the tool and, clearly, care is required to control the direction and force of the work, particularly by the hand holding the cutting tool.

Sir William Macewen (1848–1924), a Glaswegian surgeon, was considered the father of neurosurgery and was Regius Professor of Surgery at the University of Glasgow. He also made contributions to orthopaedics, and hernia and lung surgery. He pioneered cranial surgery for tumours and sepsis, and described Macewen's anatomical triangle on the skull. He used his osteotome predominantly for corrective knee surgery—particularly with skeletal limb deformity resulting from rickets.

Elevators, rongeurs, raspatories, and rougines

With regard to this group of instruments, the terminology is confusing and the format of many of the instruments varies, for example with raspatories.

Bone elevators have been used to lift depressed bone fragments or strip periosteum. These latter are often termed rougines. Bone rongeurs (bone nibblers) (*Fig. 3*) are single- or double-pivoted heavy-duty forceps with sharp cup-ended cutters for removing small pieces of bone during spinal surgery, or for obtaining bone grafts, for example. A raspatory, also known as a 'rasp', is used to scrape periosteum, and shape and file bone, nail, and cartilage. An especially-shaped curved raspatory is employed in thoracic surgery to 'clean' and lift the periosteal covering of ribs, when performing a thoracotomy.

Hermann Adolph Wülfing (1836–1910) was a German surgical instrument maker. He married Jeanne Amélie Lüer (1842–1909), taking on her surname. Herman worked on the business and marketing side of the firm, while Jeanne created instrument

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Fig. 1 Two tenon saws, and two bow or frame saws

The image also includes a Petit-type screw tourniquet. Courtesy of the Royal College of Surgeons of England.

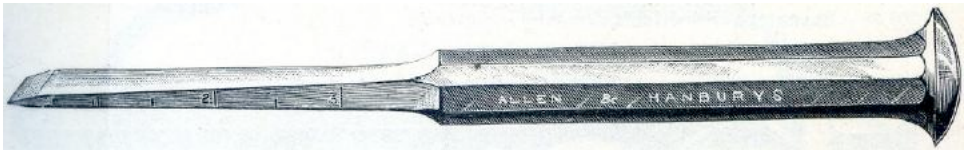

Fig. 2 Macewen's osteotome

Image from author's collection.

Fig. 3 Lüer bone rongeurs

Fig. 4 Liston pattern bone-cutting forceps

designs. She introduced the first glass syringe in 1867. The pair also created the rongeurs bearing their name.

Liston bone-cutting shears

Although both osteotomes and chisels were, and are, used to trim bone, cut out bone grafts, and perform osteotomies, one classical surgical bone-cutting implement is the Liston pattern forceps (*Fig. 4*). These are strong plier-like forceps with spring handles and the ability to cut tough cortical bone. They can be used to trim, chip or divide bone after injury, and also to create bone-grafting material. They are as useful today as they have been for the past 300 years. Other surgical shears exist, such as rib, heavy-duty digital nail, and Plaster of Paris cutters.

Robert Liston (1794–1847) was a Scots surgeon, who latterly became Professor of Surgery at University College Hospital (UCH) in 1835. He was a controversial and speedy surgeon who, in December 1846, carried out the first 'public' operation under anaesthesia—an amputation—at UCH. He left a lasting impression on two of his students, both notable pioneers: Sir James Simpson (1811–1870), with his use of chloroform, and Joseph Lord Lister (1827–1912), the champion of antiseptic surgery. He also invented the bulldog clamp and had a large amputation knife named after him.

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Surgical knives: specialty knives and cutting instruments

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Orthopaedics

Meniscotome

A meniscotome is a surgical blade designed specifically for removal of part or all of the medial or lateral meniscal cartilages of the knee. Linear tears of the menisci are common and cause mechanical problems as well as pain. Treatment initially consisted of total excision of the cartilage, using this instrument to shave the meniscus off by pushing the instrument blindly. This alleviated the acute symptoms, but loss of the menisci caused long-term issues with instability and degenerative changes in the joint. Modern arthroscopic surgery is very much focused on preservation of as much of the meniscus as possible, including repair. Before the advent of arthroscopy, the small end knife blade allowed resection of the torn cartilage through limited access; this could lead to complications in unskilled hands, such as division of adjacent structures, such as ligaments, nerves, and vascular structures around the joint. Devised by Ian Scott Smillie (1907–1992), who was awarded the first Chair of Orthopaedic Surgery at St Andrews then Dundee in 1967, the knife often bears his name (*Fig. 1*).

Arthroscopy with more modern instrumentation, including shavers, and techniques for cartilage repair have made the Smillie knife rarely used, although recent papers have described new uses where space is limited, such as in podiatric surgery.

Plastic surgery

Humby skin-grafting knife

The first popular instrument permitting cutting a skin graft with depth control was developed by Graham Humby. His dermatome (a skin-graft knife) (*Fig. 2*) is used to cut thin partial thickness slices of healthy skin from a donor site, usually the torso, buttocks or limbs. This skin is then laid or stitched on to an area of skin/tissue loss.

Humby added an adjustable calibrated roller below the blade to the Blair knife. This allowed the thickness of the skin cut to be varied, and helped avoid drag on the skin. Two knurled collars, one at each end of the sliding roller bar, could be adjusted equally to ensure even graft thickness. Sometimes the graft rolled up around the guard. Using a firm, even to-and-fro movement of the instrument, some sterile lubricant, and firm flattening of the skin donor site, with an assistant using two wooden boards, helped to produce a graft of even thickness. Further modifications, such as sharp replaceable blades and a simpler thickness adjustment, took place into the 1960s.

Graham Humby (1909–1970) worked at the Hospital for Sick Children, Great Ormond Street, London, before World War II. He was a junior dresser to Sir Heneage Ogilvie (1887–1971), after whom the condition known as Ogilvie's syndrome, an acute dilatation of the colon in the absence of mechanical obstruction occurring in severely ill patients, was named.

Ear, nose, and throat surgery

Tonsil guillotine or tonsillotome

Decades ago, tonsillectomy was a very common procedure. MacKenzie's tonsil guillotine was one of many patterns of tonsillotome used. The pattern illustrated (*Fig. 3*) is very similar to Mackenzie's instrument. Basically, squeezing the grip allowed the blunted blade to slice through and amputate the tonsillar tissue—sometimes incompletely. This was often performed as a relatively safe and rapid outpatient procedure, following gaseous anaesthesia without intubation. The mouth was held open with a gag, and the instrument, whose operating end was not visible, snared the tonsillar mass. Problems could arise with incomplete removal, bleeding and, after improper placement, even damage to the uvula, soft palate or pharyngeal muscles. If there had been a previous quinsy, the operation in scarred tissue was contraindicated.

Succeeding the use of the tonsil guillotine, tonsillectomy was carried out under direct vision, using sharp or diathermy excision with appropriate haemostasis. Subsequently, removal has been achieved using the harmonic scalpel, radiofrequency ablation, carbon dioxide laser or a suction/cutting microdebrider.

Morell Mackenzie (1837–1892) was an English, late 19th century, world renowned specialist laryngeal surgeon who became embroiled in a misdiagnosis of Kaiser Wilhelm II's laryngeal carcinoma, rather alienating the British and German establishments just before World War I.

Ophthalmic surgery

Wolfe cataract knife

The operation of removing a cataractous lens from the eye (as opposed to pushing it back into the vitreous—called 'couching') is attributed to French surgeons in the 18th century. Extraction

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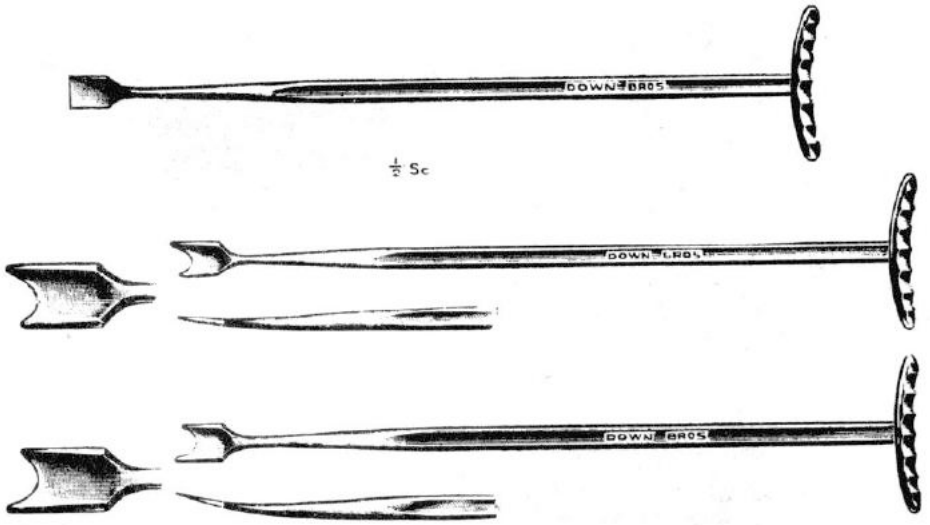

Fig. 1 Three models of Smillie's meniscotome

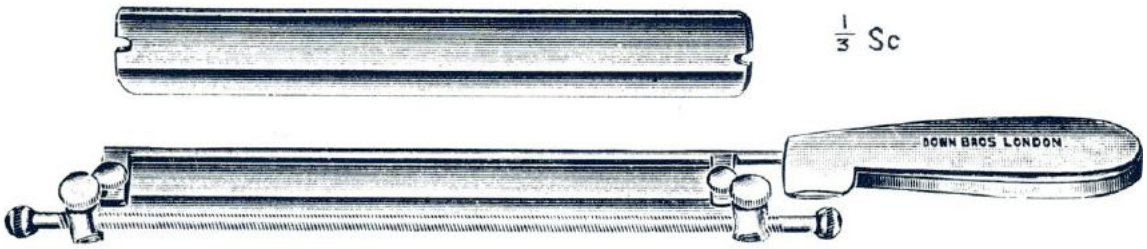

Fig. 2 Humby dermatome

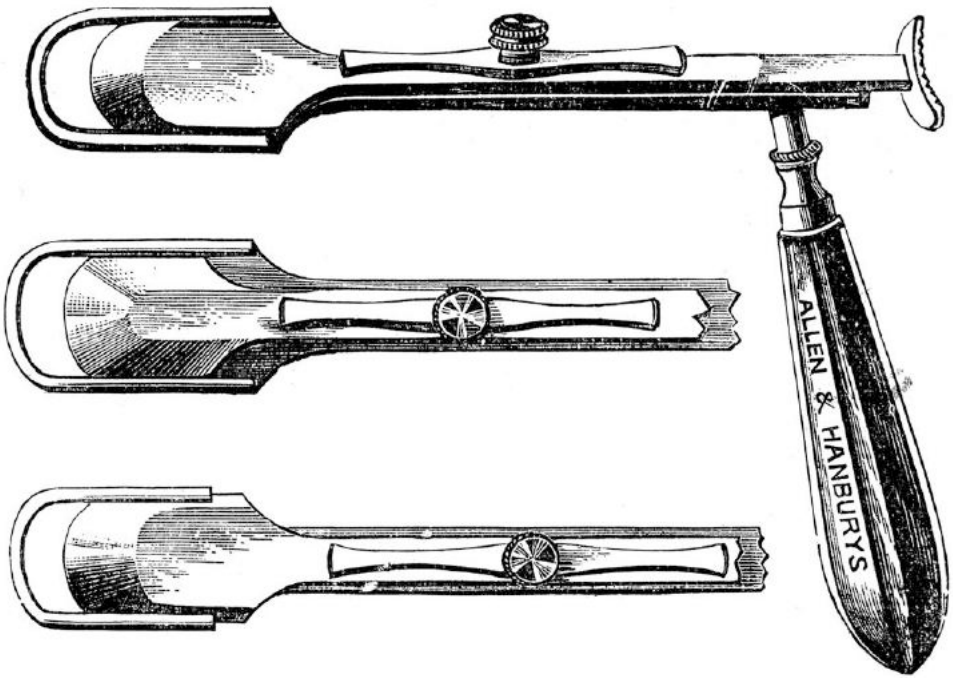

Fig. 3 Mackenzie tonsillotome

Image from author's collection.

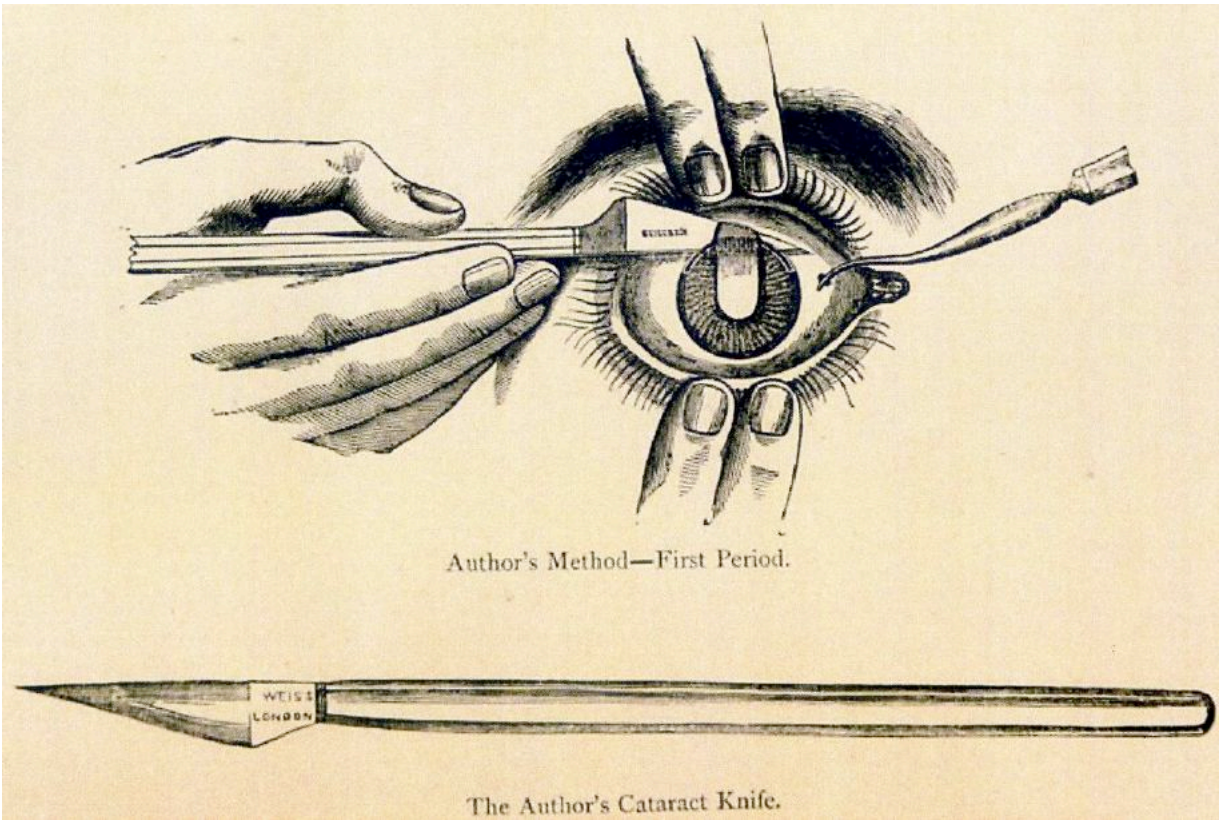

Fig. 4 Wolfe cataract knife
Courtesy of the Wellcome Collection.

obviously required the eye to be opened, and, without any form of anaesthesia, speed and sharpness of the instrument were essential. A 'cataract knife' (*Fig. 4*) had a thin blade with a sharp point to enter the eye at or near the limbus, around the 9 o'clock position, then traverse the anterior chamber, exiting the eye at 3 o'clock. The sharp long edge of the blade was then drawn up (or down) to open half of the limbus to allow the lens to be extracted. Without any sutures, wound healing depended on the patient remaining still (definitely no coughing!) for a couple of weeks. Infection and/or loss of intraocular contents were not that uncommon.

Modification in technique aimed at smaller incisions to reduce these risks, and the cataract knife became longer and thinner. That knife designed by Albrecht von Graefe (1828–1870), a Prussian pioneer of ophthalmology, became the standard, and remained in use by some surgeons until the 1980s. In the meantime, anaesthesia (topical cocaine introduced in 1884) and suture material (used infrequently after 1865) made the procedure much safer. Now, phacoemulsification, using an operating microscope, is the treatment of choice. Tiny precisely sized knife blades, creating two small incisions, enable extraction and insertion of the effete and new lens respectively.

John Reissberg Wolfe (1823–1904), a Hungarian, qualified as MD in Glasgow in 1858. He founded the Glasgow Ophthalmic Institution and served as a military surgeon in Garibaldi's army. He is also remembered as the inventor of the Wolfe full-thickness skin graft.

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Dissecting, tissue, and grasping forceps

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The word dissect originates from the Latin word *dissecare* ('*dis*'—apart; '*secare*'—to cut), that is to cut in pieces. To trim, excise, or shape tissue in surgical practice, it is necessary to have cutting tools, such as scissors or knives. However, it is usually essential to hold, steady, or stretch tissues while the incision, excision, or shaping is performed. Aside from using a surgical hand for these purposes, the surgeon will need forceps (again, a term derived from the Latin word for tongs or pincers) in the hand opposite to that holding the knife. Sometimes, during dissection, grip on tissues has to be light, at other times firm. Delicate tissues are easily damaged by forceps that slip or are held over-tight on structures such as bowel or blood vessels.

Common dissecting or dressing forceps are sprung and fused at the proximal end, with the working ends apart. They thus require digital pressure to close and grip tissue. These are made from simply folding over a piece of steel or, more usually, welding or riveting two strips of steel together. Some grasping forceps are pivoted and also grip tissues, tightly (e.g. the Lahey forceps) and others in a more atraumatic way (as do the Duval forceps). Varied constant squeeze pressures can be maintained by an engaging the ratchet near the finger bows of the instrument. Dissecting, dressing, and grasping forceps commonly have cross serrations at their working ends for improved grip and, if a firmer hold is required, a V-shaped interlocking tooth is present at the tip of the instrument, so giving the term 'toothed' forceps. Clearly, the non-toothed variety is less likely to injure tissues.

Lane's dissecting forceps

Lane's dissecting forceps are relatively tough forceps, used for holding skin, muscle, muscle and fascia during orthopaedic manoeuvres, such as joint or fracture site exposure. A good grip is often required during such robust dissection. Here the forceps have serrated ends and are toothed. There is a convenient depression in the shaft for optimum finger grip (*Fig. 1*).

Sir William Arbuthnot Lane (1856–1943) was a Guy's Hospital surgeon who served in World War 1 (WW1) and witnessed many complications of compound limb fracture, with delayed, mal- and non-union, chronic sepsis, and ultimate deformity. He pioneered internal fixation for fractures and worked with abdominal and cleft palate patients. A keen student of aseptic surgery, Lane practised the 'no-touch' surgical technique in the general pre-antibiotic era, to minimize the risk of intraoperative sepsis. His name is associated with a screwdriver, periosteal elevator, tissue forceps, an intestinal clamp a bone-holding forceps, and an osteotome!

McIndoe's dressing forceps

McIndoe's dressing forceps are an example of finer dissecting forceps. Not all dressing forceps would have teeth, as in this case, since these might catch in the dressing material. The longitudinally ribbed handles ensure the best grip. (*Fig. 2*)

Sir Archibald McIndoe (1900–1960) was a cousin of the pioneer plastic surgeon of WW1, Sir Harold Delft Gillies (1882–1960). McIndoe continued evolving Gillies's reconstructive head-and-neck surgery in battle-traumatized servicemen and developed new techniques for the management of burn victims of war. These delicate forceps were used for the painstaking work around facial surgery.

The MacDonald dissector

There is another sort of dissecting instrument, well-illustrated by the MacDonald blunt dissector. This is a double-ended straight-stemmed implement with a straight blade at one end and a curved blade at the other. It is used to tease tissues apart, lever and elevate vessels, nerves, and periosteum. (*Fig. 3*)

Greville MacDonald (1856–1944) was a Scot, who briefly served as an assistant to Joseph Lister. He was a successful professor of laryngology at King's College Hospital, retiring in 1904. He was a successful children's author.

Lahey forceps

This instrument was designed for gentle abdominal and neck dissection, its small blunt ends separating and elevating tissues, enabling the passage of ligatures round mesenteric, gastric, and colonic vascular and biliary structures. It also acts as a crushing ratcheted arterial and biliary clamp in open surgery. It is noted that the grooves at the working end are longitudinal rather than transverse. (*Fig. 4*)

Frank Lahey (1880–1953) was a world-renowned surgeon and teacher from Boston. He was well recognized for his expertise in thyroid, oesophageal, gastric, and colon surgery, and innovated in staged operations for major surgery. He founded the Lahey Clinic in Boston.

