Surgical instruments

A **surgical instrument** is a specially designed tool or device for performing specific actions of carrying out desired effects during a surgery or operation, such as modifying biological tissue, or to provide access or viewing it. Along time, many different kinds of surgical instruments and tools have been invented, some of them of a more general character, others designed for a specific type of surgery. Accordingly, the nomenclature of surgical instruments follows certain patterns, such as a description of the action it performs (for example, scalpel, hemostat), the name of its inventor(s) (for example, the Kocher forceps), or a compound scientific name related to the kind of surgery (for example, tracheotome).

The expression **surgical instrumentation** is somewhat interchangeably used with surgical instruments, but its meaning in medical jargon is really the activity of providing assistance to a surgeon with the proper handling of surgical instruments during an operation, by a specialized professional, usually a nurse.

Contents

Classification

There are several classes of surgical instruments:

- Graspers, especially tweezers and forceps
- Clamps and occluders for blood vessels and other organs
- Retractors, used to spread open skin, ribs and other tissue
- Distractors, positioners and stereotactic devices
- Mechanical cutters (scalpels, lancets, drill bits, rasps, trocars, etc.)
- Dilators and speculae, for access to narrow passages or incisions
- Suction tips and tubes, for removal of bodily fluids
- Irrigation and injection needles, tips and tubes, for introducing fluid
- Powered devices, such as drills, dermatomes
- Scopes and probes, including fiber optic endoscopes and tactile probes
- Carriers and appliers for optical, electronic and mechanical devices
- Ultrasound tissue disruptors, cryotomes and cutting laser guides
- Measurement devices, such as rulers and calipers

An important relative distinction, regarding surgical instruments, is the amount of bodily disruption or tissue trauma that their use might cause the patient. Terms relating to this issue are 'atraumatic' and minimally invasive. Minimally invasive systems are an important recent development in surgery. In the future, they devices will include many microscopic autonomous and directed devices.

History

Surgical instruments have been manufactured since the dawn of pre-history (millions of years ago). Rough trephines for performing round craniotomies were discovered in neolithic sites in many places. It is believed that they were used by shamans to release evil spirits and alleviate headaches and head traumas caused by war-inflicted wounds.

Surgeons and physicians in India used sophisticated surgical instruments since ancient times. Sushruta (circa 500 BC) was probably the most important surgeon in ancient history, often known as the "father of surgery". In his text *Sushruta Samhita* he described over 120 surgical instruments, 300 surgical procedures and classified human surgery in 8 categories.

In Antiquity, surgeons and physicians in Greece and Rome developed many ingenious instruments manufactured from bronze, iron and silver, such as scalpels, lancets, curettes, tweezers, speculae, trephines, forceps, probes, dilators, tubes, surgical knives, etc. They are still very well preserved in several medical museums around the world. Most of these instruments continued to be used in Medieval times, albeit with a better manufacturing technique.

The Medieval Breakthrough.

One of the key players who made the real breakthrough in surgical instrumentation was Abu Al-Qassim Al-Zahrawi. The first observation one must make at the outset is that Al-Zahrawi wrote his famous “Al Tasreef liman 'Ajiza 'an Al Ta'leef “, translated as “The Method of Medicine” and often referred to as “Al- Tasreef”, after long experience accumulated over fifty years of practising medicine. The book, therefore, was aimed to establish the rules of thumb in the practical medicine by emphasising the "do" and "don’t" in almost every issue encountered and the solutions/ treatments he provided or invented during this long experience. To complete his practical guide to solving various surgical problems, Al-Zahrawi ended this thirty volumes medical encyclopaedia with a treatise in which he introduces his famous collection of surgical tools exceeding a staggering total of 200 pieces. With its innovative title “On Surgery”, the treatise is considered the earliest elucidation compiled on the subject, which remained as the single best medieval source on the matter until modern times. In the words of Leclerc: “*Al-Zahrawi remains a leading scholar who transformed surgery into an independent science based on the knowledge of anatomy. His illustration and drawing of the tools is an innovation that keeps his contribution alive, reflected in its continuous influence on the works of those who came after him*”

Aditionally, Galen of Pergamum, one of the most profoung philosophers, surgeons, medical philologists and physicians of the ancient world, requested that his specialised surgical instruments be made of iron ore foound only in a quarry in the Roman town of Noricum.Galen along with other early Arab doctors, pioneered the approach to medical instrumentation and his followers of the Medieval period manufactured their instruments based on Galen's early designs.

