MANUAL STITCHING – THE PAST AND THE PRESENT

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Until the 19th century, surgery focused mainly on external injuries. Procedures on internal organs were sporadic and stemmed solely from the absolute necessity of saving life. Nevertheless, the technical skills of surgeons at the time were considerable, yet the performance of complicated procedures of larger scale was made possible only after the introduction of anaesthesia for pain management. Wars that have plagued humanity were the main setting for physicians gaining the experience in dressing and stitching of wounds (1). We may suspect that the bone needles from the Palaeolithic Era could have also served wound stitching (2). The earliest reports on stitching probably date back to Egypt. The primary source of information on this subject are mummies (circa 1100 BC: a stitch on a mummy abdomen) and papyri. The Smith Papyrus (circa 1600 BC) with surgical texts is one of the direct historic sources providing the greatest volume of knowledge on the treatment and surgeries conducted. It describes various materials used in surgery: instruments, needles, plant-origin fibres, hair, tendons, woollen threads.

The is not much knowledge on the physicians and treatment methods in ancient India. The medical sensation proved the information on the performance of surgeries combined with peritoneal opening and the manner of intestinal stitching. Ants with large mandibles resembling forceps were used to this end. They were put against the neighbouring wound edges when their mandibles were open. Once they closed them, their thoraces were ripped away and the abdominal integuments were stitched by layers with threads. The above method did not cause purulent inflammation, since the formic acid had strong antibacterial activity (Fig. 1).

One of the first known names of Indian physicians is Susruta. It is suspected he lived 800 years BC. However, other researchers

Fig. 1. Bengali ant
(http://sknchirurgiamiedzylesie.wum.edu.pl/abstract/OSKA/rany.html)
claim his activity was in 400 AD. The range in the date of birth of this unusual physician is enormous and stands at approx. 1200 years. He was the first one to describe in detail the wound stitching and materials used for it. In use were well-boiled cotton, hemp, phloem, animal hair and tendons. He described eight types of surgical procedures, including stitch application following intestinal incision (3, 4). He also wrote about how future surgeons had been learning the technique of stitching by using pieces of cloth or leather. He freed the medicine of his era from magic and mysticism, replacing them with sensible medical knowledge, particularly in the field of surgery (fig. 2a and b) (2).

Not much is known about surgical procedures in Greece of Hippocrates times (460-377 BC). Although, it is certain that he was undoubtedly one of the greatest physicians of all times, he laid down the foundations of medicine in the 4th century. Most likely, stitches were used only on superficial body wounds. The materials used for stitching were, similarly as in Egypt, India or other ancient countries, plant-origin fibres and animal tendons. The Greek surgeon Antyllus, already in the 2nd century BC, performed bone and joint resections, tracheotomies and the first surgeries of post-traumatic aneurysms with the use of materials derived from animal intestines. Most of the surgeries on the abdominal cavity were introduced by the Romans. They were removing the injured or diseased internal organs and stitching the wound carefully. The patients were anaesthetised using various narcotic extracts (e.g. opium) or alcohol (5). The largest amount of information on the Roman surgery was provided by Aulus Cornelius Celsus (3 BC – 64 AD). He was one of the main authors of medical texts of his times and an outstanding polymath. He described all the subsequent steps and manner of their performing in hernia surgery. He was recognised as an authority in the field of military surgery of Roman times. He knew both the running and the simple stitches. He described the application of tourniquets to stop the bleeding. Another great Roman physician was Galen (129-199 AD), taking care of gladiators in Pergamon. He described the stitching of abdominal and vascular injuries. He shared his experience in close to 400 texts which were the main source of medical knowledge for the subsequent dozen or so ages.

The Middle Ages were the era of activity of folk doctors and monks practicing medicine. The knowledge on surgery was reaching Europe mainly through the school in Salerno. Similarly as in the antiquity, the goal of surgeons was to find an ideal material for wound stitching. It should be characterised by the following properties: flexibility, resistance to stretching, uniformity, should not irritate the skin or contain substances that might cause harm to the human body. The biggest advances in this field were made by the Arabs. The most outstanding ones were Rhazes (circa 850-923) and Avicenna (980-1037). They stitched wounds with the use of material obtained from lute strings. Abulcasis (936-1013), a famous Arab surgeon, had knowledge on various stitching techniques and sutures used for abdominal wounds. The needles used by him, straight or angled, were made of bone or bronze. In his work, Al Tarif, he described the ligation of large blood vessels, he invented the vaginal speculum, performed orthopaedic procedures with the use of instruments for bad posture correction, made by himself. As a stitching material, he used: strings, hemp, animal fibres and tendons, hair and silk threads. In the 12th century, Roger of Salerno and in the 13th century Rolando of Parma, physicians associated with the Salerno school, recommended the application of internal abdominal sutures made of animal intestines. After the Salerno school lost on significance, the leadership in medicine went to a centre located north of Salerno – Bologna. A known figure associated with the medicine faculty in this city was Ugo di Borgognoni (circa 1160-1257) also known as Ugo or Hugh of Luca. His medical views are known owing to the works of Theodoric (1205-1296), who was his...
student and most likely his son. Theodoric feared stitching even the smallest wounds. He believed that they should heal spontaneously, under a bandage. He recommended suture application only in cases where the wound edges were separated so much that it precluded healing (2).