Duval's intestinal forceps

These forceps are designed to grasp bowel, mesentery, or peritoneum and, having an expanded working end, they spread their grip over a wider area than with narrower forceps, exerting a gentler hold on intestinal organs and the peritoneum. The forceps have slight and even serrations on their distal ends, thereby enhancing a mild hold on tissues. The grasp can be

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Fig. 1 Lane's dissecting forceps

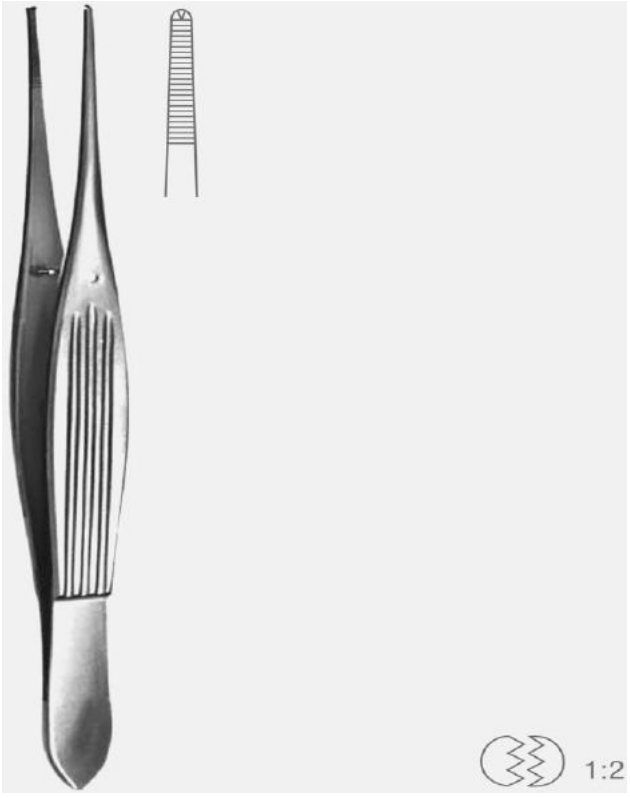

Fig. 2 McIndoe's forceps

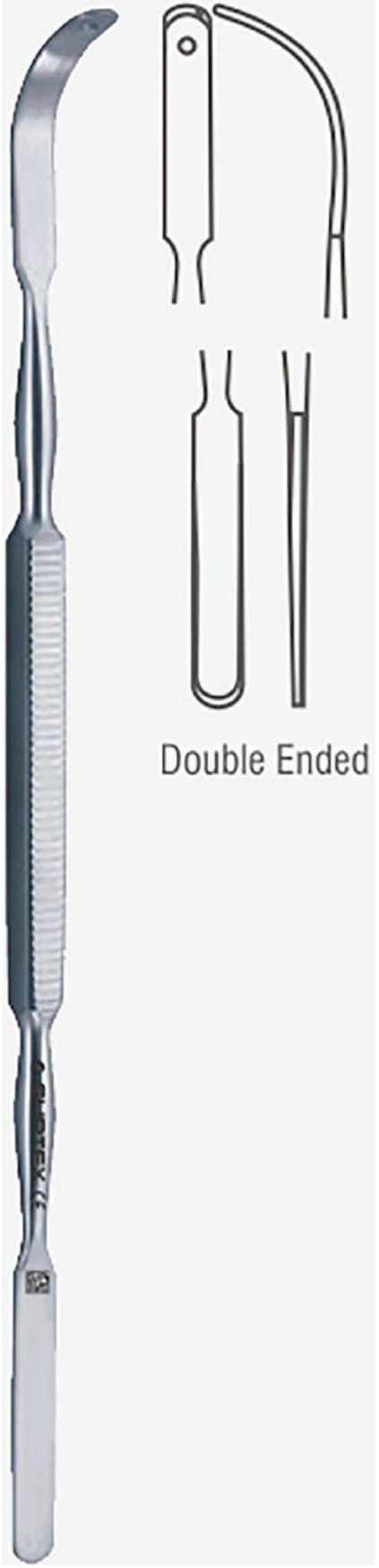

Fig. 3 The MacDonald dissector, perforated at one end for passing ligatures

Fig. 4 The Lahey dissecting forceps

tightened to a limited degree by further closing of the ratchet near the finger loops. They prove a useful instrument for intestinal work, but, as with all tissue-holding forceps, should be used with care, so as not to tear or avulse what they grip. (*Fig. 5*)

Professor Pierre Duval (1874–1941) was educated in Heidelberg and in Paris, serving as a demonstrator in anatomy to Louis Farabeuf (1841–1910, who had a rougine, retractor, and forceps named after him), a Parisian surgeon who introduced hygiene into medical education. Duval's expertise lay in studies of shock and burns, and also in gastrointestinal and genitourinary surgery. He served with distinction in WW1 and became Professor of the Faculty of Surgery in Paris.

Fig. 5 Duval's intestinal forceps

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Abdominal clamps

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A clamp may be defined as 'a brace, band, or clasp for strengthening or holding things together'. In this article, a few abdominal surgical clamps are described. Most of these instruments have a rack-and-catch mechanism for maintaining and varying pressure, ranging from the quadruple pivoted crushing action of the Payr non-racked intestinal clamp to the gentler occlusive intestinal clamps, which preserve the vascularity of the gut, but, if carefully positioned, enable a stable apposition for surgery.

Gastrointestinal and gynaecological clamps

Payr's crushing intestinal clamp, and Doyen's and Kocher's non-crushing gastrointestinal clamps

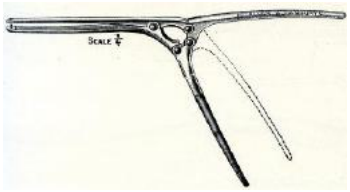
Resection and anastomosis of gut received an enormous acceleration and became routine in 1915, during the Great War. The procedure remains a fundamental technique in the surgical repertoire. When isolating and removing sections of bowel for tumour, inflammatory disorders, ischaemia, or trauma, the procedure will necessitate division of the diseased gut mesentery and control of the bowel contents, so that clean, well-vascularized bowel ends may be joined together.

Previously, and in some open surgical procedures today, an excision and anastomosis were and may still be carried out, as follows: the section of bowel to be removed is isolated by dividing its mesentery and its vasculature. Then, occlusive crushing clamps may be applied both to the preserved vascularized bowel ends and to the ends of portion of gut to be to be resected. A scalpel then cuts between each of the two sets of crushing clamps, so removing the required portion of bowel.

The edges of the retained crushing clamps are wiped with a 'peanut' pledget soaked in an antiseptic solution. Non-crushing occlusive clamps are then applied to the gut fairly close to the crushing clamps. This prevents spillage of small or large gut contents before or during the anastomosis. The crushing clamps are then gently removed and the crushed ends of bowel excised with scissors. The exposed clean-cut ends of well-vascularised gut are cleaned and the anastomosis is carried out using a single or double layer of sutures.

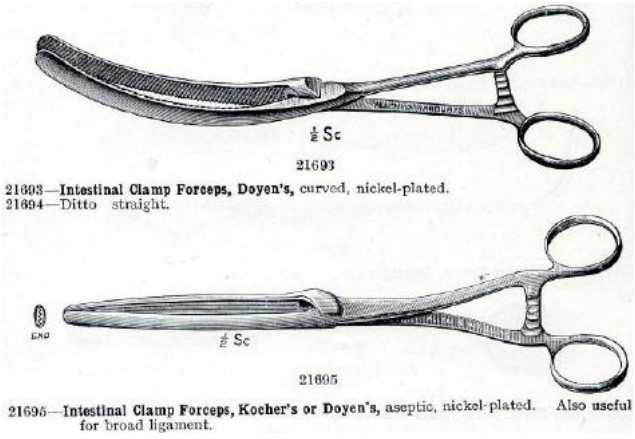
Nowadays, minimal-access techniques incorporate stapling devices for performing anastomoses in gastric, and small or large bowel surgery. Carefully performed, there remains little difference in outcome between mechanical or hand-sewn anastomosis, with the exception of the clear advantages of minimal-access procedures.

Payr's clamp is a complex tough crusher, which employs a double-action, four-pivoted closing mechanism, employing centric and inset pivot joints.



Erwin Payr (1871–1946) was an Austro-German surgeon, finally working at Leipzig. He researched the bactericidal properties of ozone, absorbable suture material, and thrombophlebitis. His original clamp was designed for closing the pylorus.

Doyen's and Kocher's straight or curved intestinal non-crushing clamps have a rack-and-catch mechanism, and consist of light springy steel blades that preserve bowel blood supply, while serving as occlusive instruments. These clamps thus prevent the leakage of bowel contents and assist with alignment of the gut for anastomosis. Care must be taken to close and maintain appropriate pressure in proportion to the texture of the gut. Some of the clamps illustrated, as below, have take-apart joints, for cleaning.



Eugène-Louis Doyen (1859–1916), was born in Reims and founded a private medical institute named after him. He researched electrocautery and worked in the fields of abdominal, cranial, and gynaecological surgery.

Emil Theodor Kocher (1841–1917) was a Swiss surgeon, a professor of surgery at Bern, who won a Nobel prize for his pioneering work on pathology and surgery of the thyroid. He

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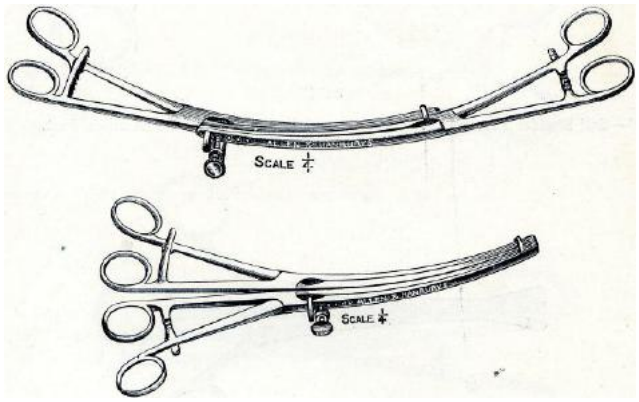
also worked in the fields of asepsis, neurosurgery, also thyroid and endocrine surgery. He had artery forceps, a thyroid enucleator, and an abdominal incision and intestinal clamp named after him; he also wrote a seminal surgery textbook. He devised a method of reducing dislocated shoulders.

Lane's twin-pattern curved clamps

These non-crushing clamps were originally designed for holding carefully positioned sections of aligned bowel, opposed for a side-to-side anastomosis, such as for fashioning a gastroenterostomy in cases of chronic or complicated duodenal ulcer. These two clamps could be aligned, as illustrated below, after a segment of gut had been positioned in each. Such an arrangement facilitated a hand-sewn anastomosis.



Arbuthnot Lane and his contributions were briefly described in a previous article in this series.

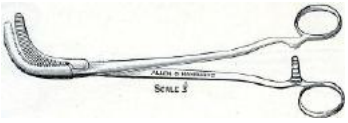
Moynihan's stomach clamp

With the discovery of *Helicobacter pylori* and the advent of minimal-access or minimal access-assisted surgery, open gastric surgery and the use of these clamps is now less common. Formerly, gastric surgery was as frequently performed as cholecystectomy is now, and such procedures as partial gastrectomy, gastroenterostomy, vagotomy and pyloroplasty, and variations of vagotomy were commonplace on operating lists. The illustrated gastric clamp was one of many designs used for occluding and controlling the stomach during excisional or anastomotic procedures, such a partial gastrectomy, performed for benign gastric or duodenal ulcer or cancer surgery. Today stapling instruments clamp, cut, and control in a seamless manner.

Berkeley, the 1st Lord Moynihan (1865–1936), born in the 'year of antisepsis' was the son of a holder of the Victoria Cross. He became professor of clinical surgery at Leeds University and worked in that city and in London. He became president of the English College, and was an early champion of blood transfusion and a noted abdominal surgeon. A founder of the Association of Surgeons of Great Britain and Ireland, his aphorism that a surgeon must have 'the heart of a lion, eyes of an eagle and the hands of a lady' still rings true today. He was the first chairman of the editorial committee of the *British Journal of Surgery* in 1913.

Wertheim's hysterectomy clamp forceps

During the radical removal of the uterus and its appendages for malignant disease this robust, right-angled crushing clamp was applied across the vault of the vagina, to control the ingress of organisms, prevent bleeding, and allow for over-sewing of the vault. He also created straight and curved forceps for occlusion of the uterine appendages.



Ernst Wertheim (1864–1920), an Austrian who became professor of gynaecological surgery at the University of Vienna and director of the world famous *Frauenklinic*. He developed a radical removal of the uterus and its appendages, the upper third of the vagina, and relevant pelvic lymph nodes. His follow-up of around 1300 cases undergoing this procedure was meticulous.

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Vascular forceps and clamps

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Intraoperative and postoperative bleeding and sepsis are two surgical complications that can threaten any surgical procedure. To combat haemorrhage, a couple of centuries ago, pressure (digital or tourniquet) and the use of a few crude tools such as primitive sprung artery forceps or a tenaculum (a sharp hook to transfix and ease out a prominent vessel) followed by ligature were often unsuccessful when complicated by sepsis or inadequate application. Haemostats, arterial forceps, clamps or peans (named after Jules-Emile Péan, 1830–1898, a Parisian surgeon) are pivoted instruments that allow a variable force to crush and control blood vessels. Although the technique of clamping a vessel before ligation may be attributed to Galen, it was Ambroise Paré (1510–1590), a brilliant French Renaissance

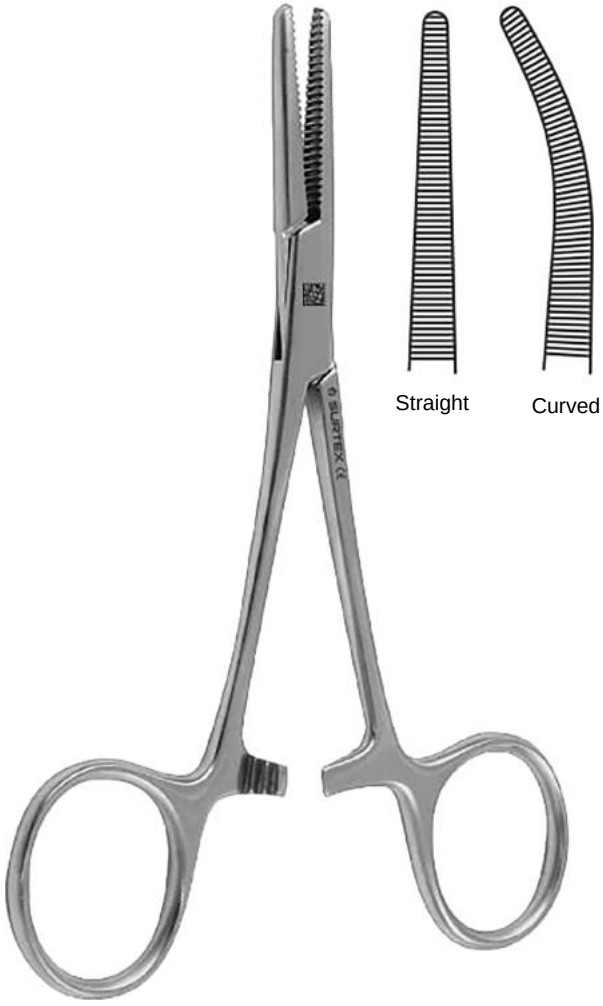

Fig. 1 Spencer Wells artery forceps

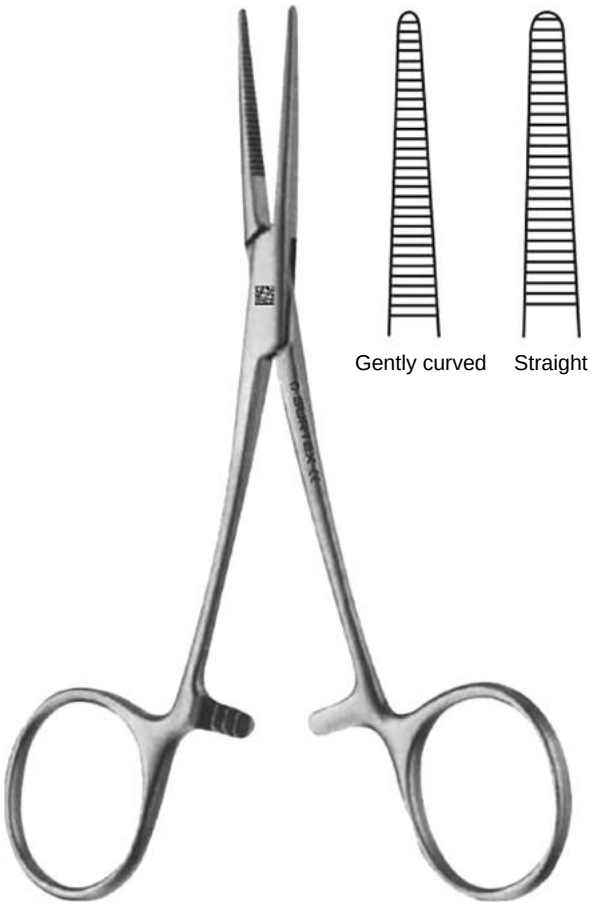

Fig. 2 Dunhill artery forceps

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Fig. 3 DeBakey atraumatic aortic clamp

Fig. 4 Satinski atraumatic tangential occlusion clamp

surgeon, who is generally credited with the technique, in addition to abandoning the use of the actual cautery (that is hot irons or boiling oil) for haemostasis.

As anaesthesia allowed calmer and more protracted operations, varied designs of dedicated artery forceps evolved, incorporating a catch and release mechanism situated below the finger bows. The tips of the forceps are serrated in one direction or another for improved grip. As time passed, finer artery forceps were produced. Following application of these instruments, single or double ligatures of silk, linen or catgut were applied before the instrument was released. As surgery became increasingly complex, larger vessels needed to be temporarily occluded or controlled, so a varied selection of lighter, springier, occlusive, non-crushing instruments evolved. This permitted safer cardiac, vascular, and reconstructive surgery, and appropriate control of bleeding. With the advent of free tissue grafts and microanastomoses, very fine atraumatic clips are used. With all such instruments, care is required in accurate application, timely controlled release. and also to pick up and grasp the correct amount of tissue.

Artery forceps

The Spencer Wells artery forceps (*Fig. 1*) must feature as one instrument with a notable reputation. Introduced in 1879, it was one of the first dedicated hinged robust artery clips that appeared on the surgical scene. When compressed, its ridged tips can exert a force of 40 N/m². Many designs and sizes of similar forceps have emerged, adapting to varying specialty needs. Clipping the delicate vessels during a thyroidectomy or paediatric procedures will require a finer haemostat (*Fig. 2*) than clamping more substantial vascular pedicles, such as during hysterectomy or bowel resection. An instrument used in the latter might incorporate an interlocking tooth at its distal point for added security.

Sir Thomas Spencer Wells (1818–1897) was surgeon to Queen Victoria. He studied in Leeds, Dublin, Paris, and at St Thomas' Hospital. After serving in the Royal Navy in Malta, he worked in London and became President of the English College. He specialized in ophthalmic, obstetric, and abdominal surgery.

Sir Thomas Dunhill (1876–1957) was an Australian surgeon who worked through the Great War and pioneered surgery for various forms and severity of thyroid goitre, often under local anaesthesia. Thrice appointed a royal surgeon, he repaired Sir Winston Churchill's hernia.

Vascular clamps

There is a selection of vascular clamps for application to larger vessels (*Figs. 3* and *4*). These are usually atraumatic springy

Fig. 5 De Bakey atraumatic bulldog clamp

Fig. 6 Acland double-vessel microvascular clamp

steel instruments that allow surgery on, and control of, major vessels requiring anastomosis or tissue resection, for example during hepatic operations. These larger clamps are reasonably

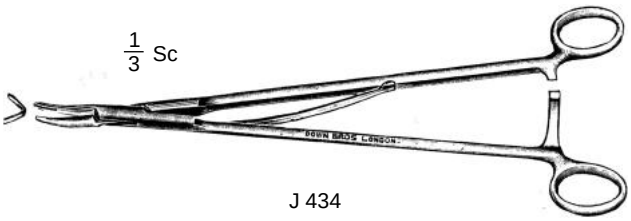

Fig. 7 Cushing silver clips and applicator

Courtesy Royal College of Surgeons of England.

atraumatic, allowed for by the finer structure of the instrument, more gentle closing force, and a varied design of the serrations at the tip of the instrument. Such procedures in which these clamps are used might be portocaval anastomosis, or aortic and cardiac surgery. When applying these large clamps in the depth of a wound, care has to be taken not to injure accompanying veins. Useful tools for application after venous injury or for an end-to-side anastomosis on large vessels are the varieties of the Satinski clamp. Here the gentle U-shaped atraumatic tips can be applied on the long axis of the vessel, allowing some continued blood flow during a repair or anastomosis.

Michael DeBakey (1908–2008) was a Lebanese–American cardiovascular surgeon trained in America, France and Germany, and who served in the Second and Korean Wars. He pioneered major vascular surgery, initially making his own Dacron aortic grafts. He performed the first carotid endarterectomy, and was an early champion of coronary artery bypass surgery, and also many other vascular procedures.

Victor Satinski (1912–1997) was also an American cardiac surgeon, who made early progress with coronary artery bypass surgery

Smaller and microanastomotic vascular clips

These are examples of progressively smaller non-crushing vascular clamps used to control bleeding from smaller vessels (*Figs* 5 and 6). The 'bulldog' clip is a well known design, comprising a small sprung cross-over clamp, easily applied and removed by digital pressure.

With use of free full-thickness transfer tissue grafts requiring a new blood supply, microvascular anastomoses are essential. The Acland double-vessel microvascular apparatus allows stable gentle compression and apposition of two ends of very small vessels, and the double clamp is steadied on a bar common to both clamps.

Robert Acland (1941–2016) was a pioneer of microvascular and plastic surgery, who left the National Health Service in Scotland to work in the USA. He developed his microvascular clamp as well as employing 10/0 nylon sutures and appropriate needles. He wrote a practical guide to microvascular surgery and an innovative video atlas of human anatomy.

Cushing silver clips

Of interest in the early days of neurosurgery, Harvey Cushing's silver wire clips (*Fig.* 7) were used to gently crush and control bleeding from fragile cerebral vessels. Simply made from cutting V-shaped sections of silver wire, these were gently positioned and tightened with an applicator to the vessel.

Harvey Cushing (1869–1939) was an American surgeon famed for developing neurosurgical techniques. He was a meticulous slow surgeon, who pioneered treatment of head injuries in World War I. He championed the use of local anaesthesia and diathermy, and described Cushing's syndrome. There are tissue forceps and a ventricular cannula named after him.

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Surgical scissors

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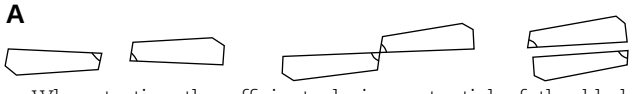
The word 'scissors' derives from twelfth- (*ciseaux*) and thirteenth-century (*cisoires*) French. Scissors probably originated around 1000 AD. A pair of rusted scissors, dating from around the early thirteenth century, was unearthed under a fallen stone of the Avebury circle. The first definitive European image of surgical scissors appears to be that found in Hieronymus Brunschwig's surgical work printed in 1497.

Surgical operations involving dissection, resection, reconstruction, and anastomoses are all procedures that require separation, apposition, incision, suturing (or stapling), and grafting of tissues. Aside from blades, which are crucial to work on the surface, head, neck, limb and body cavity surgery, recquire scissors to trim or cut skin, muscle, fascia, vascular pedicles, adhesions, scar tissue, and also hair, sutures, and dressings in a way that is distinct from knife blades.

Scissor blades do not cut as with two sharp knife blades closing together. Scissors normally have two equal-length bladed arms, each with a proximal finger bow. They are pivoted and are worked by approximating finger bows, so closing the instrument. The blades override to cut the desired structures. Each limb of the pair of scissors moves, rotating on a screw to provide an axis of rotation with the second limb. The blades are carefully set to bend slightly toward each other, to ensure maximum shear force as necessary. The obtuse-angled (of about 60–70 degrees), non-sharp edges close and cut by a tight grinding action as the edges pass over each other. This means that the proximal part of the blades, beyond the pivot joint, will be slightly apart when the scissors are closed.

Scissor blades open and close, cutting with a shearing compressing action and the gap between the proximal part of the blades in a closed position indicates efficient scission (Courtesy John Kirkup).

A



When testing the efficient closing potential of the blades, skilled manufacturers can estimate the quality of cut by listening to the slight noise when the blades are approximated.