Hamidan, for example, listed a total of twenty six innovations that Al-Zahrawi introduced . One of such discoveries was his use of catgut for internal stitching, a method that still practised in most of today's surgery. The catgut appears to be the only natural substance capable of dissolving and acceptable by the body.

Al-Zahrawi does not only illustrate the tool using clear hand drawn sketches but also provides detailed information on the material and how and when it is used. Much of these are illustrated in Spink and Lewis's (1973) book, one of the best and most comprehensive work available. For example, in cauterisation he states that: "*According to the opinion of the early (physicians) cauterisation using gold is better than when using iron. In our opinion the use of iron is quicker and more correct*". As he goes on to deal with particular instruments and their use he often gives a clear description of how it is applied in addition to an accompanying sketch.

A second example of such description is what he wrote about the scraper (majrad) tool and its use when turning a fistula into the nose. "*Doctors give the name 'fistula' to what laymen call 'a quill'. When you have treated it with the cautery or with caustic according to the instructions given previously, and it is not healed, there is no clear method of treatment except to cut down on the tumour at its ripening and let out all the humidity or pus therein, till you reach the bone. When bone is reached and you see necrosis or blackness, scrape it with an instrument like this picture. It is called 'rough-head' and is made of Indian iron. Its head is round like a button 2 but is engraved with markings finely engraved, like those of a file or a rasp. Place it on the site of the diseased bone and spin it between your fingers, pressing down a little with your hand, till you are sure all the diseased bone has been scraped away. Do this several times. Then let the place be dressed with stanching and styptic remedies. And if the place heals and flesh is generated there and the flow of sanies is stayed and there is no return after* leaving for forty days, and there is no swelling, and nothing emerges, you may know it is perfectly healed*."*

Not only the Al-Tasreef has exercised strong influence on later Muslim physicians but also became a reference book for most European medical schools and practitioners. It was first translated into Latin by Gherard of Cremona in the twelfth century to be followed by several other translations. Among the many European scholars to quote and cite from "Al-Tasreef" and many other Muslim medical works was the French Guy de Chauliac (d.1369) in his work "Chirurgia Magna". In fifteenth century Italian scholars rediscovered the works of Al-Zahrawi quoting his discoveries and remedies in their work. Among these one can refer to Mathieu de Gradibus who cited from Al-Zahrawi's 27th treatise "Fi Tabai'a Al-Adwiyya and Aghdhiyya". In the same period Arduinis de Passaro produced his book on the nature of poison "Liber de Venenis", citing the work of Al-Zahrawi numerous occasions. Leclerc summarised the impact of Al-Tasreef admitting: "*The translation (of Al-Tasreef) played a significant role in the development of Medieval*

surgery in Europe" The book constituted a central part of the medical curriculum in European countries for many centuries .

The Renaissance and after

In the Renaissance and post-Renaissance era, new instruments were again invented and designed, in order to accompany the increased audacity of surgeons. Amputation sets originated in this period, due to the increased severity of war-inflicted wounds by shot, grapnel and cannon.

However, it was only with the discovery of anesthesia and surgical asepsis that new surgical instruments were invented to allow the penetration of the *inner sanctum*, or the previously forbidden body cavities, namely the skull, the thorax and the abdomen. A veritable explosion of new tools occurred with the hundreds of new surgical procedures which were developed in the 19th century and first decades of the 20th century. New materiais, such as stainless steel, chrome, titanium and vanadium were available for the manufacturing of these instruments. Precision instruments for microsurgery in neurosurgery, ophthalmology and otology were possible and, in the second half of the 20th century, energy-based instruments were first developed, such as electrocauteries, ultrasound and electric scalpels, surgical tools for endoscopic surgery, and finally, surgical robots.

Historically, the development of a surgical instrument follows:

1. The surgeon uses a common tool and/or adapts it for use in an operation. Some ancient sources of such tools are weapons, butcher's tools, items used in ritual body modification, cannibalism or torture, carpenter's, leather worker's and metal worker's implements. (This process still continues, with tools coming out of automobile shops, aerospace workplaces, kitchens, etc.)
2. There is a period of transference and incremental improvement, generally focusing on materials, which must be nontoxic and durable. Blood tends to corrode and the repeated washing and sterilization of surgical instruments tends to quickly destroy many materials; other materials hold stains and bacteria.
3. There is a period of standardization.

However, in modern times, surgeons are also designing instruments from scratch. Also, governmental controls have modified the path of innovation somewhat.