The 16th to 18th centuries did not produce any innovations in wound healing. As in the earlier eras, divergent opinions on this subject existed. The person who initiated modern surgery was Ambroise Paré (1510-1590). He replaced wound cauterisation by hot iron with vascular ligatures, he improved the amputation technique, he performed hernia surgery without simultaneous castration as done before, he introduced plastic surgery of cleft lip and palate, he described foetal repositioning from its incorrect position. He designed orthopaedic devices with which he attempted to restore the limb function (6). He was the first one to use artificial eye ball.

A huge breakthrough in surgery is the 19th century and the first half of the 20th century, resulting mainly from the developments in general anaesthesia and counteracting pain during surgical procedures, as well as the advances in antiseptics and asepsis. Ignaz Philipp Semmelweis (1818-1865) was the first one to take on the fight with infections, while Joseph Lister (1827-1912) used carbolic acid for hand washing, spraying of operating field, dressings, sutures and in the air in the operating room. He introduced the carbolic acid-soaked catgut (1869); at the same time, he paid attention to cutting the sutures right above the knot so the suture ends do not hang from the wound – this was an innovation (6).

After the implementation of antiseptics, the incidence of infections dropped and stood at below 5% (7). The name “catgut” was invented at the end of the 16th century and meant a thread or string made of sheep’s intestines, used in the manufacture of violin strings. In surgery, it started to be used in the 17th century, when it was noticed that as a material used for wound stitching it results in a lower incidence of infections than the materials used before (11). An exceptional success of the American gynaecologist James Marion Sims (1813-1883) from Alabama was the use of silver wire in surgeries of vesicovaginal fistula (1852).

It should be mentioned that the above procedures were performed on African American slaves by the names Anarcha, Betsy and Lucy without anaesthesia, mainly because it was believed that African Americans are extremely resilient to pain, as opposed to Caucasian females. In addition, Sims feared inhalation anaesthesia. Before that (1838), John Peter Mettauer (1787-1875) from Baltimore used lead wire in such procedures (6). Apart from the metal materials, such as silver, copper, bronze, aluminium wire, also in use were plant-origin products: flex, hemp, cotton threads, and animal ones: fur, tendons, blood vessels, muscle and nerve strips, silk, catgut. Chrome catgut was the first suture developed specially for the needs of surgical procedures in 1881. The German physician Franz Kuhn (1866-1929) developed sterile catgut in 1906. Since then, catgut and silk has become the most popular materials for wound stitching in Germany and many other countries. It enjoyed popularity until 2001, when it was withdrawn in many countries due to the risk of Creutzfeldt-Jakob disease.

In 1902, the French surgeon Alexis Carrel (1873-1944) published his work in which he described a new technique of performing vascular stitching. It consisted in performing end-to-end anastomosis, the so-called axial anastomosis, or end-to-side one, the so-called lateral-axial anastomosis, as a “reliable, multiple, technique of stitching. Creating new possibilities in the field of cardiac surgery and vascular surgery and in organ transplantation” (8). The 19th century also brought the developments in science and chemical industry, which to a large extent contributed to the modification of materials used for wound stitching. The first synthetic absorbable sutures based on polyvinyl alcohol appeared in the early 1930s, produced by B. Braun Melsungen in collaboration with Wacker Chemie. In the years 1946 and 1949, there were introduced in clinical practice coated polyamide sutures (Supramid) by BASF, while between 1950 and 1951 – synthetic collagen sutures Collafil.

Further research in this direction revealed that polyacids may be used in the manufacture of absorbable sutures of particularly advantageous properties. In the 1970s, in the hospitals worldwide, there was introduced the suture made of glycolic acid, Dexon, which in 1979 was modified and named Dexon S (9). Presently, depending on the indications, there are used absorbable sutures made of cutgut...
and chrome cutgut, and synthetic absorbable sutures made of glyconate, polyglycolic acid. The threads in those sutures are woven, coated with magnesium stearate or polyglyconate. There are also used natural non-absorbable sutures made of metal materials (stainless steel) and natural ones of silk; they may be woven and coated with wax, and twisted, made of linen fibre coated with silicone and polyvinyl solution. On the other hand, synthetic non-absorbable are made of polyester and may be coated with polyethylene or vinyl acetate. In cardiovascular surgery, there are used non-absorbable sutures made of polypropylene, polyamide coated with polyamide 6 and polyester coated with silicone (10).

The observations of many centuries and experience associated with the use of various materials of animal and plant origin for wound stitching have undoubtedly contributed to the development of surgery as a medical specialisation, enabling the performance of increasingly more complicated surgeries. The development of synthetic material technology that took place in the 20th century enabled the elimination of complications associated with the use of natural materials in wound stitching, reduced the incidence of post-operative wound infections, enabled the refinement of surgical techniques. The evolution of surgical suture constitutes an excellent example of mutual impact of medical skills and medical technology, contributing to the development of medicine.

REFERENCES


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