The work performed by scissors is usually done with the distal parts of the blades. Most scissors that dissect have gentle blunted ends, to avoid damage by pointed tips. In addition to cutting, the blades can separate and open to spread tissues gently. Various scissor designs have emerged since the late eighteenth century, requested by specialist surgeons of their instrument makers. While most pairs are made for right-handed surgeons, operators often learn to become ambidextrous.

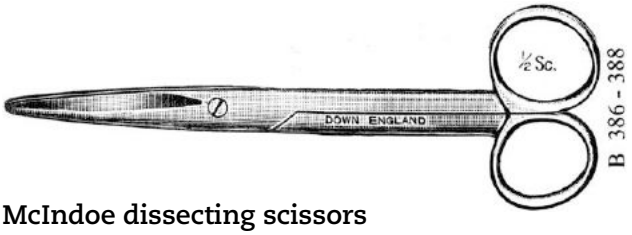
Some pairs have very specific functions such as for dividing the umbilical cord, tonsillar resection, and also cutting bandages and sutures, and thus may vary from a standard structure.

Mayo's straight scissors

Mayo's straight scissors are an example of general-purpose scissors. The shanks close completely against each other. They can be used for cutting any tissues, sutures, bandages, or trimming ragged wounds. They have chamfered or 'dished' blades. These would not be employed in most surgical procedures, being of most use 'outside' the patient.

Mayo's straight scissors (Courtesy of the Royal College of Surgeons of England)

William and Charles Mayo were a legendary pair of brothers who founded the Mayo Clinic in Rochester, Minnesota, a not-for-profit academic teaching medical centre, now with three large campuses in the USA. Aside from the scissors, the Mayo name is attached to forceps, needles, a vein varicose vein stripper, and retractors.



McIndoe dissecting scissors

These elegant and light scissors have a curved on flat design with rounded 7½-inch tapering blades. They are used for many purposes and are excellent for dissection work in the abdomen, thorax, and neck. The distal curvatures of the blades allow appropriate angulation. They permit gentle incision, taking small bites and can be opened to define tissue planes. Similarly designed scissors in frequent use are the slightly shorter Metzenbaum pattern scissors.

McIndoe's scissors (Courtesy of the Royal College of Surgeons of England)

A brief synopsis of Sir Archibald McIndoe has been given in part 4 of *The Instrumentalist*.

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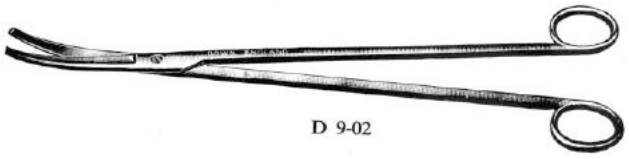
Lloyd Davies rectal scissors

These longer scissors, with 10½-inch rather squared blunted blades, are designed for work deep in the pelvis during open surgery. The curved-on-flat design allows clear vision of the tips when work is carried out at the sides of the pelvis and with the sharp dissection that follows the natural curves of pelvic organs. Needless to say, working at a depth requires clear vision to prevent any 'blind' incision!

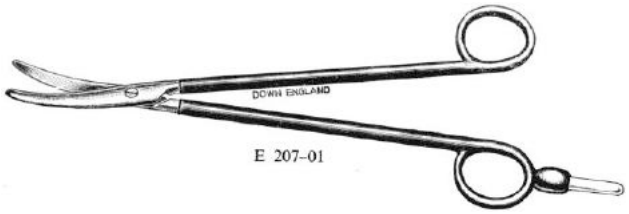


Lloyd Davies rectal scissors (Courtesy of the Royal College of Surgeons of England)

Oswald Lloyd-Davies was a colorectal surgeon who worked at St Mark's and later at the Middlesex Hospital. He developed the synchronous combined abdominoperineal excision of the rectum for carcinoma and was one of the first to excise liver metastases. He has a forceps, a sigmoidoscope, and a patient position on the operating table attributed to him.

Turner Warwick diathermy scissors

These 7-inch-long curved-on-flat scissors permit electrocauterization to be used as delicate dissection is carried out at the tips. The finger bows and shafts are insulated to a point just above the pivot joint. These scissors were used to dissect in the pelvis and along the lower urinary tract for the purpose of reconstruction of urethral strictures. The diathermy sealed a myriad of small vessels that, when cut, would hinder view in a limited space. Care would have to be taken not to inflict burns on adjacent tissues with the more proximal uninsulated portion of the blades.



Turner Warwick diathermy scissors (Courtesy of the Royal College of Surgeons of England)

Richard Turner Warwick was a urologist who gained many degrees and awards, and who worked at the Institute of Urology and the Middlesex Hospital. He specialised in thyroid and urological surgery, including reconstructive surgery for strictures and urodynamics.

Castroviejo's corneal scissors

These delicate, spring-activated scissors close by gentle digital pressure on the curved serrated shanks. In cataract surgery the eye is initially entered using a small incision made by a keratome (an angle-bladed ophthalmic knife). The resulting escape of aqueous humour softens the globe and extension of the small wound allowing delivery of the lens is easier using scissors. If they are held vertically, a clear view of the length of the curvilinear blades is possible. Both right and left pointed scissors are required.

Castroviejo's corneal scissors (Courtesy of the Royal College of Surgeons of England)

Ramón Castroviejo was a Spanish surgeon, qualifying in Madrid in 1927. He then emigrated to the United States, working in Chicago, the Mayo Clinic, and then in New York. He improved the technique of corneal transplantation and keratoplasty. He also had a needle holder named after him.

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Self-retaining surgical retractors

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The clear advantage of this group of retractors is that it obviates the need for a hand-held instrument and gives a stable clear view of the operative field. These retractors are invaluable for surgeons working in remote areas or in areas of high surgical turnover in war zones, for example, where assistance may be difficult to find. There is a range of these instruments both in size and function. These retractors can exert considerable pressure on tissues, and so the surgeon has to be careful not to unwittingly trap or damage vulnerable structures in the blades or claws. With the larger and more forceful self-retaining retractors (SRRs), care is required not to crush the retracted edges. The two principal types of SRR are those employed in body cavity surgery, and the smaller instruments, which are mainly used in orthopaedic, spinal or more superficial operations.

Balfour abdominal self-retaining retractor

There are around six other varieties of this useful SRR, but the Balfour model (*Fig. 1*) is fairly well known. Basically, it is a three-bladed instrument which can be aligned in two directions. The two bars are fixed and permanently joined to one of the side blades. One bar stabilizing the structure has a hinged strut at its free end, which allows removal of one side blade, and a clamp, which fixes the middle curved solid blade in the desired position. This take-apart facility is useful for cleaning the instrument. The central wider curved blade allows both retraction and spreading at one extreme of a linear incision. The closed instrument is placed gently in the incision and the three blades carefully opened, positioned appropriately, and the screw is then tightened to fix the central blade. To prevent any pressure damage on skin, fat, and muscle, dry or damp surgical swabs can be placed between the SRR and the incised abdominal wall. The instrument has a trivalve 7-inch opening, 2.5-inch deep lateral blades and 1.75-inch centre blade.

Donald Church Balfour (1882–1963) was a well qualified Canadian surgeon who specialized in gastrointestinal work. Recommended to the Mayo brothers in Rochester, he not only became Director of the Division of General Surgery at the Mayo Clinic, but married William Mayo's daughter. He designed operating tables and stents for colonic anastomosis. A prolific writer and educator, he directed the Mayo Foundation for Education and Research. His department trained around 1500 medical officers for the World War II. Awarded many honours, he survived tuberculosis and died from a myocardial infarct.

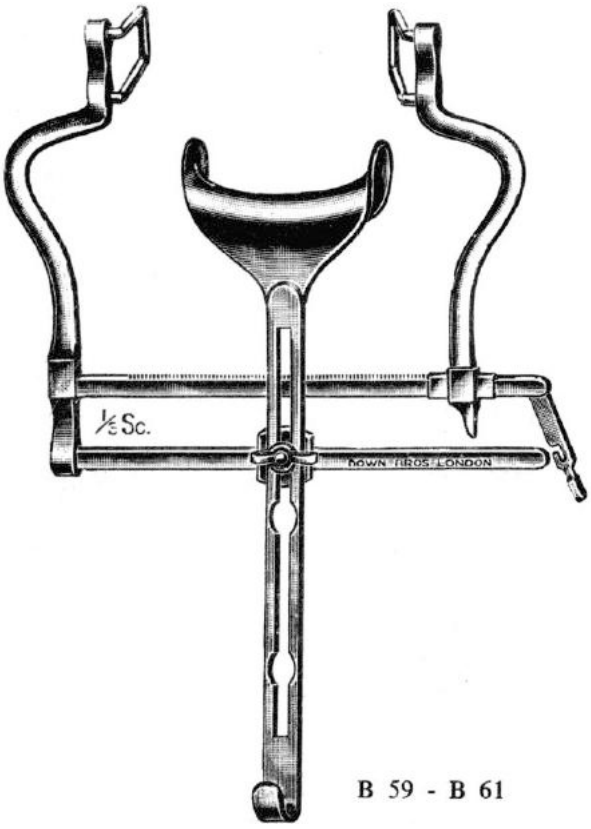

Fig. 1 Balfour abdominal self-retaining retractor
Courtesy of the Royal College of Surgeons of England.

Denis Browne self-retaining retractor

The Denis Browne ring retractor (*Fig. 2*) stands out because of its simplicity and effectiveness in securely holding the edges of incisions by pulling in four directions. It was developed by the addition of new sizes of ring and a variety of blade shapes. Its wide adoption by many surgeons outside the paediatric field reflects the genius of its inventor. The blades are attached by hooks to the serrated edge of the steel ring, allowing varied strength of pull and position.

Sir Denis John Wolko Browne is widely known as the 'Father of Paediatric Surgery' in Britain for good reason. Although not the first full-time paediatric surgeon in the country, he was among a

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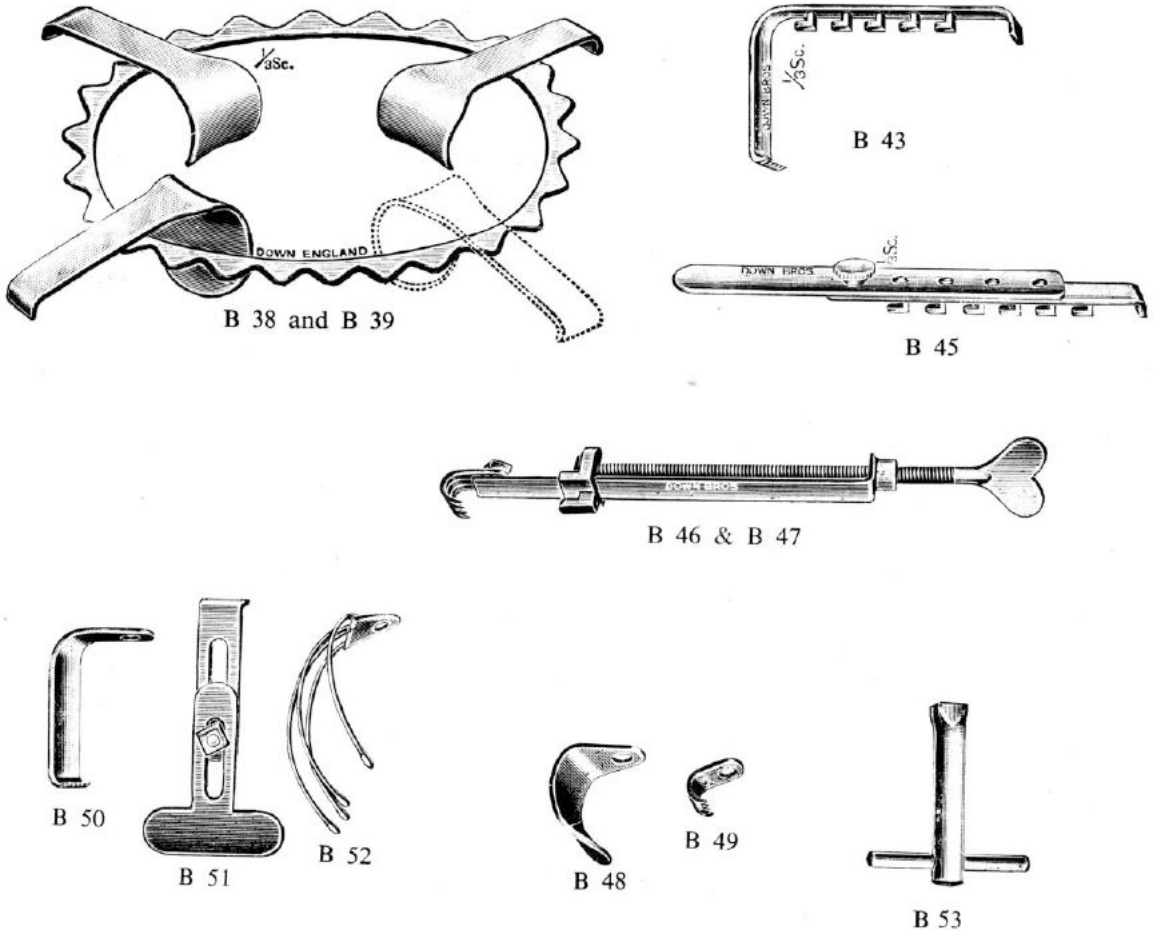

Fig. 2 Denis Browne self-retaining retractor
Courtesy of the Royal College of Surgeons of England.

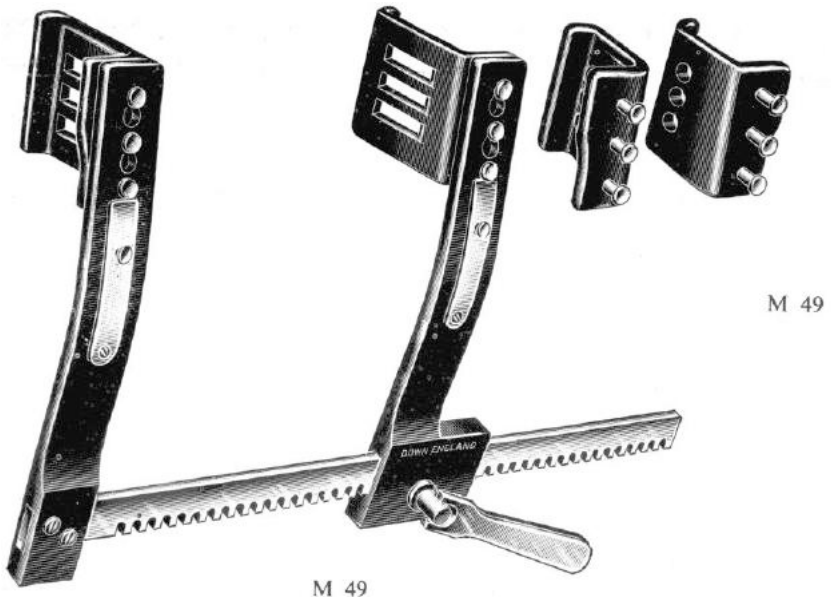

Fig. 3 Burford–Finochietto's thoracic self-retaining retractor
Courtesy of the Royal College of Surgeons of England.

Fig. 4 Travers self-retaining retractor
Courtesy of the Royal College of Surgeons of England.

small group of surgeons who dedicated themselves to the specialty, which evolved in the National Health Service from 1948. As consultant surgeon at the Hospital for Sick Children (Great Ormond Street), he led the creation of the British Association of Paediatric Surgeons in 1953. He designed many different surgical procedures and instruments, many of which have been superseded.

Burford–Finochietto's thoracic self-retaining retractor

This is a robust ratchet-operated rib spreader with changeable blades (*Fig. 3*). It is opened by gradually turning the handle attached to the base of one of the blades. It may break ribs and, sometimes, proactive rib division with rib shears will allow improved access, with less trauma. It is employed in sternotomy or lateral chest incisions.

Thomas Burford (1907–1977) was born in Missouri and pioneered thoracic surgery in World War II, championing the practice of decortication. After the war he worked as Director of the Division of Thoracic and Cardiovascular Surgery in Washington, where he took an interest in coarctation of the aorta and oesophageal caustic strictures.

Enrique Finochietto (1881–1948) was an Argentinian surgeon who trained in Europe, to where he returned to help in the Great War. He later became chief surgeon at the Rawson Hospital in Buenos Aires and Professor of Surgery in that city. He developed 67 surgical items and instruments. An avid fan of the tango, he contracted syphilis during travels abroad, which may have hastened his premature demise.

Travers self-retaining retractor

This 8-inch long retractor (*Fig. 4*) proves useful particularly in minor orthopaedic and superficial general surgical procedures. It opens on a ratchet, controlled by the finger bows, and has turned-back claw blades that securely grip the retracted structures. The spreading of the retractor arms is released by lifting a lever on the ratchet mechanism.

There were two well known, yet unrelated, surgeons named Travers. Benjamin Travers was one of the early ophthalmic surgeons, and William Travers (1838–1906) was an obstetrician

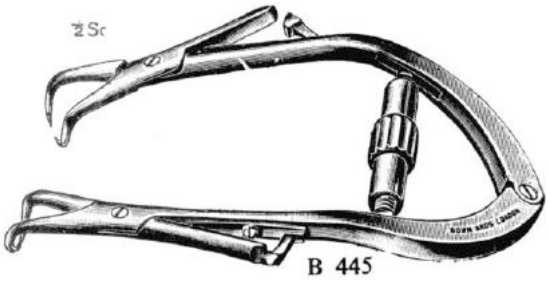

Fig. 5 Joll's thyroid retractor with locking nut
Courtesy of the Royal College of Surgeons of England.

and gynaecologist. He worked at the Chelsea Hospital for Women and in private practice. William was a founder the British Gynaecological Society. This retractor is named after him.

Joll's thyroid self-retaining retractor

This well designed specialized retractor (*Fig. 5*) is most commonly used in open thyroid surgery. Following a transverse neck incision for thyroidectomy, upper and lower skin flaps are fashioned. The instrument with its two arms—one upper, the other lower, with ratchet-controlled sharp clips at each end—is placed ready across the neck. The sharp clip ends are closed, piercing the middle of each edge of the two flaps. The retractor arms are then spread by turning the grooved central screw mechanism, which can be locked. This manoeuvring gives an adequate diamond-shaped access wound to the strap muscles above the thyroid.

Cecil Augustus Joll (1885–1945) was born in Bristol and studied medicine at Bristol, University College Hospital London, the London Hospital, and in Paris. In 1931, after training in Leicester and Birmingham, he became senior surgeon at the Royal Free Hospital. He garnered a considerable number of consulting surgeoncies at other London and suburban hospitals, and had a large private practice. He worked in Paris and other hospitals in the Great War and in the World War II, he slept in the Royal Free every other night during heavy bombing raids. He took a particular interest in thyroid and gastric surgery.

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Hand-held surgical retractors

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The word retractor is derived from the Latin '*re*' (back) and '*trahere*' to (draw). Given adequate surgical skills, a critical adjunct to any surgical procedure is a clear view of the operating field. Today, many operations are performed by minimal access surgery, which affords clear, well-illuminated views of the working environment, and often an improved exposure compared with open surgery. For all to be optimal, open and minimal-access surgery require organs and other structures to be kept out of the way, not only to provide good vision and a clear operating field, but also to avoid injury to adjacent structures. There is a large range of both hand-held and self-retaining retractors to achieve these objectives. This short account will deal with the hand-held variety.

Retractors are varied in their size and uses, and—as with so many other instruments—they frequently bear the name of the surgeon who designed and preferred them. Hand-held varieties have to incorporate a comfortable handle and the retracting blade angled to the handle according to required function. Handles are often hollowed for lightness. These instruments are usually made of stainless steel and the blades may be dulled to prevent reflected glare. Some retractors have a lip on the blade to prevent the blade slipping out, for example, when retracting the parietes (or when an assistant is inattentive or falls asleep!).

Assistance is given to the surgeon by the person operating the retractor, who must always adjust the instrument to give the operator the best view possible, particularly with limited access. Care is to be taken by the assistant while when retracting, so as not to damage structures such as gut or liver when pulling back or angulating the instrument. Likewise, in minimal-access surgery, the position of the retractor should be carefully placed and checked, especially as it is often out of sight.

The Morris retractor

A basically practical and robustly useful instrument for holding back tissues, for example the incised anterior abdominal wall or flank musculature during open intestinal, renal, and thoracoabdominal surgery. It proves useful when the tough subcostal region has to be retracted. There is a fenestrated handle with serrations for improved grip and an outwardly concave blade with a lip for secure hold (*Fig. 1*).

Sir Henry Morris (1844–1926), educated at University College London and Guy's Hospital, subsequently became a surgeon and anatomist at the Middlesex Hospital, and a medical politician. In 1880 he performed the first recorded case of open nephrolithotomy and was the author of a number of books on genitourinary surgery. He was surgeon in charge of the cancer wards at the Middlesex.

The Deaver retractor

This deep curved retractor was designed for abdominal and pelvic work, being able—sometimes padded with gauze swabs—to hold back large organs. Perhaps not the most comfortable retractor to hold, assistants had to be cautious not to damage tissues in the depth of the abdominal or pelvic cavities with the tip of the long, curved back blade, which might be out of vision (*Fig. 2*).

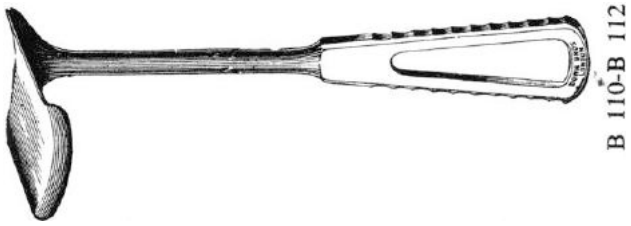

Fig. 1 The Morris retractor
(Courtesy the royal college of surgeons of England.)

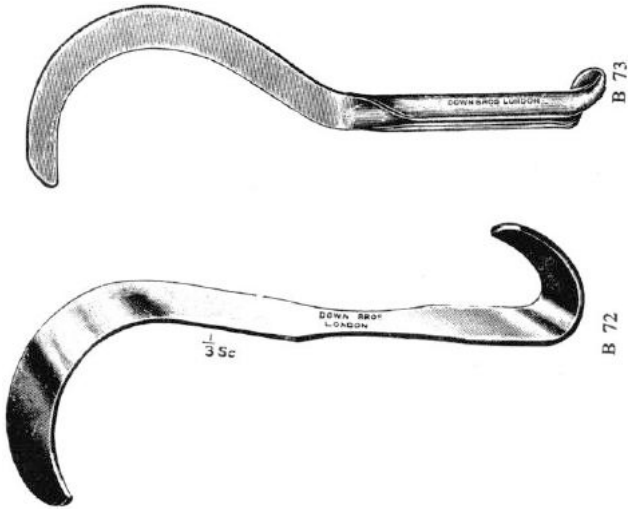

Fig. 2 The Deaver retractor
(Courtesy the royal college of surgeons of England.)

