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History of osteosynthesis in the Department of Orthopaedics and Traumatology, Medical University of Gdansk, based on examination of surgical instruments withdrawn from the operating theatre

Historia osteosyntezy w Katedrze i Klinice Ortopedii i Traumatologii Narządu Ruchu Gdańskiego Uniwersytetu Medycznego na podstawie badania narzędzi chirurgicznych wycofanych z bloku operacyjnego

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HISTORY

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Abstract

Based on the analysis of surgical instruments withdrawn from the operating theatre, it was decided to briefly present the history of osteosynthesis in the orthopaedic department in Gdansk, Poland. Boxes with orthopaedic instruments withdrawn from the operating theatre were obtained. The instruments were grouped, numbered, photographed and catalogued. Not all obtained instruments were used in orthopaedics; the boxes contained several instruments typically used in other fields of surgery. Attempts have been made to divide orthopaedic instruments into several groups, depending on their use in bone fixation. Some specific instruments are used only in one method. The most interesting tools are discussed in detail, with attention to their features and role in shaping modern orthopaedics. Some of the obtained equipment could have been made in the Orthopaedic Workshop in the hospital. They are specific exhibits related to the development of orthopaedics in this hospital that required preservation.

Key words: history of medicine in Gdansk (Poland), surgical instruments, osteosynthesis.

Streszczenie

Na podstawie analizy narzędzi chirurgicznych wycofanych z sali operacyjnej postanowiono pokrótce przedstawić historię osteosyntezy na oddziale ortopedycznym w Gdańsku. W badaniu wykorzystano pudła z narzędziami ortopedycznymi wycofanymi z sali operacyjnej. Narzędzia zostały pogrupowane, ponumerowane, sfotografowane i skatalogowane. Nie wszystkie narzędzia były wykorzystywane w ortopedii; pudła zawierały również kilka narzędzi typowo stosowanych w innych dziedzinach chirurgii. Podjęto próby podzielenia narzędzi ortopedycznych na kilka grup, w zależności od ich zastosowania w zespalaniu kości. Istnieje kilka specyficznych narzędzi, które są używane tylko w jednej metodzie. Szczegółowo omówiono najciekawsze narzędzia, zwracając uwagę na ich cechy i rolę, jaką odegrały w kształtowaniu współczesnej ortopedii. Część uzyskanego sprzętu mogła zostać wykonana w Pracowni Ortopedycznej w szpitalu. Są to specyficzne eksponaty związane z rozwojem ortopedii w tym szpitalu, które wymagały konserwacji.

Słowa kluczowe: historia medycyny w Gdańsku (Polska), narzędzia chirurgiczne, osteosynteza.

Introduction

The term "osteosynthesis" originates from ancient Greek ("osteon" – bone and "synthesis" – the process of putting together [1]) and means the stable fixation of broken bone using implants made from artificial materials. The creator of this word is the Belgian surgeon Albin Lambotte, who used the term "osteosynthesis" in his original book about fracture treatment in 1907 [2].

In modern times, we use many technologically advanced methods of osteosynthesis. It is a multidisciplinary science consisting of medicine, biophysics and biomedical engineering. The historical aspect must also be noted; however, it should not be analysed without knowledge about a specific hospital or country, as local conditions often influence the guidelines or preferred treatment options.

The Department of Pediatric Surgery and Orthopaedics was established in the Gdańsk Medical Academy (GMA) buildings at Dębinki Street on July 5, 1945. Then, at the beginning of 1953, the department was transformed into the Department of Orthopaedics of GMA, which in August of the same year was transferred to the buildings of the Municipal Hospital in Gdańsk. The location is the same to this day. Initially, the Department's interests were treating congenital defects, hip dysplasia and complications of polio. In the fall of 1956, rooms for adult patients were opened, gradually expanding the spectrum of surgeries performed, including traumatology procedures [3].