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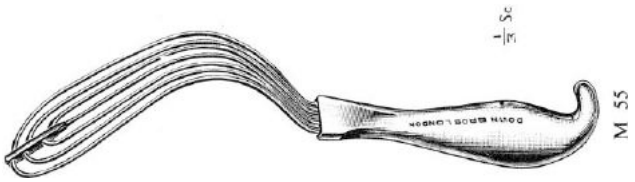

Fig. 3 The Allison lung retractor
(Courtesy the royal college of surgeons of England.)

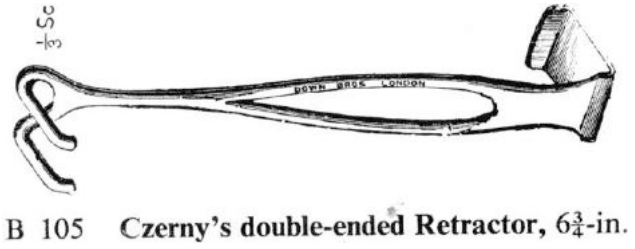

Fig. 4 The Czerny double-ended retractor
(Courtesy the royal college of surgeons of England.)

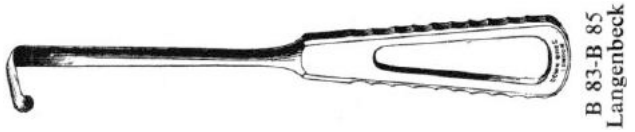

Fig. 5 The Langenbeck retractor
(Courtesy the royal college of surgeons of England.)

John Blair Deaver (1855–1931) was an American surgeon who became senior surgeon at the German Hospital in Philadelphia, now the Lankenau Medical Centre. He was primarily an abdominal surgeon and was, unusually for the time, an early advocate of appendicectomy. By repute he was a very radical surgeon and prodigious worker, being given—perhaps unkindly—the sobriquet of the 'Great Slasher', leading to a phrase, 'death by Deaver'! He authored five textbooks and many articles. He was said to have been the originator of the saying, 'cut well; get well; stay well'.

The Allison lung retractor

This well-designed retractor was primarily used to keep the lungs out of the operative field of dissection. It was angled to keep the assistant's hand out of the way and to provide a gentle spreading force on the lung parenchyma. It could also be employed in holding back other bulky tissues or organs, such as the liver (*Fig. 3*).

Professor Philip Allison (1907–74) was a well-qualified Yorkshire man who served for 5 years as a consultant general surgeon at the Leeds General Infirmary. He then switched to specialize in thoracic surgery. During World War Two he created a regional mobile chest surgical unit. After serving as professor of surgery at Leeds, he moved to Oxford to take the Nuffield Chair of Surgery. His prime interest was surgery of the oesophagus.

The Czerny double-ended retractor

This small hand-held instrument was used to retract tissues during surgery performed on the surface of the body. It is used to retract skin, fat, and muscle during hernia, breast, axillary surgery, or orthopaedic operations, for example. Lightly constructed, it lifts or pulls back tissues using either the double-hook or bladed end (*Fig. 4*).

Vincenz Czerny (1842–1916) was a German Bohemian surgeon who specialized in oncological and gynaecological surgery. Studying at Prague and Vienna, he served under Billroth, and later took the chair of surgery at Heidelberg. He became a cancer surgeon, and carried out the first partial nephrectomy for renal carcinoma, and, apparently, the first vaginal hysterectomy.

The Langenbeck retractor

This popular instrument works in a similar way to the Czerny retractor, but it has a narrower blade for working in a limited space (*Fig. 5*).

There has been some confusion over which of the Langenbeck family gave their name to this retractor. It was Bernard Konrad von Langenbeck (1810–1887) rather than his uncle Conrad Johann (1776–1851). Both these men were educated at Göttingen. Bernard became the professor of surgery at Kiel and, later, director of surgery at the Charité in Berlin, where, importantly, he evolved the surgical residency system. Two of his notable pupils were Billroth and Kocher. He served in no fewer than four wars.

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Needle holders

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In previous centuries, surgical needles were hand held. Suturing was inevitably crude and hand-threaded needles were used to close wounds using silk, linen or, later, catgut stitches. Hand-held needles were curved or straight, as discussed in the next article. In Victorian times and into the mid-20th century, many surgeons performed wound closure, suture transfixion, tissue repair, and anastomoses with skills, employing hand-held needles. A few earlier needle holders were designed to grip straight or J-shaped needles end on, so as to push the needle points into tissues by a forward movement.

However, with finer work in the evolving craft, requiring more accurate placement of sutures, instruments grasping a needle at right angles to the shafts of the holders became the preferred way of controlling smaller curved needles. Straight needles remain mainly hand-wielded and are pushed or dragged through the tissues. The correct positioning of the modern curved needle in the jaws of the holder should ideally be at two-thirds of the distance from the point of the needle. This is to allow adequate penetration by the needle and to prevent its buckling if placed too close to the non-working end. Care is always needed when mounting or dismounting the needle to avoid stick injuries.

Many designs of long and short needle holder exist and, as is the way, almost all were named after the surgeon who invented them. The two basic designs of more recent patterns have been with either plain or finger-bowed handles. Most, but not all, needle holders have rack-and-catch mechanisms to secure a varied, sound, and steady grip on the needle. Jaw surfaces are scored with parallel or cross serrations to bite the needle. Jaw inlays of softer or harder metals have been employed to allow either some adaptive distortion for the needle or a harder grip on the needle respectively.

Rack-and-catch or ratchet mechanisms on modern needle holders have just one to three catches. In comparison, visceral clamps or a vulsellum (long forceps, mainly used in gynaecological procedures to grasp slippery tissues for traction or torsion) might have up to 10 catches, allowing a varied and more gentle hold.

Kilner's and Glendining's needle holders

Both of these short holders exert a firm grip on the needle, by virtue of the rack-and-catch mechanism situated just beyond the finger bows, and also the short jaws, whose working surfaces are cross-serrated to minimize slippage. The curved shank in the Kilner design permits a different rotational arc compared with the straight-shanked model (*Fig. 1*).

Thomas Pomfret Kilner (1890–1964) was born and trained in Manchester. He became one of the principal founders of plastic surgery, and worked with Sir Harold Gillies at the end of, and after the Great War. Gillies and Kilner were the only two plastic surgeons in Britain, until they were joined later by Rainsford Mowlem and Sir Archibald McIndoe. In World War II, Kilner worked at Roehampton (later Stoke Mandeville).

Interestingly there were two surgeons, possibly siblings, named Glendinning, but one, Bryden (1880–1927), appears to have two n's in his surname. The other's name was Vincent (1888–1964). Both were from Dunedin, New Zealand, and both qualified at Guy's Hospital, worked for Sir Arbuthnot Lane, and served in the Great War. Bryden became a prominent gynaecologist, specializing in cancer therapy, working in London, and Vincent worked in Watford. It is likely Bryden that had this needle holder named after him.

Osmond-Clarke's self-releasing needle holder

This holder has an obvious differently operated rack-and-catch mechanism compared with the previous two holders. The two arms of the holder are kept sprung apart and gentle pressure is applied to click the arms together with one to three steps in the end ratchet. Here, instead of adjusting individual finger bows to disengage the grip on the needle, the palm and fingers of the surgeon's hand press the arms to release the grip on the needle. The fenestrated jaws possibly allow alternative needle placements (*Fig. 2*).

Henry Osmond-Clarke (1905–1986) was born and educated in Northern Ireland. He undertook postgraduate studies in Manchester, London, Vienna, and Boston, and was appointed consultant orthopaedic surgeon to the Crumpsall, Biddulph Grange, and also the Robert Jones and Agnes Hunt (Oswestry) Hospitals. After serving with the RAF during World War II, he moved south where he took up various posts. He received royal appointments and was elected vice president of the English College.

Gillies' combined suture scissors and needle holder

This instrument differs from many in that there is no rack-and-catch mechanism, and continued manual pressure is required to keep gripping the needle. Another unusual feature of

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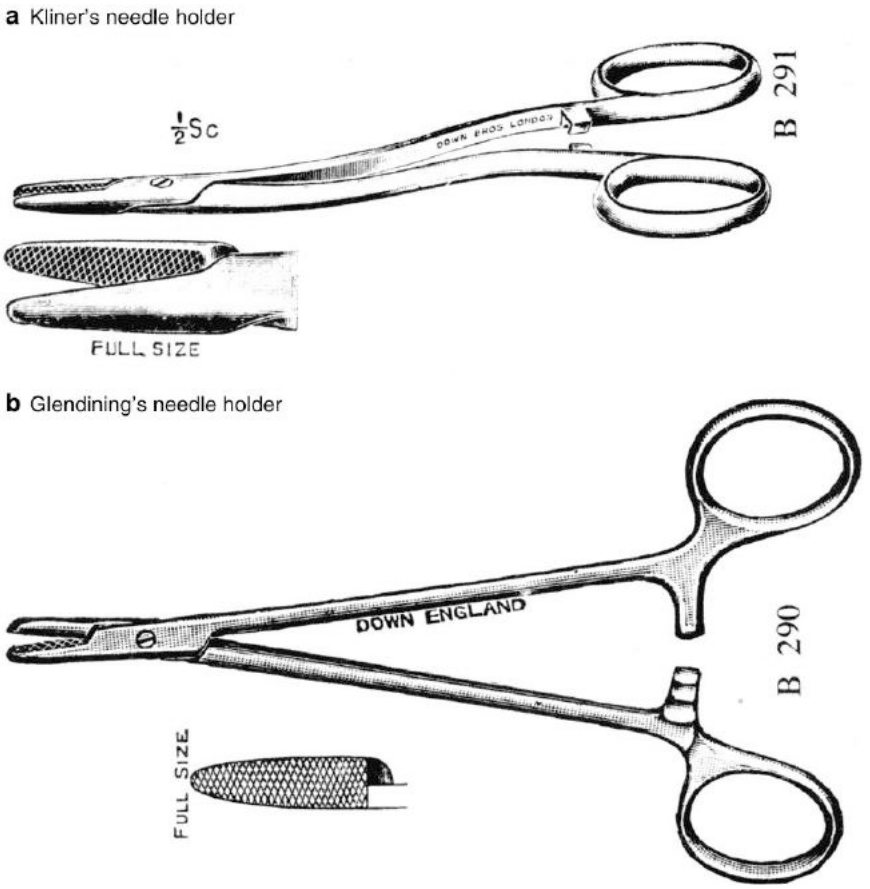

Fig. 1 Kilner's and Glendining's needle holders
a Kilner's and **b** Glendining's. Courtesy of the Royal College of Surgeons of England.

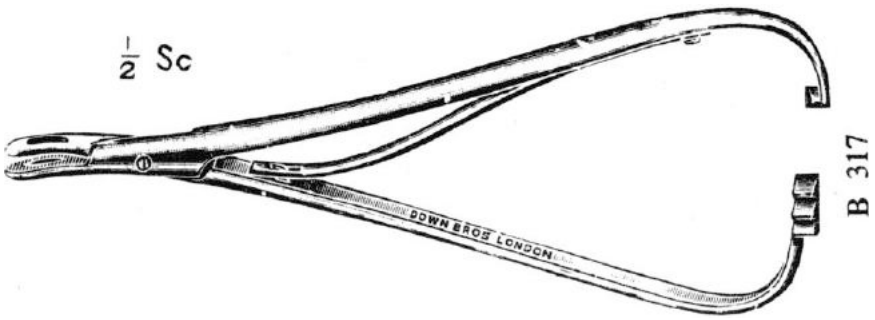

Fig. 2 Osmond-Clarke's self-releasing needle holder
Courtesy of the Royal College of Surgeons of England.

the instrument is the more distal placement of the thumb finger bow. Just proximal to the fenestrated and serrated jaws is a pair of scissor blades to permit suture cutting, so avoiding a change of instrument (*Fig. 3*).

Sir Harold Delft Gillies (1882–1960), a notable sportsman, was born in Dunedin, New Zealand, and studied medicine at Cambridge. During World War I, after observing some French facial and jaw surgeons at work, he persuaded the army to let him set up a plastic surgical unit at Aldershot. Deluged with terrible facial and neck wounds, he eventually created a dedicated surgical facility at the Queen's Hospital Sidcup. Here, several teams of British and Commonwealth surgeons and artisans worked together. Alongside Kilner, Mowlem and McIndoe, the latter Gillies' cousin, who joined him in 1930, he co-founded British plastic surgery. After the World War II, he pioneered sex reassignment surgery.

Denis Browne's needle holder

This unusual needle holder, with an extended and angled handle, enables the operator to depress the vertical catch-and-release system to close the tips using the thumb to depress the upper arm. The surgeon's right forefinger releases the grip by pulling the bottom end of the ratchet towards him or her (*Fig. 4*). Sir Denis Browne's contributions to surgery were briefly discussed in this series.

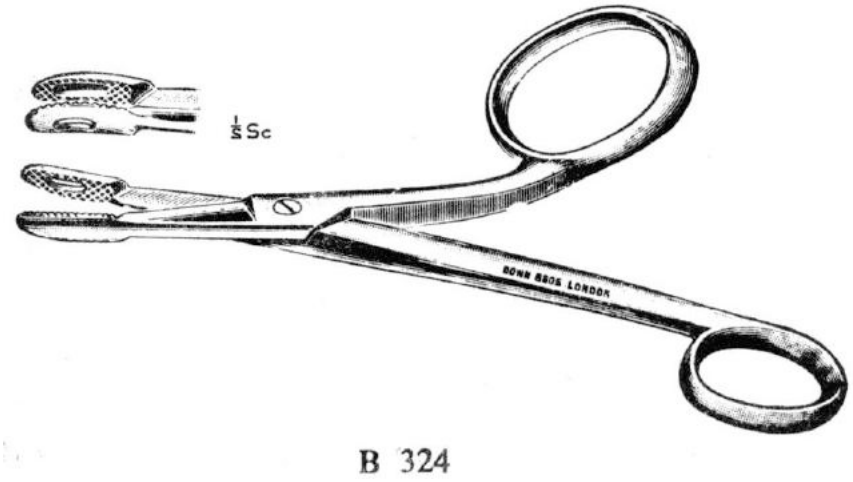

Fig. 3 Gillies' suture scissors and needle holder combined, 6 inch
Courtesy of the Royal College of Surgeons of England.

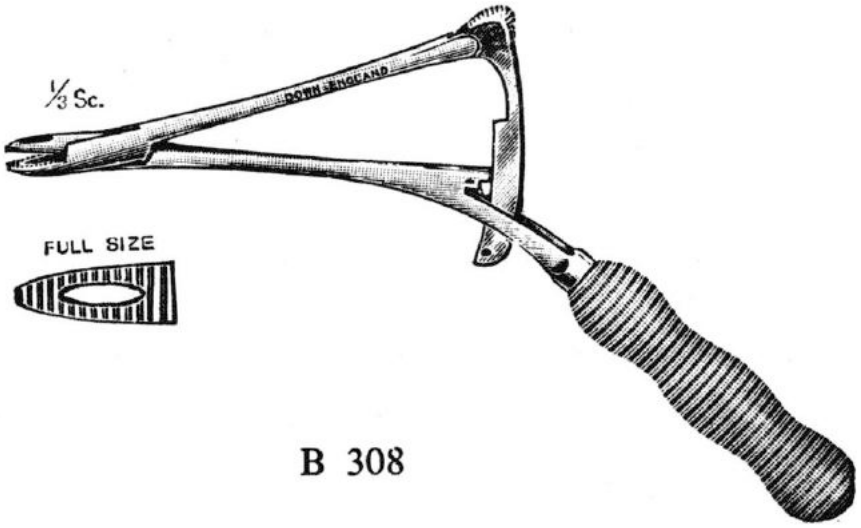

Fig. 4 Denis Browne's needle holder
Courtesy of the Royal College of Surgeons of England.

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Surgical suture needles

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> Have a needle thre cornered…and the lippis of the wound schal be sowid togideris
>
> Lanfranc of Milan (1250–1315)

The original date of the first needle-and-thread insertion for wound closure is uncertain. Ancient terminology referred to the *sutura cruenta*, or the 'bloody' or 'true' suture. Organic needles preceded those made of metal. Bronze needles for stitching bandages into position were employed by the Romans and the Sushruta Indian texts of 800 BC are said to have described iron triangular and pointed needles. Creating an eye in needles made of any early organic or inorganic material always proved challenging and some proximal needle ends had notches, spring, or slot eyes rather than the usual complete standard excavated eyes (*Fig. 1*) Onwards of the sixteenth century, the eye for threading sutures was sometimes placed near to the point of a (broader) needle, mounted on a handle. As the point pierced the pedicle, the thread was carried through and was then slid out of the eye, to be tied.

As centuries passed, manual threaded needles were held in one hand and either a stitching cannula or another similar apparatus held in the other. Both these latter tubular instruments steadied and provided counter pressure to the tissues to be pierced by the needle—functions now replaced by the use of spring forceps in the non-stitching hand.

When steel needles came into being, there were three main shapes—curved (to varying degrees of a circle—that is ¼, ⅜, ½, and ⅝, as examples), J-shaped (fish hook), and straight. Ergonomically, straight needles just require a pushing motion from the shoulder joint, while curved needles mounted in a needle holder demand predominantly rotational wrist movements. Curved needles have the advantage of being used in confined surgical spaces.

To understand the type and function of needles, it is necessary to consider the nature of tissue to be punctured. Tough tissues such as skin, fascia, and ligaments require cutting edges to the needle points, while delicate and more fragile structures such as gut, mesentery and blood vessels can easily be punctured by a

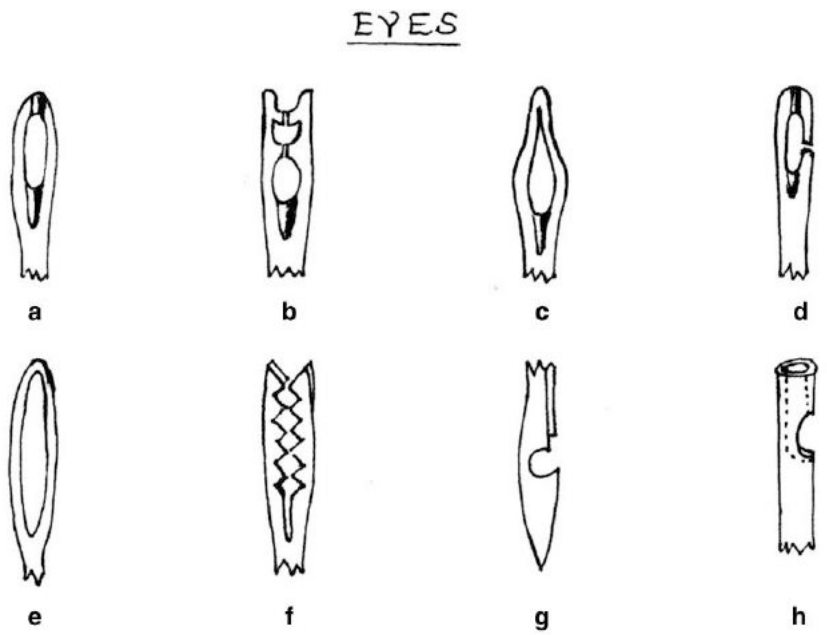

Fig. 1 Varieties of surgical needle eyes (courtesy John Kirkup FRCS)

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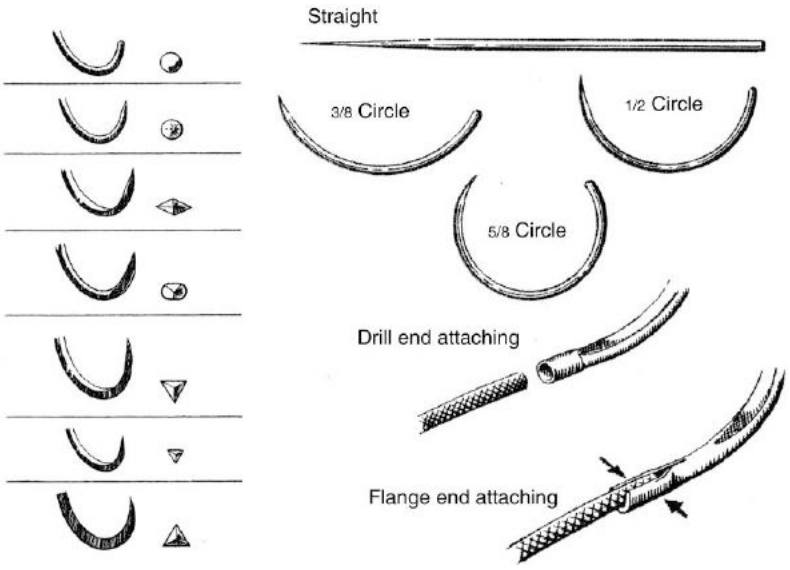

Fig. 2 Needle shapes, points, and methods of creating atraumatic needle sutures (courtesy John Kirkup FRCS)

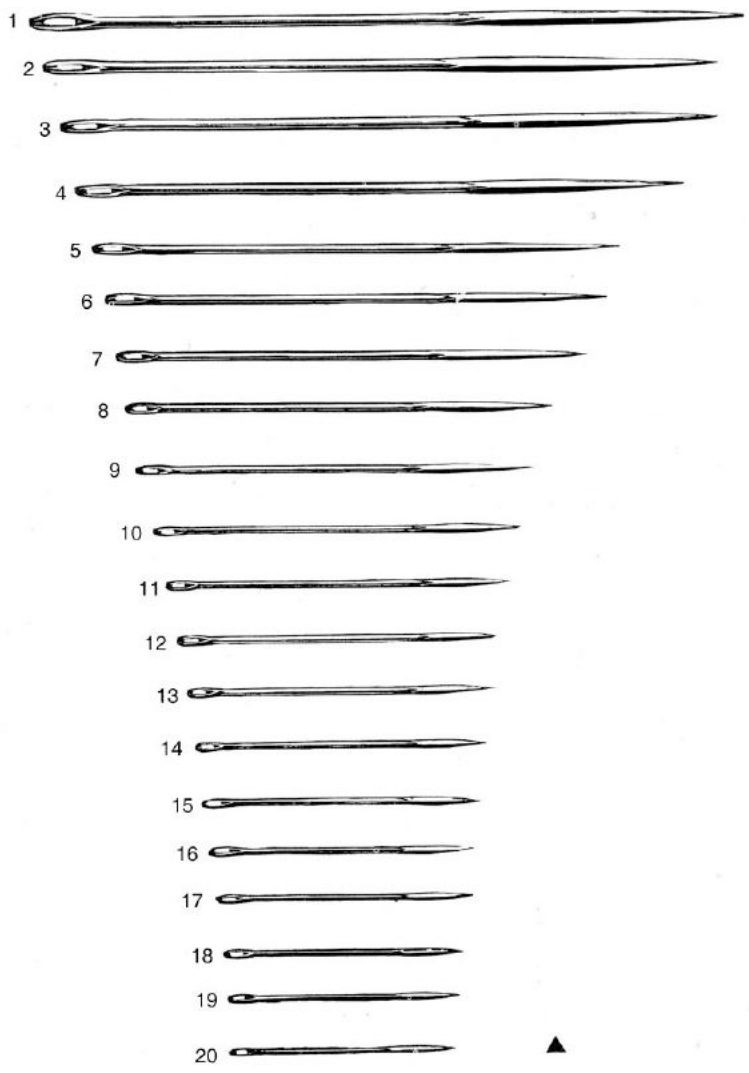

Fig. 3 Sizes 1–20 straight triangular-pointed needles (courtesy the Royal College of Surgeons of England)