The Municipal Hospital also housed Clinical Orthopaedic Workshops. They were established in 1959 and were mainly engaged in the production of braces and orthopaedic supplies. The transformation of the Clinical workshops into Provincial allowed the opening of an experimental department under the leadership of engineer Janusz Martin (both events in 1969). This workshop produced surgical instruments and osteosynthesis implants. The production of own supplies permitted using the latest state-of-art techniques in the era of severe shortages [4].

Based on the analysis of surgical instruments withdrawn from the operating theatre, the authors decided to briefly present the latest history of osteosynthesis and traumatology, with particular emphasis on its development at the Department of Orthopaedics and Traumatology of the Medical University of Gdańsk (MUG).

In November 2019 and May 2020, two boxes were packed with used surgical instruments withdrawn from the operating theatre. One of the authors (J.O.) reviewed the equipment contained in the received boxes, grouped, catalogued and photographed them. In the case of several identical pieces, the entire group was given one number. Current catalogues of the leading manufacturers of orthopaedic instruments (Aesculap, ChM) [5,6] and older positions such as the "Catalogue of medical articles" from 1952 [7] were used in the identification process. Not all the received instruments are in current use; some are historical equipment, therefore the need to use older literature. The punch marks and signatures on some pieces were also helpful in identifying them. It was possible to find them in the appropriate manufacturers' catalogues, which led to determining the exact name and purpose of individual elements.

Review of devices

The boxes contained several pieces of equipment used in other fields of surgery (urology, gynaecology, general and vascular surgery, neurosurgery and ENT surgery). They have been catalogued in the above-mentioned manner, but it has been decided not to include them in the article below. The instruments wear out over time - there were a few destructed items in the boxes. They were also not included in the article.

Orthopaedic instruments were divided into several groups depending on their use in osteosynthesis. The following groups of equipment were distinguished: arthroscopy, alloplasty, wires and rods, bone plates, intramedullary nails, bone screws, external fixation devices, skeletal traction and other orthopaedic instruments. In some cases, the process of assignment to one specific group was complicated - some instruments, such as bone screws, are used in several different methods of bone fixation (osteosynthesis with lag screws or screws as a part of bone plates).

The history of arthroscopy and alloplasty is not related to the topic of this article; therefore, the instruments assigned to these groups will not be described in detail.

Skeletal (direct) traction is not a method of osteosynthesis; it is classified as a functional treatment of fractures. The collection includes two traction clamps (Kirschner II clamps, according to catalogues) and three traction rods eponymously known as Denham rods (with threading in the middle part, which ensures stability inside the bone). The skull traction was used in the injuries of the cervical spine. A Crutchfield tong was used in this procedure; sadly, there is no such clamp in the obtained instruments. However, there are drills for drilling into the skull to prepare the bone for such traction. They have a special depth limiter, necessary for not exceeding the limit of the diploe and not damaging the dura (Fig. 1).

Fig. 1. Bone traction.

The first widely used intramedullary nails were the Küntscher nails. The obtained equipment contained elements of the original instruments used in this osteosynthesis method. The bone awl (reamer) was used to drill manually through the cortical bone to provide access to the medullary canal. Then, rigid guides were inserted, and the nail was hammered inside the bone using an impactor. One of the preserved impactors has the manufacturer's signature – "Spółdzielnia Pracy Pruszków, Zrzeszenie Metalowców". This proves that in past times not only specialised manufacturers were involved in the production of medical equipment. An interesting piece is a small Küntscher nail with drilled holes at both ends, possibly to interlock it. This is an example of improvisation with limited resources. In later years, numerous modifications were made to the intramedullary nail method, including the drilling and rinsing of the medullary canal. For this purpose, two flexible drill bits and a polytetrafluoroethylene (Teflon) tube have been preserved (Fig. 2).

Fig. 2. Kuntscher instruments.