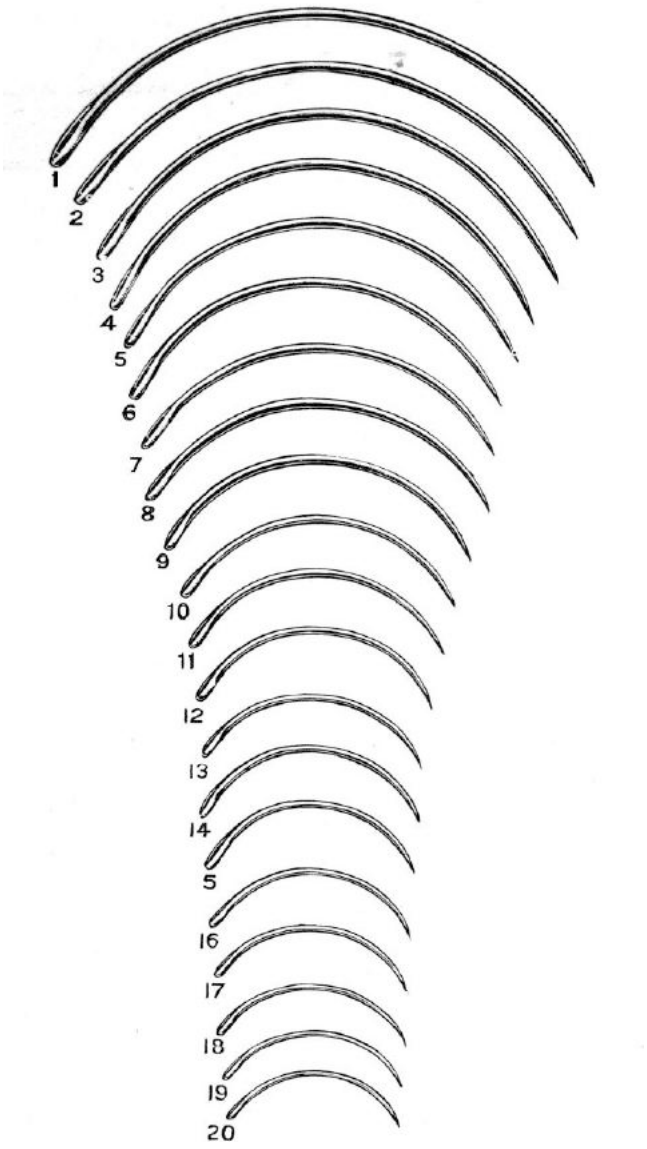

Fig. 4 Size 1–20 curved round-bodied needles (courtesy the Royal College of Surgeons of England)

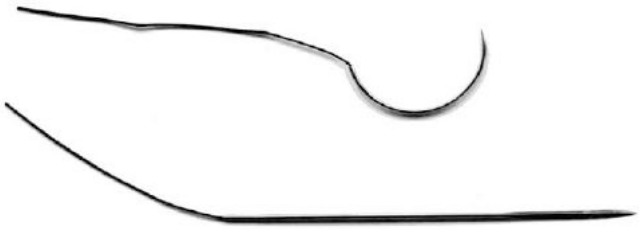

Fig. 5 A curved and a straight atraumatic needle incorporating 2/0 silk sutures (author's collection)

round-bodied, non-cutting needle point. *Figure 2* illustrates not only the common needle shapes, but also the various types of points for cutting needles. These are varied with the body of the curved needle tapering into diamond, oval, or triangular points. This point could be cutting on the convex (outside or reverse) or the concave (inside) of the needle.

Fig. 6 Colt's needle (courtesy the Royal College of Surgeons of England)

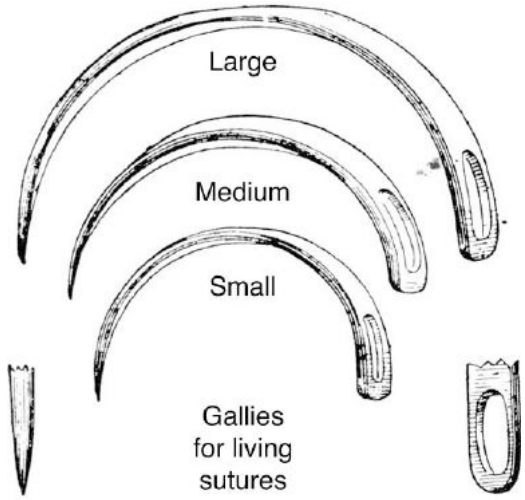

Fig. 7 Gallie's needles for fascia lata (courtesy the Royal College of Surgeons of England)

At the proximal end of suturing needles, there were problems associated with threading the eyes. After the suture material was passed through the eye, the needle carried the bulk of two threads and the expanded eye through tissues. The introduction of atraumatic eyeless needles in the 1960s provided a labour-saving device and a less traumatic passage. The thread was attached to the needle end in one of two ways. Either the needles had an open groove into which the thread was laid and two side flanges were then closed around the thread, or the end of the needle was drilled and the thread passed into the hollow, which was crimped onto the thread. Interestingly, the concept of employing 'eyeless' needles, similar in a way, to those we use today, was described in a French text in the late eighteenth century.

Figures 3 and *4* show two examples from many, taken from a commercial catalogue of the varying sizes of straight triangular-pointed cutting needles and curved, round-bodied needles.

Figure 5 illustrates examples of atraumatic sutures which are sterilized and sealed in tinfoil packages.

There were and are many surgical needles that serve specific functions.

Colt's needle

Colt's mass closure needle (*Fig. 6*) was a large curved cutting needle that was used for mass wound closure, especially in cases where standard layered closure threatened to fail.

George Herbert Colt (1878–1957) was a surgeon trained at Cambridge and St Bartholomew's Hospital. He worked in

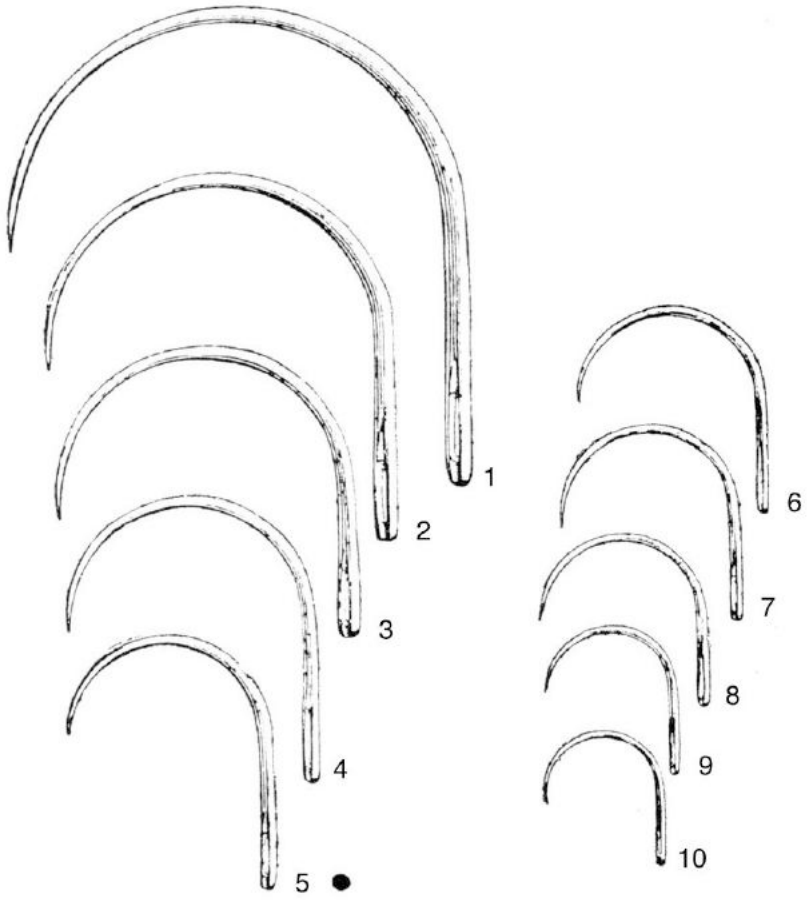

Fig. 8 Symond's round-bodied fish hook needles (courtesy the Royal College of Surgeons of England)

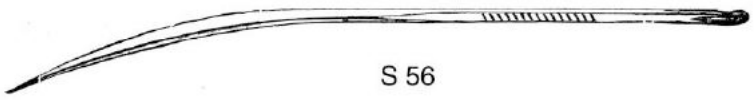

Fig. 9 A triangular-pointed post-mortem needle (courtesy the Royal College of Surgeons of England)

Aberdeen, served in World War One in Salonika and later practised in London and Kent.

Gallie's needle

Gallie's needle, (*Fig. 7*) with a large eye, was used for inguinal hernia repair. After removing a strip of fascia lata, this was threaded onto the robust curved cutting needle. The fascia lata was woven over the hernial defect.

William Edward Gallie (1882–1959) was a Canadian surgeon, who visited Great Britain, where he obtained various degrees and became Professor of Surgery in Toronto.

Symond's round-bodied fish-hook needle

This design of needle (*Fig. 8*) was of use when working in confined spaces, for example in under-running of a bleeding chronic duodenal ulcer.

It is likely that the innovator of this unusual needle was Sir Charters James Symonds (1852–1932). He was a Canadian-born surgeon, and was a notable surgeon at Guy's Hospital.

Postmortem needle

This tough, part-curved cutting needle (*Fig. 9*) is used to close body cavities and other incisions made during postmortem

examinations. This design of needle was employed in past centuries as an alternative to straight needles.

There are a multitude of eponymous needles, such as Mayo's, Hagedorn's, Fergusson's, Moynihan's, Ogilvy's, Bonney's, Kelly's, Murphy's, etc.

Likewise, some needles are designed and named for specific purposes, such as fistula, cleft palate, vascular, thoracic, cervical, microsurgical work, etc.

With all types of needle, care has to be taken in passing, handling, and mounting to avoid needlestick injuries.

The various types of suture materials and their evolution will be reviewed in a later article in this series.

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Surgical needles with handles

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Having given examples of hand-held surgical needles and of needle holders of various types, we can consider a few needles that are mounted on handles. Greco-Roman and Arabic sources described ornately handled eyeless needles for displacing cataracts for use in the technique of couching. Also of historical origin are the various types of acupuncture needle. In 1564, Ambroise Paré illustrated a robust handled needle, which had an eye part way along the needle, through which were passed gold or lead ligatures, used during hernia repair.

Handled needles have sharp or blunt tips, the latter for passing ligatures around structures to be tied off, such as pedicles or individual blood vessels. Hand-held needles have proximal eyes, whereas handled needles have distally placed eyes. This allows ligatures to be applied at some depth by one of two methods: passing ligature-loaded needles through tissues to be ligated or, passing the 'empty' needle through tissues and then loading the needle by feeding the ligature into a closed or open eye manually by an assistant or, rarely, by using a mounted ligature holder. The needle then is carefully withdrawn and the ligature tied on each side of the pedicle. These now rather historical instruments were frequently used in pelvic surgery by gynaecologists or urological surgeons. The longer reaching needle is clearly useful when working in other rather inaccessible areas, for example, when repairing vesicovaginal fistulas or cleft palates.

A minor disadvantage of using a rigid handled needle is that it allows no adjustment (such as angulation) of the tip that is permitted by mounting a separate needle held in the surgeon's hand or in a needle holder.

Deschamps' handled sharp-tipped needle

Figure 1 shows two sides of the sharp-pointed rigid handled needle. Here for example, a silk, linen or catgut ligature is loaded into the eye and the sharp needle is passed with a rotational supinated movement through a vascular pedicle. One drawback of this manoeuvre is that the sharp tip could inadvertently puncture a blood vessel, so causing haemorrhage, necessitating further control. Both Deschamps and Astley Cooper used the same instrument with blunt tips that could be passed safely around vascular pedicles.

Louis-Auguste Deschamps (1765–1842), a French surgeon and naturalist, was born in St Omer. He was also a noted botanist, specializing in the flora of Java and Mexico.

Sir Astley Paston Cooper FRS (1768–1841) was a notable English surgeon and anatomist, who was taught by John Hunter and worked at St Thomas' and Guy's Hospitals. He was Serjeant Surgeon to King George IV and twice President of the English College. He made progress in both vascular surgery and the anatomy and surgery of hernias. He was the first to ligate the abdominal aorta for aneurysm in 1817.

Bonney's needle holder

Bonney's needle holder, with a take-apart joint for cleaning, clamps its dedicated needles in its distal jaws (*Fig. 2*). The three sharp needles are shown in varying sizes, with distal eyes for preloading of the ligature. Interestingly, there is also illustrated a blunt needle, for passing round (or through) tissues before ligation. The needles have proximally serrated hubs to prevent them swivelling during use. This firm grip mechanism allowed some adjustment of the needle.

William Francis Victor Bonney (1872–1953) was a highly qualified gynaecologist and surgeon, who trained at St Bartholomew's and transferred to the Middlesex Hospital. He worked through the First World War, became a champion of myomectomy and Wertheim's hysterectomy, and advocated the

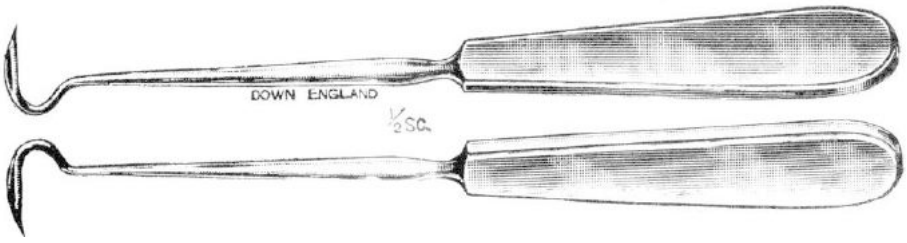

Fig. 1 Deschamps' handled needle
Courtesy of the Royal College of Surgeons of England.

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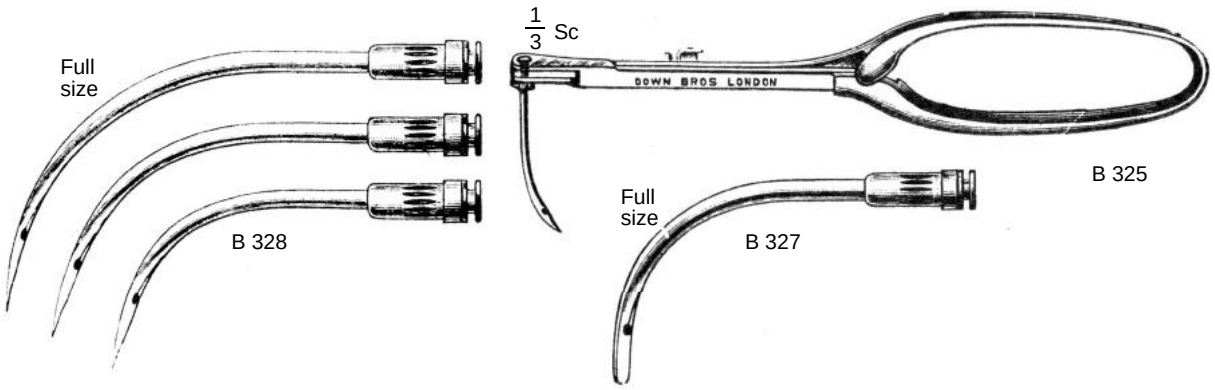

Fig. 2 Bonney's needle holder with three sharp and one blunt needles
Courtesy of the Royal College of Surgeons of England.

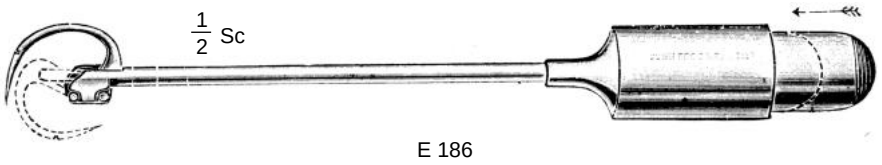

Fig. 3 Millin's boomerang needle with two needles
Courtesy of the Royal College of Surgeons of England.

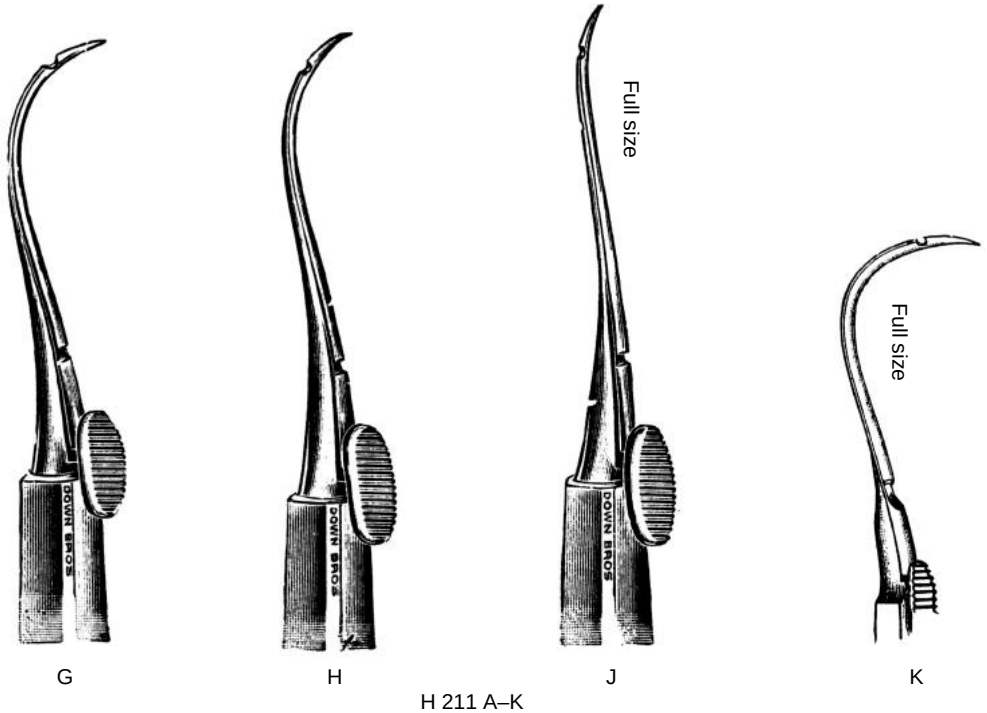

Fig. 4 Reverdin's needle
Courtesy of the Royal College of Surgeons of England.

lower-segment caesarean section. He described two clamps, a round ligament forceps, and introduced the antiseptic dye, Bonney's Blue.

Millin's boomerang needle

This ingenious instrument was used primarily during open prostatectomies (*Fig. 3*). In the limited retropubic space, it was employed to suture the prostatic capsule after the prostatic adenoma(s) had been removed digitally. The instrument has a broad thick handle that tapers on to a shaft. The surgeon's index and middle finger curled around the lower shoulders of the stubby hollow handle, while the thenar eminence of the surgeon's hand pressed down the rounded end, which was then pushed down into the hollow handle. This caused a rotational movement of the needle by almost 180°. The slot eye was then afterloaded with catgut or silk and the pressure on the rounded proximal handle end released, so bringing the needle back to its resting position. The unrotated hinged needle brought the suture out to be tied, having passed it through both edges of the capsule.

Terence John Millin (1903–1980) was an Irish surgeon, who qualified in Dublin in 1927. He worked at Guy's and the Middlesex Hospitals, then he succeeded Edward Canny Ryall at the All-Saint's Hospital in Pimlico. In 1945, he introduced his retropubic prostatectomy, superseding Freyer's transvesical operation. He was elected President of the Irish Royal College in 1963, for 3 years.

Reverdin's needle

This slim instrument, which underwent several modifications, is shown with fixed needles of varied curvatures (*Fig. 4*). It is used to transfix tissues and, after loading with a ligature, is withdrawn to allow ligation or suture of the structures transfixed. The operator passes the needle through the tissues, pulling back the ribbed button on the shoulder of the instrument. This opens the notched eye and the assistant rapidly slides the suture into the eye, which is then closed as the operator pushes the button forwards. Following transfixion, the eye is then opened to release the suture. Used by gynaecologists, it required an alert assistant, not only to load the suture rapidly, but to avoid needle-stick injuries.

Jaques-Louis Reverdin (1842–1929) was a Swiss surgeon who studied in Paris and, after working in the Necker Hospital, moved to Geneva. Here he was appointed to the Hôpital Cantonal de Geneve and achieved a chair in surgery at the University of Geneva. He invented the first fresh skin allograft, also known as the 'pinch' graft. He noted the condition of myxoedema after thyroidectomy. The Reverdin's Blue Butterfly is named after him.

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Some Everyday Surgical Instruments: Part 13 - Surgical suture material

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Following trauma, excisional or reparative surgery, wounds require closure and tissues require apposition to restore the anatomy. Over time, diverse methods have been employed to approximate tissues. Skilled bandaging, thorns, pins, insect claws, and adhesive tapes are some examples of methods employed over many centuries. Before the advent of stapling instruments today, surgical sutures (or stitches) had been in use for over 3000 years. The earliest known examples are those found on an Egyptian mummy from around 1100 BCE.

Suture materials are either absorbable or non-absorbable, with many of the latter requiring removal. Most earlier sutures were made from organic materials and were commonly braided (multifilament). This latter property was a problem as the braided threads were slightly more traumatic, and the interstices of these threads harboured bacteria. Various forms of linen and silk threads possessed long enough filaments, yet this was not the case with cotton.

The development of catgut sutures, later improved and championed (1868) by Lord Joseph Lister by treating them with chromic salts, added a longer retained variety of stitch to the surgical armamentarium. With no feline connection at all, catgut is made from preparations of strips of the submucous and muscular layer of animal intestine (usually from sheep). The etymology of the word catgut reveals it to have been derived from 'kitgut', a kit being another term for a master's fiddle. Other organic materials used for sutures were horse hair and various strips of tendon or fascia. Ideally, a stitch should be monofilament, inert, strong, have a degree of elasticity, and be easy to tie.

Previously, sutures were threaded on to eyed needles, which necessitated time to thread the needles and proved slightly traumatic as sutures were dragged through the tissues. Today, there is a wide variety of synthetic sutures, created in varied sizes and materials, which are swaged on to curved or straight needles, available as a prepacked, sterilized atraumatic combination of stitch and needle.

Suture materials can be categorized into absorbable and non-absorbable types, either of which may be subdivided in to those manufactured from natural or synthetic materials.

Absorbable sutures

Some of these need to remain functional and intact for around 3 days to 1 month or so. They are dissolved by proteolysis or hydrolysis.

Natural absorbable sutures

Plain catgut

Multifilament plain catgut retains tensile strength for 1–2 weeks. This material stimulates tissue reactivity and is most often used within the body cavities.

Chromic catgut

Chromic catgut can remain effective for 3–4 weeks. It is elastic and incites less tissue reaction, and is often used for closure on mucosal surfaces or the genitalia.

'Fast' gut

So-called 'fast' gut is heat-treated to degrade its protein and is absorbed within a few days.

Synthetic absorbable sutures

These include Monocryl™ (Ethicon, GA), Maxon™ (Medtronic plc, MN), PDS™ (Ethicon, GA), Dexon™ (Medtronic, MN), Vicryl® (Ethicon, GA), and Vicryl Rapid™ (Ethicon, GA) sutures. These stitches are retained for longer intervals; they lose most or all of their strength in around 20–50 days.

Monocryl (poliglecaprone) and its variants

This is strong monofilament, elastic material which is easy to tie. It lasts only around 20 days and is used for closing superficial wounds.

Maxon (polglyconate)

This monofilament stitch is strong, and lasts around 3 weeks.

PDS (polydioxanone)

This is another monofilament suture material, which is strong but less easy to tie.

Dexon (polyglycolic acid)

This is frequently used in subcutaneous closure. It is a strong multifilament and lasts at least 1 month, but ties less easily.

Vicryl® (polyglactin 910)

Vicryl® has strength, little tissue reaction, and ties well. Apart from the face, it is used in skin closure. Its irradiated variety (Vicryl Rapid) is more rapidly absorbed within 10 days. It is useful for suturing scalp and face wounds or incisions (*Figure 1*).

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Fig. 1 Natural and synthetic absorbable sutures

Chromic catgut (1940–1950—glass tube), plain catgut, and coated Vicryl® (1980s) (author's collection).

Fig. 2 Natural non-absorbable sutures

Silk (1980s), silkworm gut (1950s—glass tube), and linen (1980s) (author's collection).

Non-absorbable sutures

Natural non-absorbable sutures

These sutures hold their strength for longer periods. Silk (or Mersilk™ (Ethicon, GA)) and linen are multifilament coated suture and ligature materials of historical interest. Linen is produced from the flax plant and silk is obtained from silkworms, including the monofilament silkworm gut, a variety of material made by interfering with the usual silk-making process. Silk and linen are temporarily strong and possess good knot-tying capabilities. However, they both cause tissue reaction, act as foci of sepsis, and can lose their strength and disintegrate over time. Silk may be used by dentists and for securing postoperative tube drains (*Figure 2*).

Fig. 3 Synthetic non-absorbable sutures

Ethilon (1980s), nylon (1950s—glass tube), Prolene (1980s), and multifilament surgical steel wire (1950s—glass tube) (author's collection).

Synthetic non-absorbable sutures

These are single or multifilament threads made from a variety of plastic polymers. Some examples are: Ethilon™ (Ethicon, GA), Nurolon™ (Ethicon, GA), Ethibond™ (Ethicon, GA), Novafil™ (Medtronic plc, MN), Prolene™ (Ethicon, GA), and Stainless steel wire™ (Ethicon, GA).

Ethilon, Dermalon™ (Medtronic plc, MN) (nylon)

This monofilament polyamide is strong yet less easy to tie because the material has a significant 'memory'. It is useful for wound closure, has a low tissue reactivity, and a degree of elasticity.

Nurolon, Surgilon™ (Medtronic plc, MN) (nylon)

This multifilament thread has a good tensile strength and ties more easily than its monofilament counterpart.

Ethibond, Synthofil® Tuttlingen (braided polyester)

Created from polyethylene terephthalate, many of these are braided, coloured, and silicone-coated. They are strong and tie well, but can drag a little through tissues. These sutures can be used in orthopaedic and paediatric heart surgery.

Novafil™ (Medtronic plc, MN) (polybutester)

This monofilament suture, a co-polymer of polyester, has considerable strength, and some elasticity. It is useful for suturing tough tissues, such as in tendon repair.

Prolene (polypropylene)

This synthetic monofilament polypropylene stitch is inert and durable. It is frequently used for skin closure.

Stainless steel wire sutures

These are made from a variety of steel alloys. They are very strong and are used in orthopaedic and chest surgery. They do not degrade but require careful tying. Poor handling remains their chief drawback (*Figure 3*).

Suture technique and placement

There is a considerable range of suture techniques and placements, such as simple interrupted, tension, mattress, subcutaneous, subcuticular, purse-string, interlocking, and figure-of-eight sutures. When suturing or ligating tissues, a surgeon's knot is frequently used. This is a modified reef knot, whereby there is an extra twist when the first throw is tied. This increases friction and reduces the risk of loosening after the first throw has been formed. The second twist is a single throw. It is always important to obtain the optimal tension when tying a knot, and not to place sutures in a way that might cause devascularization of approximated tissues. During minimal access surgery, intracorporeal knot-tying involves use of long needle-holders and forceps, and tying reef and surgeon's knots which can be adjusted to half-hitches that slide to tighten grip. Skin closure is usually performed using subcuticular and interrupted sutures, staples, Steri-Strips or cyanoacrylate glues.

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Some everyday surgical instruments part 14: endoscopes and specula—part 1

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The ability to inspect the internal structure of hollow organs or cavities permits assessment, suction, biopsy, and now a large range of therapeutic manoeuvres. Before the 1960s, endoscopic procedures were somewhat limited, involving peering down a long rigid tube with relatively poor proximal or distal electric lighting systems, which provided a limited distal view for diagnosis or therapy. During the author's career (1960–2001), the introduction of fibreoptic rod-lens symptoms revolutionized diagnostic and therapeutic endoscopy. Long flexible tubing coated with a durable plastic sheath contains lenses and continuous bundles of flexible glass fibres, which by internal reflection, transmit clear images to the eyepiece. Intense illumination with a powerful fibreoptic light source has enabled a greater variety of diagnostic and interventional procedures.

Therapeutic techniques enabling biopsy, haemostasis, tissue ablation, laser therapy and extraction of foreign bodies, suction, and other surgical manoeuvres evolved over the last years of the previous century. Modern endoscopes and specula are now available to inspect the abdominal and thoracic cavities, urethra, bladder, oesophagus, stomach, large gut, nasopharynx, larynx, gynaecological cavities, bronchi, and joint spaces. This article focuses on older rigid endoscopes that are used in some circumstances. The large variety of current laparoscopic and flexible endoscopic instrumentation will not be discussed here.

Thudichum's nasal speculum

This speculum is remarkable for its simplicity (*Fig. 1*). There are at least five other varieties of nasal specula—most of them longer and with handles. This instrument is used to inspect the anterior nares, assist removal of foreign bodies and nasal packing, and also to cauterize bleeding points. The instrument is inserted gently by compressing the two blades of the instrument, inserting it into the sensitive nasal cavity, and allowing the blades to expand on release of the fingers. An external light source is then shone into the nasal cavity.

John Louis Thudichum (1829–1901) was born and educated in Germany. He underwent spells of military and civilian practice in Germany. He obtained his English MRCS, and settled in London in 1853. With interests in nasal disorders, chemistry, and electricity, he lectured at St Thomas' Hospital.

Macintosh's folding laryngoscope

This is an essential and everyday instrument used by anaesthetists to visualize the orolaryngeal airways, including the epiglottis, vocal cords, and oropharynx, before intubation with a cuffed endotracheal tube (*Fig. 2*). The instrument is unfolded, which turns on the light source, and is held upside down, and then the sympathetically curved and illuminated blade lifts the lower jaw, keeping the tongue out of the way. Following induction of general anaesthesia and muscle paralysis, the instrument then permits tracheal intubation.

Sir Robert Macintosh (1897–1989) was born in New Zealand. In 1915, he travelled to Britain and was commissioned into the Royal Flying Corps in World War I. He was shot down and taken prisoner. Later, he trained at Guy's Hospital and, while working as a surgeon, he became interested in anaesthetics. Appointed as Professor of Anaesthetics in Oxford, he worked in World War II and invented this instrument in 1941.

Chevalier Jackson's rigid bronchoscope

Before passage of a bronchoscope, (*Fig. 3*) it is necessary to ascertain that the patient has no underlying cervical spine or other neck pathology. It is also important to check the patient's dentition for loose or damaged teeth and crowns. To intubate the lower airways using a rigid instrument, a general anaesthetic is necessary, using intermittent ventilation. The neck must be extended gently to straighten the line of the airway for passage of the instrument. This is achieved either by raising the shoulders on a shoulder pad and placing the head in a head ring, or by dropping the head piece of the operating table, and gentle neck extension can take place by an assistant supporting the patient's head. With the bevel of the bronchoscope facing downwards, the furthermost rounded lip of the instrument is eased under direct vision in the midline, into the larynx and trachea, to enable inspection, suction, biopsy or removal of foreign material, as needed. The side vents at the distal end of the instrument enable oxygen delivery to adjacent bronchi. Suction of unwanted viscid secretions is carried out via the tube fused to the main body of the instrument. The fibreoptic light source channel is situated along the opposite side of the bronchoscope. Complications, such as mucosal damage or bleeding, may occur as a result of rough or improper direction of the bronchoscope.

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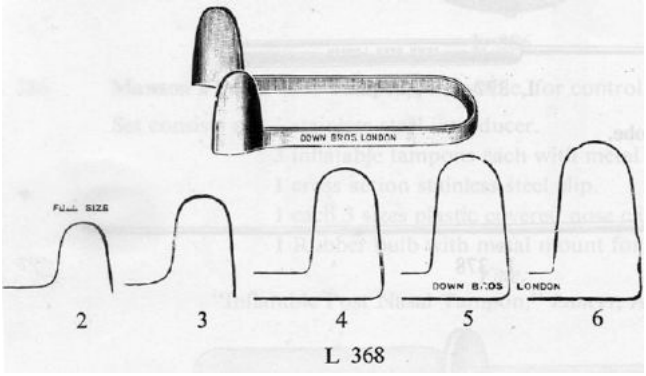

Fig. 1 Thudichum's nasal speculum (available in sizes 1–7)
Courtesy of the Royal College of Surgeons of England.

Fig. 2 Macintosh's folding laryngoscope
Courtesy of the Royal College of Surgeons of England.

Chevalier Quixote Jackson (1865–1958) was born in Pennsylvania and, after qualifying in the USA, dedicated his life to the techniques of endoscopy. He removed over 2000 swallowed foreign bodies via an oesophagoscope during his career. His pioneering endoscopic work on the upper airways and oesophagus reduced the mortality from emergency tracheostomy and chest surgery, pre-eminent in the 19th century. He held chairs of surgery in six different institutes.

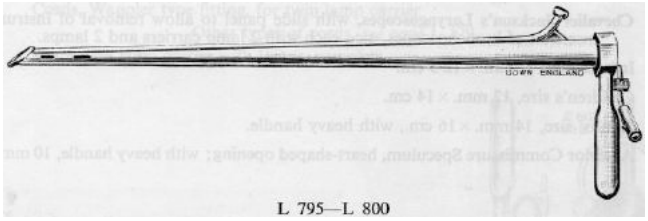

Fig. 3 Chevalier Jackson's rigid bronchoscope
Courtesy of the Royal College of Surgeons of England.

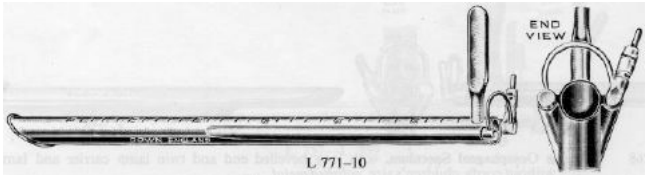

Fig. 4 Negus rigid oesophagoscope
Courtesy of the Royal College of Surgeons of England.

Rigid oesophagoscope

Similar preoperative precautions are necessary for the performance of rigid oesophagoscopy (*Fig. 4*) as for bronchoscopy in regard to neck, oral, and dental stability. The positioning of the patient is as for bronchoscopy. It is best to inform the anaesthetist of the likely duration of the procedure. After induction of anaesthesia and intubation, a gauze roll or mouthguard is placed to protect the teeth. The oesophagoscope is passed with its tip in the midline, posterior to the endotracheal tube, and then, pressing the longer tip of the instrument gently against the posterior wall of the oropharynx and hypopharynx, after inspection of the piriform fossae, the instrument is advanced into the upper oesophagus. Careful assessment, biopsy, and removal of foreign bodies follow, using suction as necessary. Any part of the gullet may be injured, but especially the hypopharynx and cervical oesophagus. Iatrogenic perforation of the oesophagus almost always requires surgical repair on an urgent basis.

Today, with improved illumination, the small-calibre channels in modern flexible endoscopes allow passage of a range of modern instrumentation such as laser fibres, heat probes, and balloon dilators, which allow a variety of novel therapeutic options, excepting removal of some larger foreign bodies, which might require rigid endoscopy.

Sir Victor Negus was a British surgeon who specialized in laryngology. After qualifying, he served in World War I and, during his following surgical career, designed laryngoscopes, bronchoscopes, oesophagoscopes, and other surgical equipment. He was a consultant at King's College Hospital, had studied under Chevalier Jackson in the USA, and was an usher at Lord Lister's funeral.

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Some everyday surgical instruments part 15: endoscopes and specula—part 2

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This brief article describes some of the classical rigid endoscopes and specula used previously and currently to inspect or treat problems within the cavities of pelvic organs. Transforming the quality of the obtained images was revolutionized after the introduction of the Hopkins rod lens systems and fibre-optic bundles (1954–1957), which replaced earlier proximal or distal electric light sources.

Riches' rigid cystoscope

See *Fig. 1*. Useful in the investigation of malignant disease, urinary bleeding or obstruction, calculous disease, and trauma, a rigid cystoscope was introduced blindly into the bladder, usually relying on a side-viewing ability. The bladder neck, trigone, and ureteric orifices could be seen and, by rotating the scope, the entire bladder mucosa could be inspected. The early rigid scopes, such as those used by Riches, who standardized fittings for British cystoscopes, were poorly illuminated by a distal electric bulb. Visualization relied on a multiple lens system with air gaps, in contrast to later models incorporating the Hopkins rod lens system (a longer lens with shorter air gaps). An elevating end piece incorporated into the rigid scope sheath called the Albarran Bridge permitted ureteric catheterization, ureteric brush cytology, ascending ureterography, or the passage of a Dormia basket for removal of ureteric calculi. Irrigation was feasible through the cystoscope's sheath. Modern end-viewing urethrocystoscopes embody flexible fibre-optic bundles, which use a proximal light source and transmit clear images to the eyepiece. Improved illumination permits views of the urethra, verumontanum, and bladder neck, in addition to the bladder surface. Passage of the rigid cystoscope in male patients often required general anaesthesia and the patient to be in the lithotomy position. Today, flexible cystoscopy can be easily carried out with the patient supine, under local anaesthesia. Eyepiece images obtained from the lower urinary tract can be transmitted onto a screen. Some modern instruments use solely screen-projected images.

Sir Eric William Riches (1897–1987) was a urologist who, from 1930, practised as a consultant at The Middlesex Hospital. He held many honoured positions, including president of the British Association of Urological Surgeons. A superb technician and lecturer, he published on many subjects, including urological malignancies. He was an examiner and council member at the English College. He was a consulting surgeon to the British Army and had, amongst many other notables, Sir Barnes Wallis as a patient.

Naunton Morgan's proctoscope

See *Fig. 2*. The word proctoscope is partly derived from the Greek word proktos, meaning 'anus' or 'hindparts'. With the patient usually placed in the left lateral position, this rigid scope is lubricated and introduced with a round- or conical-ended removable obturator and lit by an electric light source; it is of use in the inspection of the anal canal and very low reaches of the rectal ampulla. With this speculum, haemorrhoids (a term derived from the Greek word haimorrhois, meaning a 'discharge or flow of blood') may be inspected, injected with phenol, or banded, tumours of the anal canal may be biopsied, and anal warts may be cauterized. In some cases, the internal opening of an anal fistula can be visualized or the nature of inserted foreign bodies assessed.

Sir Clifford Naunton Morgan (1901–1986) was born in South Wales and eventually worked at St Bartholomew's Hospital and St Mark's Hospital. Having served in the Middle East in World War II, he held appointments at five London hospitals, specializing in colorectal surgery. He was widely honoured and served two years as Vice President at the English College.

Lloyd-Davies' rigid sigmoidoscope

See *Fig. 3*. This distally lit rigid scope was generally used to inspect, biopsy, snare, or apply diathermy to pathology found in the rectum or very distal sigmoid colon. Being rigid, it required gentle manoeuvring and the views obtained were not as good as those obtained with modern flexible instruments. As always, perforation and bleeding were inherent risks. Explosions occasionally occurred when diathermy was applied in the presence of flammable gases in the rectum. In the past, when investigating the pathology of the large intestine, it was usual practice to supplement a barium enema with a preceding rigid sigmoidoscopy. All this is now superseded by colonoscopy.

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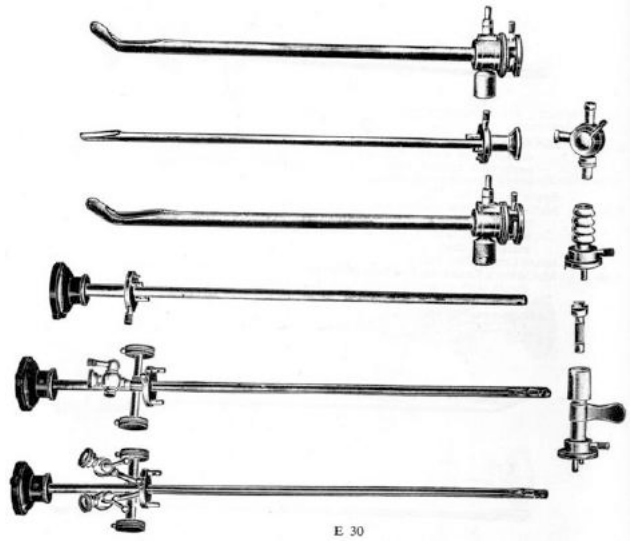

Fig. 1 Riches' operating, catheterizing, and examining rigid cystoscope, including 22 Charrière gauge sheath (named after J. F. B. Charrière, a French instrument maker, who described a gauging system for catheter sizing), obturator, irrigating tap, telescopes, and various attachments

Courtesy of the Royal College of Surgeons of England's library.

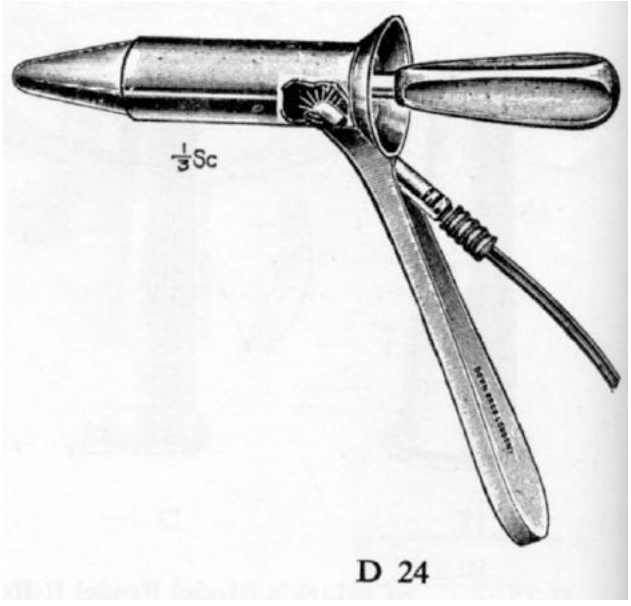

Fig. 2 Naunton Morgan's anorectal speculum or proctoscope

Courtesy of the Royal College of Surgeons of England's library.

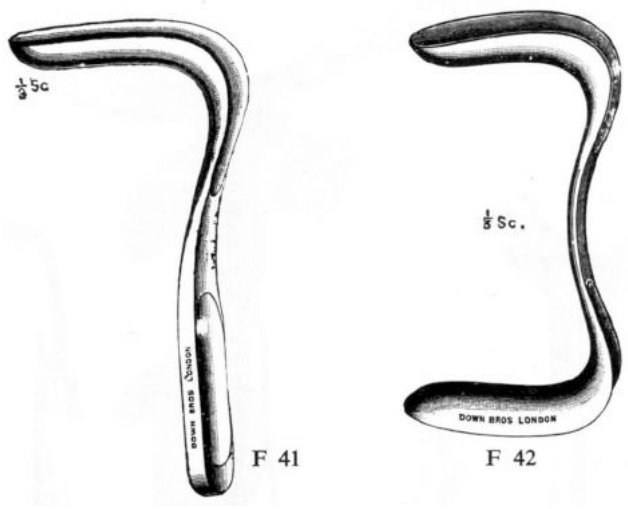

Fig. 4 Sims' duckbill specula

Courtesy of the Royal College of Surgeons of England's library.

Oswald Lloyd-Davies (1905–1987) was a colorectal surgeon who worked at St Mark's Hospital and later at The Middlesex Hospital. He developed the synchronous combined abdominoperineal excision of the rectum for carcinoma and was one of the first to excise liver metastases. He has forceps, a sigmoidoscope, and a patient position on the operating table attributed to him.

Sims' duckbill specula

See *Fig. 4*. These single- and double-ended specula were principally used for vaginal inspection, biopsy, and cauterization, utilizing an external light source. Sympathetically curved and produced in various sizes the operator could, after gel lubrication, rotate the instrument to obtain a complete view of the cavity. Originally designed to assist with the repair of vesicovaginal fistulae, Sims' instruments meant that the use of a pewter spoon and light reflected from mirrors was superseded.