Wires and rods are one of the earliest methods of osteosynthesis. The instrument set includes two pieces of wire used for suturing bones. The special needle used for guiding the wire was produced by the J. Odelda company, Vienna. However, it was impossible to establish even the approximate date of its production. Martin Kirschner (born in 1879 in Breslau, obecnie Wrocław) introduced the eponymously named wire in 1909 (commonly referred to as K-wire) [8], used for percutaneous stabilisation of bone fragments. Steinmann rods (by Swiss surgeon, Fritz Steinmann [9]) have a similar use but are thicker in diameter and so may be used in bone tractions. Both of the above wires are included in the collection. Bone staples are used to connect bones after osteotomies or to temporarily block the growth cartilages to correct joint deformities (Fig. 3).

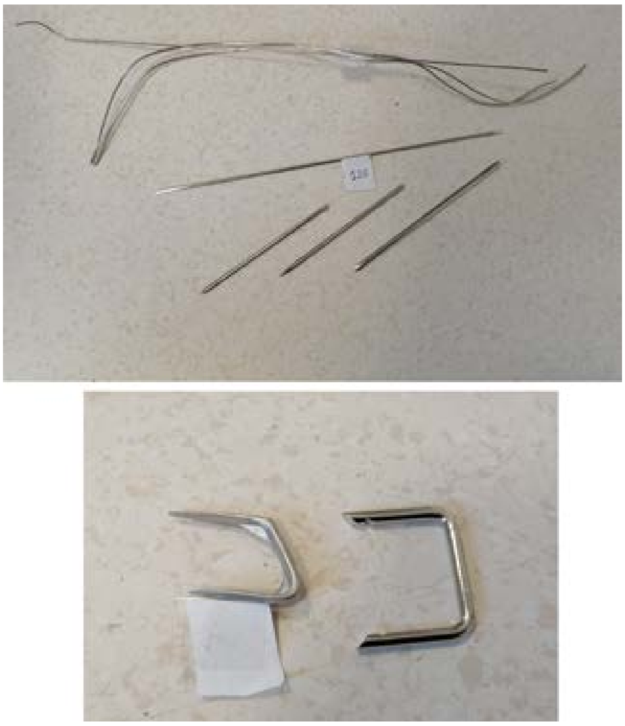

Fig. 3. Wires and rods.

The first step in screw fixation is drilling a hole in the bone with drill bits. Then, the hole is prepared with a bone tap. The collection includes 4 pieces of manual bone taps. Special gauges were used to measure the depth of the hole in order to select the appropriate screw length. The screw was then inserted using screwdrivers or spanners. Initially, flat cuts were used on the heads of the screws; now, the cuts are in the hexagonal system. The collection includes a bone screwdriver with interchangeable caps, a modern screwdriver with a screw retainer and several hexagonal spanners (two of them are proprietary designs, made of appropriately bent wire). To avoid excessive pressure on the cortical bone, washers are used to distribute the force over a larger area. This is especially important in patients with osteoporosis. Several bone screws were preserved, some of which are self-tapping, i.e., they do not require threading of the hole before insertion. These types of screws are widely used today (Fig. 4).

Fig. 4. Bone screw instruments.

A large number of bone plates and instruments used for osteosynthesis have been collected. Classic compression plates required a compressive apparatus to approximate the bone fragments closely. The apparatus preserved is not an AO apparatus but a Karpff compression apparatus [10]. An interesting piece is an American-made compression plate, patented in 1966 by Harry Treace (US patent 3,463,148) [11] (Fig. 5). This proves that the implant development process occurred independently of the AO foundation. The bone plates were also used to stabilise the bone after corrective osteotomies, and the wedge located on the lower surface of the implant fits into the incision made in the bone. The first method of treating a hip fracture was nailing. The so-called nail plates (plates that could be joined with a bone nail), several plates, probably produced by the Provincial Orthopedic Workshop in Gdańsk

[4], have survived to this day. The angular plates were a further improvement; they had the intraosseous part. The bone hole for this part was made with a special gouge. Two types of such gouges were obtained. Dynamic screw plates have been used in fractures of the proximal and distal ends of the femur – DHS (dynamic hip screw) and DCS (dynamic condylar screw) (Fig. 6).