James Marion Sims (1813–1833) was an American gynaecologist, renowned for his pioneering work in the operative treatment of vesicovaginal fistulae. This debilitating problem occurred not infrequently following complicated and prolonged childbirth. A truly venerated surgeon, Sims took an

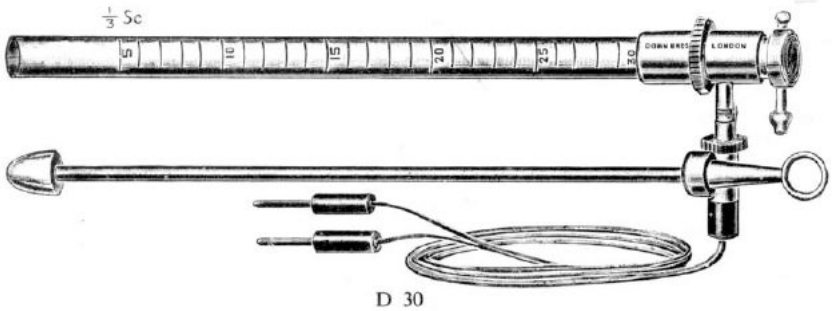

Fig. 3 Lloyd-Davies' 30 cm sigmoidoscope with obturator and light cables

Courtesy of the Royal College of Surgeons of England's library.

interest in cancer therapy, became president of the American Medical Association, and was extremely wealthy. He led a controversial, colourful, and varied life, operating without anaesthesia on enslaved people. He specialized in the surgery of females and was not only a pioneering gynaecologist but was the first to establish a hospital for women in America, in New York in 1855.

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Miscellany of instruments part 16: general surgery

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This article describes some interesting, yet now less often used instruments from past decades, representing a selection of surgical specialties.

Dupuytren's and Eve's aneurysm 'needles'

See *Fig. 1*. These instruments are not strictly needles as usually defined. They are blunt-ended with an eye at the distal rather than the proximal end of the instrument. However, they do have some similar functions to needles. They are used to pass a ligature around (or occasionally, gently pushed through) a soft tissue pedicle that might contain blood vessels, before ligation and division. Classically, they were used to pass a ligature around a feeding artery proximal to an aneurysm (or arteriovenous fistula), hence their name. The blunt ends ensure less chance of damage to nerves or vessels when passed around structures. The needle can be preloaded or subsequently loaded with a ligature. The two Dupuytren's varieties illustrated have curves to the right and left for ease of handling by the surgeon, who merely has to rotate his or her forearm to get the ligature around the vessel, when the instrument is in position. Eve's needle has a large simple curve.

Paul F. Eve (1806–1877), an American surgeon, studied at and graduated from Pennsylvania University and travelled through Europe learning under some notable surgeons and experiencing many military adventures. He served in the Mexican and American conflict and then worked for the Confederate forces in the Civil War. He became an expert in amputation and lithotomy. Innovative and skilful in his surgery, he was the first surgeon to perform a hysterectomy in the USA.

Baron Guillaume Dupuytren (1777–1835), best known for his palmar contracture and for treating Napoleon Bonaparte's haemorrhoids, proved a brilliant surgeon, working in Paris at the Hotel Dieu Hospital. A tough, controversial, energetic taskmaster and brilliant teacher, he took an interest in cancer, cerebral pathology, and melanoma.

Esmarch's bandage

See *Fig. 2*. Esmarch's bandage is used to produce an exsanguinated limb and the tube, hook, and chain are a tourniquet to maintain a bloodless limb. This form of tourniquet (a word derived from the Old English word 'turnian', meaning to rotate or revolve, and also from the French word 'torner', meaning to turn away or around) allows bloodless surgery and also permits anaesthetic or cytotoxic medication to be taken up by the exsanguinated tissues and not be released into the general circulation. The limb is elevated and the broad rubber bandage is carefully and tightly wound around the limb to milk out most of the blood. The

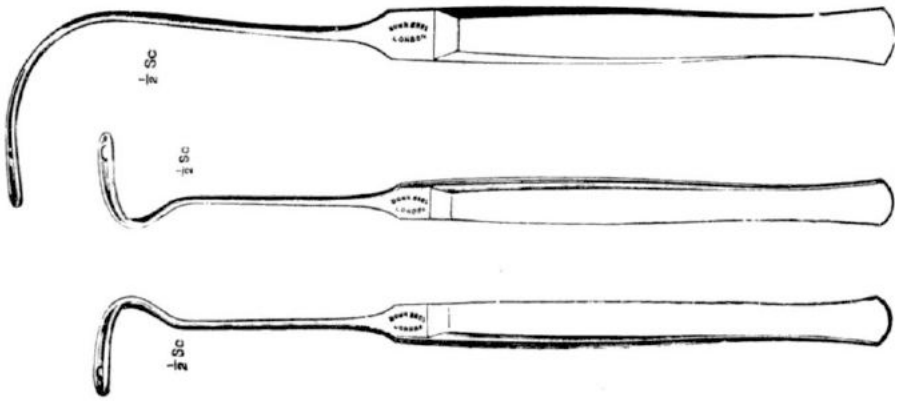

Fig. 1 Eve's (top) and Dupuytren's (middle and bottom) aneurysm needles
Courtesy of the Royal College of Surgeons of England's library.

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rubber tube tourniquet illustrated or other similar apparatus is then tightened above the systolic blood pressure and the rubber bandage removed. Care has to be taken over the time the tourniquet is applied. Esmarch also invented a most valuable and versatile linen triangular bandage, which could be applied in 32 different ways to bandage or support limbs after trauma or surgery.

Johannes von Esmarch (1823–1908) was a German surgeon who studied at Kiel and Göttingen and served as von Langenbeck's assistant in Kiel. Specializing in first aid, battlefield medicine, and hospital management, he held the Chair of Surgery at Kiel. Promoted to Surgeon General in the Franco-Prussian War (1870–1871), he married into nobility and died in Kiel.

Yankauer's sucker

See *Fig. 3*. Sometimes the humblest of surgical implements are forgotten. Such an instrument frequently used in open cavity surgery is Yankauer's sucker. It is conveniently curved for access, with a comfortable hollowed metal handgrip, which, when connected via plastic or rubber tubing to an electric or foot-operated mechanical suction pump, removes blood or fluid from the abdomen, chest, or oropharynx. The removable metal rounded tip, which has multiple perforations to minimize blockage by debris or blood clots, is screwed over the central metal tube. Other models had interchangeable straight or less curved tubes. Some other types of straight suckers have a similar function, but longer sleeves with multiple perforations covering the central sucking tube. These latter instruments were often useful for removing larger pools of fluid, but were less able to target small areas, compared with Yankauer's apparatus. Later models are made of rigid plastic.

Sydney Yankauer (1872–1932) was a German immigrant, who became a pioneering American otolaryngologist who worked at Mount Sinai Hospital in New York. He was an innovative surgeon, skilled in bronchoscopy. He devised an anaesthetic face mask, which was later modified. He worked in a base hospital in World War One and later died of a cardiac problem.

Fig. 2 Esmarch's bandage, rubber tube, hook, and chain
Courtesy of the Royal College of Surgeons of England's library.

Trocars and cannulas (or cannulae)

See *Fig. 4*. The word trocar is derived from the French 'trocart' (trois-quarts), meaning three-fourths or three sides, relating to the instrument's triangular point. The word cannula originates from the Latin word 'canna', meaning a small reed or pipe. The larger instruments were used for draining fluids (that is ascites, urine, or pleural effusions) from body cavities. These have now been superseded by plastic drainage tubes that are inserted using a sharp-tipped metal introducer. The instrument on the left, described as a suprapubic (bladder) trocar and cannula, could also be inserted into the chest or peritoneal cavities. The smaller right-hand set was used for tapping hydroceles. Today a needle and syringe would be used for that purpose. The trocars were made of stainless steel and the cannulas were constructed of either nickel silver or silver (incidentally, medical silver is rarely hallmarked). The distal ends of the cannulas were slightly tapered, incorporating two splits in the metal to allow temporary expansion and closure behind the trocar point.

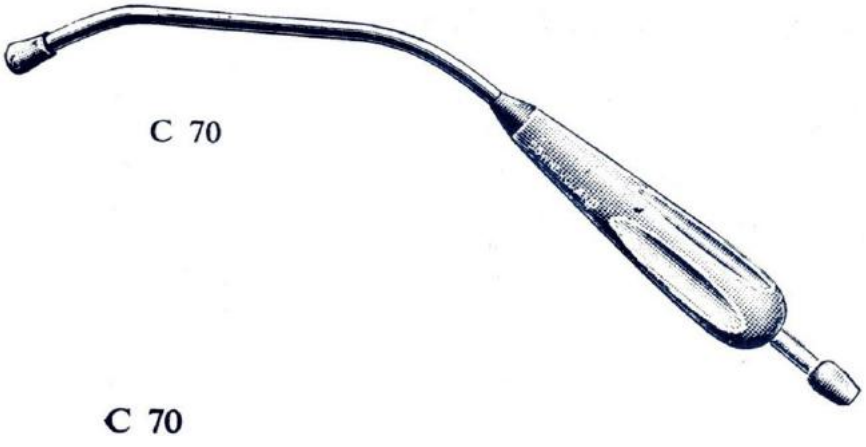

Fig. 3 Yankauer's sucker
Courtesy of the Royal College of Surgeons of England's library.

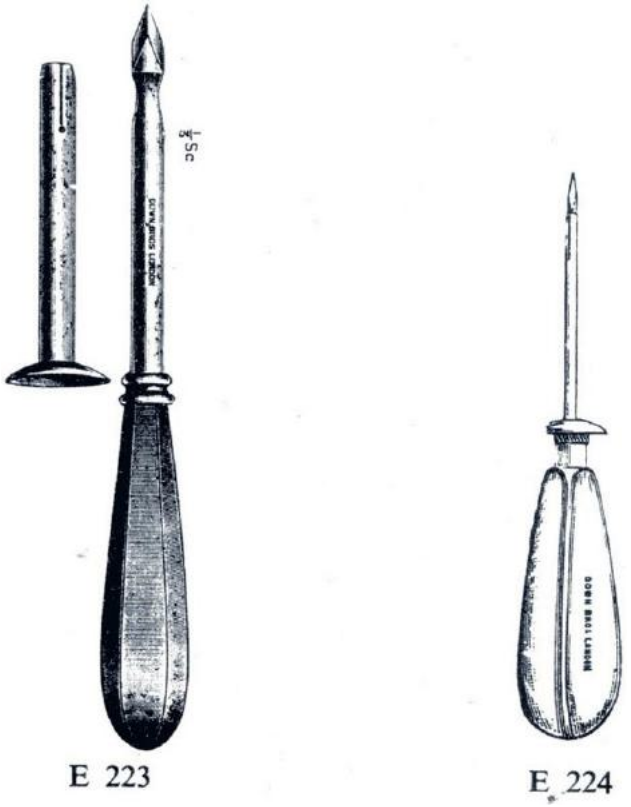

Fig. 4 Suprapubic (left) and hydrocele (right) trocars and cannulas
Courtesy of the Royal College of Surgeons of England's library.

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Miscellany of instruments part 17: urological and gynaecological surgery

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Progress in transurethral prostatic surgery began in 1830, when George James Guthrie passed a concealed knife *per urethram* to cut prostatic tissue. The technique was not performed under direct visualization and there was no way of controlling haemorrhage. Once any body cavity could be clearly visualized, endoscopic therapy was an inevitable and safer sequitur.

McCarthy resectoscope

Benign enlargement of the prostate became a frequent challenge as the male population's age increased. The first feasible open prostatectomy was introduced in 1904 and, via a lower abdominal incision, prostatic tissue was enucleated digitally by the fairly invasive and often bloody transvesical or retropubic route. In the mid-1920s, an early type of prostatic resectoscope was introduced. Further modifications were required and, in 1931, Joseph McCarthy produced his first model, incorporating improvements in electrical current delivery, insulation, lens systems, and cutting loop design. This instrument, with modifications, remains the standard model to the present day. It uses a cutting diathermy wire loop to shave off slivers of gland, working around the prostatic bulk. In the early days, this novel procedure was rapidly taken up but, being wrongly regarded as rather too simple to learn, soon became fraught with complications. Perforations, incontinence, urethral strictures, sepsis, and bladder neck disruption were some examples. Proper training and care gradually led to the procedure being slotted into its correct place in urological practice.

The model illustrated (*Fig. 1*) shows a Bakelite sheath, the wire cutting loop just protruding, and a rack and pinion action to draw the loop towards the surgeon. Irrigating, cutting or coagulating currents and optical lighting connections are shown, along with the introducing obturator. Proper training enables the correct limits of resection, an adequate volume of prostatic tissue to be removed, haemostasis, and thorough bladder washouts to remove the resected chips.

Joseph McCarthy (1874–1965) was born in New York and started life as a pharmacist. He then qualified in medicine at Columbia University. He studied urology in Europe and was appointed Professor of Urology at New York and later at Columbia. Having a great interest in instrumentation, he worked with Maximilian Stern (1878–1946), further developing the Stern–McCarthy resectoscope.

Clutton's urethral sounds

The word sound is derived from the French word *sonde*. Sounding for depth of water is well known in nautical terminology. Thus, we can 'sound' for measuring, exploring or gauging. An alternative origin is derived from the sound (or clink) made when a metal urethral lithotomy probe collided with a bladder calculus. Older types of metal sound were used as directors in the various lithotomy operations. Uterine sounds were used to gauge patency, direction, and length of a uterine cavity. These solid white metal probes came in graded sizes appropriate to their tasks. The instrument illustrated (*Fig. 2*) is sized 22/26, indicating the expansion of the probe proximally. These sounds were commonly used to dilate urethral strictures. At stricture clinics and for the less experienced surgeon in previous times, the patient was often usefully knowledgeable about the exact way to manipulate the instrument through the stricture. It was, and is, important to employ as little force as possible, particularly so as not to create false passages.

Henry Hugh Clutton (1850–1909) was an English surgeon. He was best known for his description of the painless symmetrical hydrarthrosis of the knee joints in cases of congenital syphilis. A Clutton medal and prize for excellence in clinical surgery is awarded at St Thomas' Hospital.

Sims' uterine curettes

Blunt and sharp curettes (*Fig. 3*) are used in the practice of dilatation of the cervix and curettage of the uterus. This was, and is, a common procedure used to remove tissue from the uterine cavity by controlled scraping with the curette. Curetting the uterine cavity may be required for diagnostic purposes or after a miscarriage, abortion or retention of placental fragments following childbirth, to ensure that the uterus is empty. Irregular or abnormal uterine bleeding owing to sepsis, polyps or carcinoma may also require curettage. These procedures are now often assisted or replaced by using a hysteroscope, with or without biopsy, to visualize the cavity. Local, general, epidural

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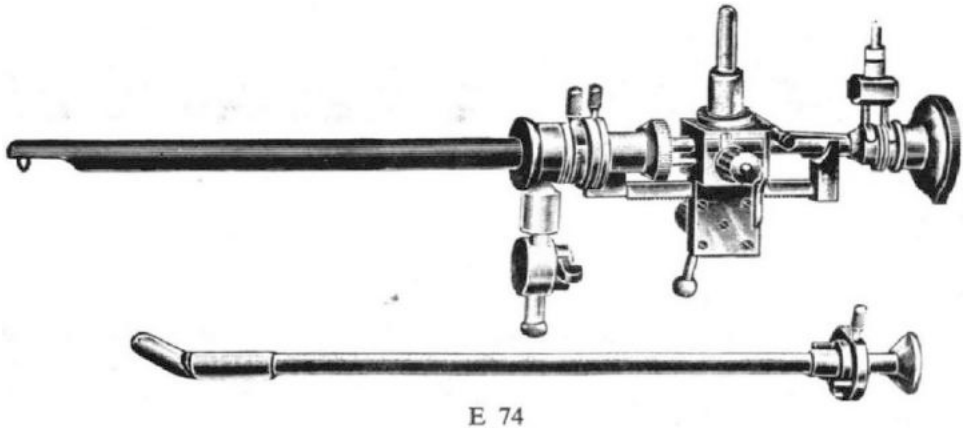

Fig. 1 McCarthy resectoscope
Courtesy of the library of the Royal College of Surgeons of England.

Fig. 2 Clutton's urethral sounds
Courtesy of the library of the Royal College of Surgeons of England.

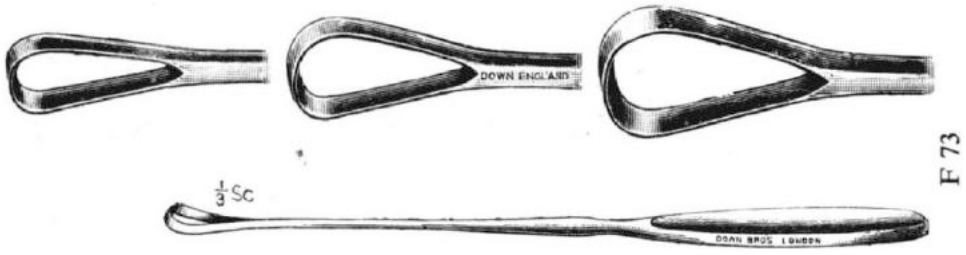

Fig. 3 Sims' uterine curettes
Courtesy of the library of the Royal College of Surgeons of England.

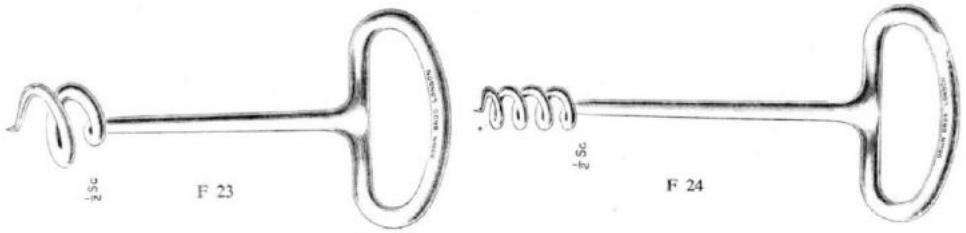

Fig. 4 Doyen's uterine myoma screw
Courtesy of the library of the Royal College of Surgeons of England.

or regional anaesthetic may be required. The cervix is gradually dilated using a series of Hegar's dilators (Alfred Hegar, a German gynaecologist, 1830–1914) and careful curettage is carried out in a systematic fashion. Caution has to be observed, using sharp or blunt loops, depending on the perceived fragility of the uterus. Perforation of the organ, bleeding, and sepsis are recognized complications. Even rarer is the formation of intrauterine adhesive bands after the procedure.

James Marion Sims (1813–1833) was an American gynaecologist, renowned for his pioneering work in the operative treatment of

vesicovaginal fistula, which could occur after complicated childbirth. A most able surgeon, Sims took an interest in cancer therapy, became president of the American Medical Association, and was extremely wealthy. He led a controversial, and colourful life, operating without anaesthesia on enslaved people. He was not only a pioneering gynaecologist, but the first to establish a hospital for women in America, at New York in 1855.

Doyen's myoma (or myomectomy) screw

This corkscrew-like implement (*Fig. 4*) was used to stabilize large myomas (uterine fibroids) during removal from the main body of the uterus. The instrument was carefully screwed into the centre of the fibroid, either at open or laparoscopic surgery, or passed *per vaginam*. This stabilized the tumour so that resection and excision could be performed. The fibroid mass was dissected out with haemostasis and the resultant uterine defect, which had the potential to weaken the integrity of the uterine musculature, was then repaired with sutures.

Eugène-Louis Doyen (1859–1916) was a skilled and innovative French surgeon born in Reims. He opened a private surgical clinic in Paris, and became was a pioneer of electrocautery and of early surgical cinematography. His early films included those of performance of a craniectomy and hysterectomy.

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A miscellany of instruments part 18—orthopaedic surgery

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Farabeuf's elevator (syn. rugine)

The terminology for this group of instruments (raspatories, rugines and elevators) is somewhat obscure. Raspatories and rugines are basically scrapers. The term elevator is used to describe both tooth extractors and instruments to elevate depressed portions of cranium following skull fracture. However, an elevator may also be used to 'elevate' the periosteum. The term raspatory is more frequently used by British surgeons and rugine is used by French surgeons, or may refer to instruments of French design (*Fig. 1*). Scrapers and elevators may be used in a pushing or pulling action by the surgeon. A typical example of the former might be scraping away the pericranium to 'clean' the skull bone, prior to trephination. An example of the latter could be the pulling action of the Doyen rib raspatory, to 'clean' a rib, prior to a thoracotomy. This latter action strips away the rib periosteum and intercostal muscle fibre attachments. Periosteum may be scraped off bone prior to any surgical procedure, but it must be remembered that, in addition to the bony medulla and epiphyses, this important membrane carries nutrition and sensation to the bones.

Luis Hubert Farabeuf (1841–1910) was a French surgeon who became professor of anatomy in Paris. He restructured the teaching of anatomy and surgery and is reputed to have introduced the practice of hygiene into French medical schools. He described an anatomical triangle, bounded by two veins and a nerve in the neck, and also designed a retractor and a pair of forceps which were named after him.

Volkmann's 'spoon' (syn. curette)

Essentially, this 'spoon' (actually a curette) as it commonly referred to, is an instrument to scoop out and clear away dead or 'useless' tissues. The spoon edges are sharp and several sizes are shown in *Fig. 2*. Curettage can be part of the process of primary wound excision—a fundamental post-trauma procedure for removing material that would otherwise form a feeding medium for harmful anaerobic and other bacteria. Devitalized or necrotic fascia, muscle, cartilage, and bony debris and also unhealthy excessive granulations can be scraped away to assist in the exposure of viable vascularized tissue.

Richard von Volkmann (1830–1898) was born in Leipzig and qualified in Berlin. He became a prominent German surgeon and served as professor and director of the surgical clinic at Halle. He was a senior surgeon in two wars, and introduced antiseptic wound therapy to Germany. He became a distinguished author and poet and has a post-traumatic ischaemic contracture of the forearm and a clinical law named after him.

Smith-Petersen cannulated tri-fin nail

Fractured neck of the femur is a common orthopaedic emergency, occurring principally in elderly patients. Today, displaced intracapsular fractures of the femoral neck are usually treated by either hip hemi-arthroplasty or total hip replacement. Historically, from the 1930s through to the 1970s and now, occasionally, the femoral head can be and was stabilized by the insertion of a Smith-Petersen pin (*Fig. 3*). This pin, or nail, is used to fix the head of the femur back in its correct position on the femoral neck and with its three fins is designed to prevent any subsequent rotation of the femoral head. One of the challenges remains the integrity of the blood supply of the head of the femur, for which two arteries, the medial and lateral circumflex branches of the profunda femoris artery, are important. If the vascularity of the head of the femur is seemingly not compromised, then this tri-fin steel nail has been a useful and relatively simple management for this type of fracture. After due assessment, the patient is taken to theatre and a guide wire is passed up through the fracture site. Following radiological confirmation of its position, the Smith-Petersen tri-fin pin is tapped in over the wire and its position radiologically confirmed. If the fracture is trans-trochanteric and extracapsular then most of these injuries are managed using a sliding hip screw, with or without an extension plate. Hip arthroplasty has largely replaced this form of surgery.