Fig. 5. H. Treace bone plates.

Fig. 6. Bone plates.

External stabilisation was introduced on a large scale by Clayton Parkhill and Freeman (both in 1897, USA) and Albin Lambotte (1902, Europe) [12]. The collection included several dozen support rods that could be used in AO stabilisers or Konzal stabilisers, an extended stabiliser element and three Schanz screws used to secure the bone stabiliser.

The distraction-compression apparatus found in the boxes are authentic, unique pieces. These instruments were manufactured in the Orthopedic Workshops at the hospital. Unfortunately, the exact time of their production is unknown. The authors only have a photo of almost identical stabilisers produced in the local workshops in the 1960s[4]. An interesting coincidence is the similarity to the Indian JESS stabiliser (Joshi External Stabilizing System). However, it was not possible to establish a precise date for the development of this Indian stabilisation system [13] (Fig. 7).

Other instruments include retractors, coagulation electrodes, a dermatome blade, surgical needles, raspators, bone elevators, bone curettes, osteotomes, oscillating saw blades, rongeurs, chisels and bone holders. Each of these instruments is used in traumatology (Fig. 8). Two retractors deserve special attention; they are intended for delicate structures, e.g. nerves, vessels or hand surgery procedures. They were produced by pressing and properly bending a straight metal wire (Fig. 9). In 1979, the Department of Hand Surgery was established in the Department [4]; therefore, it is possible that these retractors were from that period and used during precise procedures, although these assumptions cannot be verified.

Fig. 7. Distraction – compressive apparatus.

Fig. 8. Other orthopedic instruments.

Fig. 9. Retractors for delicate structures.

It should be underlined that Polish orthopaedists also influenced the development of osteosynthesis methods. The achievements of professor Andrzej Gruca deserve special attention. The most notable examples are the traction table for orthopaedic surgeries, the designs of the traction apparatus and the set for closed nailing of the femoral neck [14]. In the post-war times, Stanisław Pyszko from the hospital in Nowy Bytom patented a modification of the Küntscher nail allowing its extraction from both sides [15] and (together with engineer Franciszek Wójcik) a new type of nail extraction device operating on the inertial principle (devices with a similar idea of action are used extensively to this day) [16]. At the turn of the '70s and '80s, Witold Ramotowski developed a Zespol stabilisation system, which could be used both as an external or internal fixation (depending on the anatomical area). The innovation in this implant was the rigid connection of the screw with the plate so that it did not have to adhere closely to the bone surface. The first human implantation surgery took place in 1982 [17,18]. This idea was developed by introducing the Polfix stabiliser in 1993, characterised by a better biomechanical profile than its predecessor [19]. The Zespol system can be considered a precursor of locking plates.

Conclusions

The analysis of the development directions of historical osteosynthesis methods allows for a better understanding of those currently used. In addition, it deepens the awareness of how far the current traumatology has progressed and what advanced techniques we use today. Several main trends can be distinguished within modern osteosynthesis. Initially, in the second half of the nineteenth century, bone suture with wire dominated but was gradually replaced at the turn of the century by various types of bone plates, which were unreliable and far from perfection. The times of World War II popularised intramedullary nails, which for several years became the primary method of stable osteosynthesis due to their superiority to the bone plates of that time. A milestone in the field of surgery was the establishment of the AO foundation and development of new types of plates that forever defined the concept of stable osteosynthesis. Currently, we observe the coexistence of various techniques (plates, screws, nails, wires, external stabilisers), each of them has its advantages and disadvantages and is especially applicable to specific types of fractures. We owe the organisation and systematisation of knowledge about bone injuries and the most appropriate methods of their treatment to the AO Foundation.

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