Marius Nygaard Smith-Petersen (1886–1953) was a Norwegian who emigrated to America where he eventually worked as a laboratory assistant to Nobel prize-winner Dr Joseph Erlanger. He graduated in 1914 from Harvard and served under Harvey Cushing. A truly gifted surgeon who worked through World War I, eventually becoming chief of orthopaedic services at the Massachusetts General Hospital, in which post he served for 17 years. He also invented a hip-mould arthroplasty.

Thomas' leg splint

Although not a surgical instrument, this orthopaedic splint appliance achieved such marked prominence and success in the management of compound femoral fractures in both civil and

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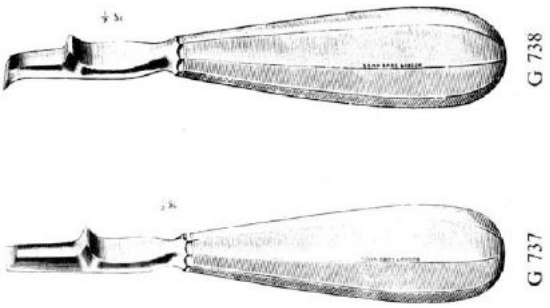

Fig. 1 Farabeuf's rugines with straight and curved chisel edges (courtesy of the library of the Royal College of Surgeons of England)

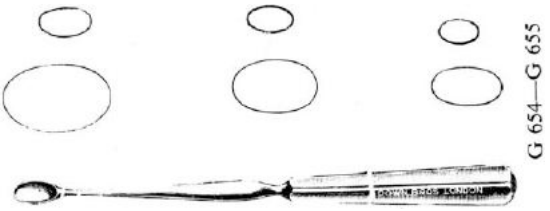

Fig. 2 Volkmann's spoon or curette (courtesy of the library of the Royal College of Surgeons of England)

particularly wartime settings it is worthy of mention. Originally designed by Hugh Owen Thomas to maintain stability of open or closed fractures of the femur (modifications of the splint can be employed with other fractures, for example of the humerus). The splint was designed to manage femoral fractures, particularly in labourers involved in the construction of the Manchester to Liverpool ship canal, where there were frequent bony injuries. It proved of greater value during World War I with the potentially lethal compound fracture of the thigh, which in 1914 carried an over 80% mortality rate. Performing primary wound excision, the use of antiseptic dressings and the application of this splint as soon as feasible after injury resulted in a fall in mortality rate to less than 10%.

Hugh Owen Thomas (1834–1891), born in Anglesey, north Wales, eventually became, along with Robert Jones, one of the 'Fathers of Orthopaedic Surgery'. Thomas was one in a line of Welsh bonesetters. After studying in Edinburgh and London, he gained his MRCS and visited Paris to study surgery. Following a

Fig. 3 Smith-Petersen tri-fin pin (courtesy of the library of the Royal College of Surgeons of England)

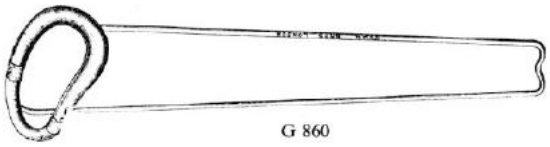

Fig. 4 Thomas' leg splint (courtesy of the library of the Royal College of Surgeons of England)

short stint in his father's practice in Liverpool, he set up his own unit, employing splint-makers in his workshop. He particularly studied and treated patients with bony trauma and TB. Aside from his splint (*Fig. 4*), he had a clinical test, collar, manoeuvre, wrench and shoe-heel named after him.

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Data availability

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Miscellany of instruments part 19: vascular and thoracic surgery

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Cannon's endarterectomy loops

With increasing longevity and a significant incidence of obesity and diabetes, deaths caused by atheromatous disease, especially strokes, and, although with some decline, ischaemic heart disease, remain among the five leading causes in the UK. Added to these are the problems caused by peripheral vascular occlusion. Early attempts to remove atheromatous obstructing lesions from larger and peripheral arteries were used (and occasionally still are, often incorporating a patch angioplasty) to improve the blood supply to limbs, brain or other organs. One technique of historical interest, developed in the 1950s to clear atheroma from femoral arteries, was the deployment of straight endarterectomy loops (*Fig. 1*). The technique involved performing an arteriotomy and, having found a plane around a tube of atheroma within the vessel, cutting the tube across, inserting the loop around it, and stripping out the tube. The plane usually had to be outside the intima, through the media, so preserving the majority of the muscular coat of the artery. There were problems with this procedure, such as trauma to the artery's integrity, lifting of obstructing flaps of atheroma downstream of the operation, where the tube excision ended. Clearly, using a long straight rigid instrument in a flexible relatively fragile vessel would have its limitations. The technique of arterial endarterectomy (not using loops) is now limited mainly to the carotid and larger arteries, and occasionally removing complex localized lesions in coronary vessels. Endarterectomy has now largely been replaced by synthetic or animal interposition or bypass grafting.

Dr Jack Cannon (dates not currently available) was an American surgeon, who served his surgical residency at the Massachussetts General Hospital.

DeBakey woven bifurcated vascular grafts

In 1954, Michael DeBakey and colleagues began researching various extant materials for grafts, which could be used to manage aneurysmal or occlusive vascular disorders. DeBakey collaborated with Professor Edman, a Philadelphian textile engineer, to build a new knitting machine to make seamless synthetic grafts of varying sizes and configurations (*Fig. 2*). Eventually, knitted or woven grafts were produced commercially, although porosity remained a recognized problem. In patients undergoing surgery for abdominal aortic aneurysm, following cross-clamping of the vessel above and below the aneurysm, the graft is sewn into the bed of the diseased vessel. The old abdominal aneurysmal sac was often then

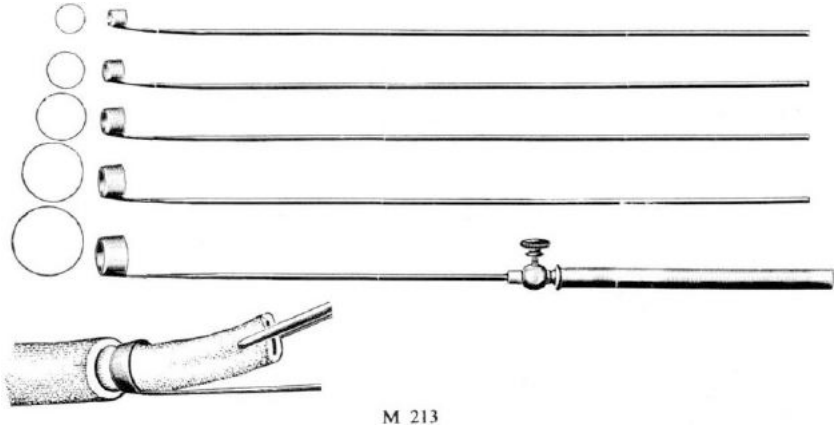

Fig. 1 Cannon's endarterectomy loops, sizes 6–12, with an interchangeable handle
Courtesy of the library of the Royal College of Surgeons of England.

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wrapped around the graft. Knitted grafts had to be preclotted *in vitro* or by briefly releasing the aortic clamp. Many examples of specially designed branched or straight synthetic vascular insert or bypass grafts are currently employed in the treatment of a variety of aneurysmal and occlusive vascular disorders (including dissections), both in the chest and abdomen. These are fashioned from polyester fibre, elasticized woven Dacron® (DuPont, Wilmington, DE, USA) or other plastic materials, such as expanded polytetrafluoroethylene. Other examples are impervious heparin-bonded Gore-Tex® (WL Gore and Associates, Newark, DE, USA), or Vascutek® (Terumo) (Glasgow, Scotland, UK) polyester gelatine-sealed models.

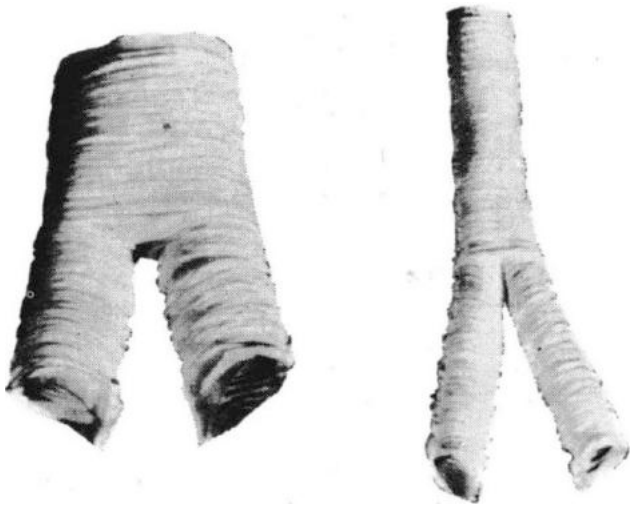

Fig. 2 Early bifurcated DeBakey seamless, woven grafts
Courtesy of the library of the Royal College of Surgeons of England.

Michael Ellis DeBakey (1908–2008), born of Lebanese immigrants, was an American cardiovascular surgeon, scientist, and medical educator who headed up the Department of Surgery, at the Baylor College of Medicine at Houston in Texas. He was an innovative and pioneering surgeon, who pushed forward the development of cardiovascular operations, particularly those for aortic aneurysms and dissection, and also for carotid artery surgery. He developed a roller pump for transfusion and a cardiac ventricular assist system. Several instruments are named after him.

Sauerbruch's sternum cutter

The first sternotomy was carried out in 1897, although rarely used after this until the mid-1950s, with the evolution of cardiac surgery. Today, despite a burgeoning increase in less invasive operations for valvular and coronary artery surgery, around a million patients per year worldwide undergo a median sternotomy.

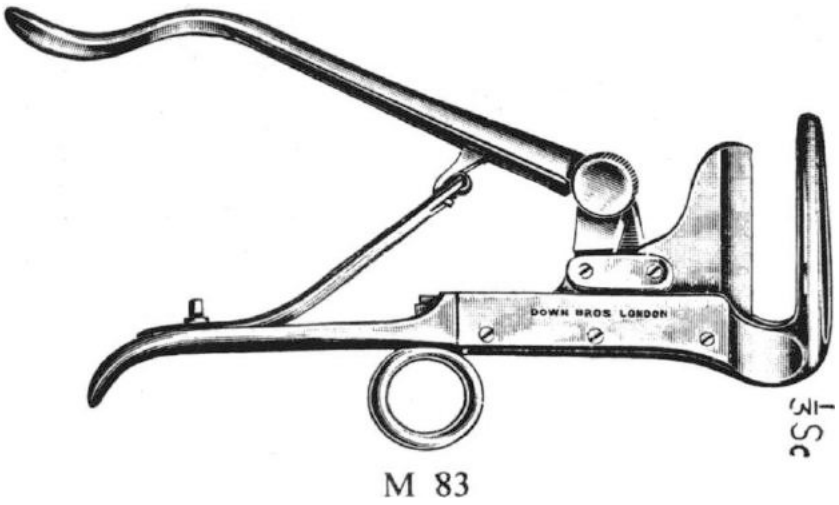

Fig. 3 Sauerbruch's sternum cutter
Courtesy of the library of the Royal College of Surgeons of England.

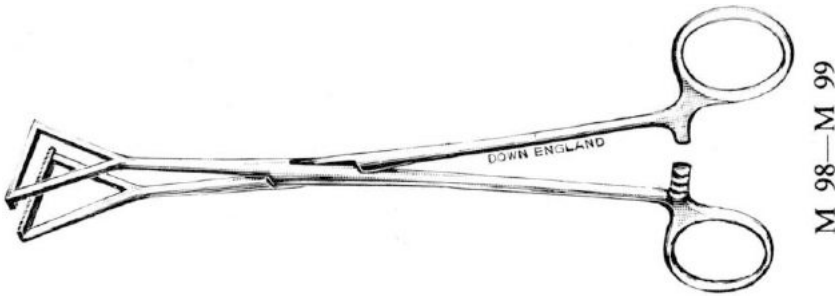

Fig. 4 Duval's lung grasping forceps
Courtesy of the library of the Royal College of Surgeons of England.

Earlier attempts to open the chest for access to the mediastinum, heart or great vessels involved the use of a specially designed Lebsche knife or chisel with a side blade, which could be tapped down the sternum. Another type of instrument was one such as the Sauerbruch sternum cutter (*Fig.* 3). The lower lip of this instrument was held up against the underside of the sternum after creating an incision in the lower part of the neck. The lip would then be slid down the sternum until the full extent of the bite was reached. The instrument was then closed repeatedly, until the whole bone had been divided. Clearly, care had to be taken passing the lip under the bone. Other uses of sternotomy are to provide access for transplant, pulmonary or upper spinal surgery, and also for excision of retrosternal thyroid goitre and mediastinal tumours, particularly those of thymic origin. Today, electric or air-powered oscillating jig or circular saws (the latter especially useful for reopening previous sternotomies) are used to minimize soft tissue damage, while passing up or down the bone. Care is always required to avoid injuries to the brachiocephalic vein while opening and closing the sternum. Today, pulmonary and mediastinal surgery is increasingly being carried out using minimal access techniques.

Ernst Ferdinand Sauerbruch (1875–1951) was a German surgeon who studied medicine in Marburg, Jena, and Leipzig. He later worked in Breslau, Munich, and Berlin. He was well known for his work on negative-pressure chambers used for early thoracic surgery. In World War II, despite being an ardent nationalist, his role in the service of the Nazi regime remains unclear, and he certainly spoke out for victims of persecution and against a euthanasia programme.

Duval's lung grasping forceps

Just to emphasize the importance of careful handling of tissue in surgery, these long, non- crushing ratchet-controlled forceps, with 'gentle' serrated grasping edges, allow a steadying, retracting or occlusive use of the instrument when applied to lung tissue (*Fig.* 4). A similar instrument is available for handling intestine or mesentery (see article 4 in this series).

Professor Pierre Duval (1874–1941), educated in Heidelberg and Paris, served as a demonstrator in anatomy to Louis Farabeuf, a Parisian surgeon who introduced hygiene into medical education. Duval's expertise lay in his studies on shock and burns, and also in gastrointestinal and genitourinary surgery. He served with distinction in World War I and became Professor of the Faculty of Surgery in Paris.

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The Instrumentalist

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The Instrumentalist

A miscellany of instruments part 20—a few instruments of historic interest

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Maurice Lee's vein stripper

Surgical treatment for varicose veins (from the Latin *varicosus*—dilated veins) was noted in Hippocratic teaching from 300 BCE. Here, multiple puncturing of the veins was recommended. Since then, the treatment has encompassed cauterizing, leeching, avulsion, ligation, division, or stripping out. Today, assisted by detailed duplex ultrasound, endovenous therapies such as those using catheter-delivered laser or radiofrequency energy, microwave, steam, or chemical sclerosis are replacing previous operations. One might have regarded ligation and stripping of the long saphenous vein for saphenofemoral incompetence as still being a 'standard' therapy. However, it is not used as frequently as in previous decades. Exposure and ligation of the saphenofemoral junction, followed by stripping out of the long saphenous vein (from the Greek word *safaina*—meaning 'evident', or perhaps 'easily seen') was first described in 1905. It became common practice, in the 1960s/1970s and 1980s.

The long saphenous vein was exposed at the ankle and in the groin and then the saphenofemoral junction was carefully dissected out and all tributaries tied off. The wire stripper (*Fig. 1*), headed with a small acorn, was passed up the vein and, after division of the long saphenous vein at its junction with the femoral vein, the stripper was exited from the vein at the groin and the larger wire head was then drawn up until it impacted at the lower vein incision. The distal end of the vein was divided after a ligature had been passed around the vein over the stripper wire at the ankle. The saphenous vein was avulsed by pulling it up the length of the leg, as a firm compression bandage was applied, following the stripping proximally. Bruising, pain and recurrence could occur. Lee's wire incorporated a saline infusion channel around the introducing acorn to ease passage up the varicose vein.

Maurice Lee (1906–1984) was born in Dublin, but in his early childhood, the family moved to Newcastle-upon-Tyne. He qualified early at the age of 21 and served at sea and travelled widely. He was appointed consultant surgeon to Wexham Park and Taplow Hospitals. He published a good deal and was a founder member of the Ambroise Paré Surgical Club.

Hudson's brace

This drilling apparatus (*Fig. 2*), well-known to carpenters and joiners, is used for creating holes or defects in neurological or orthopaedic settings. The bits used, tightened into the female grip were screws, perforators, or circular saw blades. Now usually replaced by power saws or drills, the brace was formerly used by surgeons to create burr holes for limited intracranial access. Single or multiple applications, using variable sizes of circular blades, were employed after compound or comminuted skull fractures. Sawing the cranium on a relatively stable part of the skull meant that depressed impacted bone shards could be elevated or access could be gained to release blood clots, control intracranial bleeding, debride dead cerebral tissue, and repair the dura if breached. Historically, this type of saw was more frequently used by continental surgeons. British surgeons

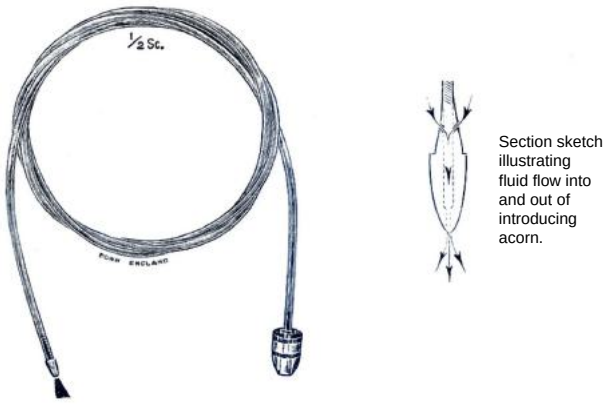

Fig. 1 Lee's varicose vein stripping wire (courtesy of the library of the Royal College of Surgeons of England)

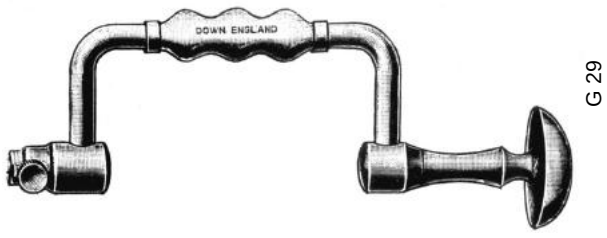

Fig. 2 Hudson's brace (courtesy of the library of the Royal College of Surgeons of England)

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seemed to prefer the shorter trephine, whose application could be made nearer the cranium and thus the depth of penetration was easier to control.

William Henry Hudson (1862–1917), born in Georgia, USA, was an itinerant pioneering neurosurgeon who trained in New York and Philadelphia, eventually settling in Alabama. From there he travelled around with his skills. He designed laminectomy and cranial forceps. In 1913, he published 152 cranial operations without mortality.

Brock's mitral knife

The year 2023 marked the centenary of the first mitral valvotomy for stenosis performed by Elliot Cutler in Boston. The procedure was propelled into the surgical armamentarium since rheumatic heart disease prevailed in earlier times. 'Closed' mitral valvotomy, *via* controlled transventricular or atrial incisions, was ultimately replaced by open heart surgery. Blind incision of the obliterated commissures often resulted in severe iatrogenic mitral regurgitation. Later innovations were developed, using a left or right lateral thoracotomy, and access was gained via the left atrium or its appendage. The finger-controlled small knife illustrated in *Fig.* 3 could cut right or left. There had been many ingenious instruments created to split, dilate, or cut the scarred valve commissures. Results were better with non-calcific disease and mortality rates varied but ranged between 4% and 8%. Better things were to come beginning in the 1960s, using cardiopulmonary bypass with open or recently, minimal access valve replacement and repair.

Russell C. Brock (1903–1980) qualified from Guy's Hospital in 1926 and proved to be a pioneer of open heart surgery. After a successful training, he became a consultant thoracic surgeon to Guy's and the Brompton Hospitals. He accurately described

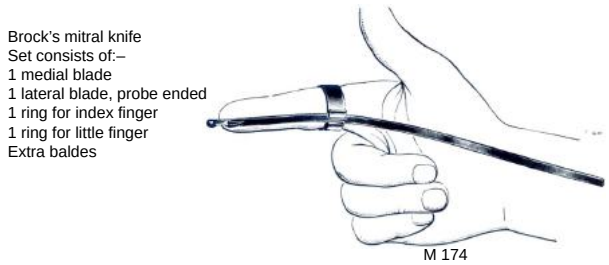

Fig. 3 Brock's mitral knife (courtesy of the library of the Royal College of Surgeons of England)

bronchial anatomy and, after early pioneering work for 'blindly' treating mitral stenosois, he introduced hypothermia and the early use of the heart–lung machine. He was an outstanding clinician and a tough but fair consultant surgeon.

The Mikulicz enterostomy crushing clamp

This was an instrument designed to assist anastomosis of two gut ends after proximal and distal bowel ends had been exteriorized in the form of a 'double-barrelled' stoma. After some time, the clamp (*Fig.* 4) was applied by passing one limb of the clamp (note this example is spiked) down each stoma, and with a crushing action exerted by tightening the hinged screw, pressure necrosis obliterated the spur between the apposed gut sections. The manoeuvre would not in itself effectively result in a closure and burial of the stomas. This would be achieved by mobilizing the stomas, trimming the bowel edges from the skin, and carefully inverting the remaining gut edges with single or double layers of sutures.

Jan Mikulicz-Radecki (1850–1905) was of Ukrainian, German, Austrian, and Polish descent. He studied under Bilroth in Vienna and championed antiseptic surgery. He specialized in early bowel cancer surgery and was one of the first to suture a perforated gastric ulcer, operate on the oesophagus, and wear surgical gloves. During his career, he directed three departments of surgery, at Krakow, Könisberg, and Breslau. Friendly with Brahms, he also proved a talented pianist.

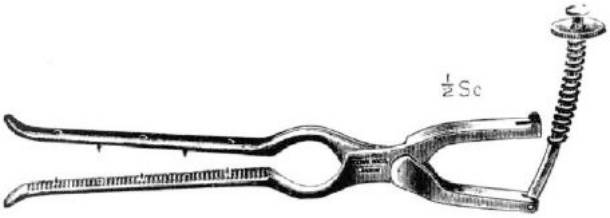

Fig. 4 Mikulicz enterostomy crushing clamp (courtesy of the library of the Royal College of Surgeons of England)

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