Since the ancient times, man was faced with the problem of fracture treatment, which is first described in the records from ancient Egypt. Ever since, many treatment methods have been developed, but the real revolution in the fracture treatment was achieved by internal fixation. Since it was described for the first time, at the end of the 18th century, this method has continuously developed, but sterilization, radiographies, anaesthesiology, antibiotics made this surgery modern and safe. The great ideas and practical solutions of the new methods were done by Albin Lambotte, William Arbuthnot Lane, Robert Danis, William Hey Groves. They lead to the expansion of this method and truly made the principles for the future AO school. New methods, biological internal fixation, minimally invasive procedures, new technologies and devices for internal fixation are introduced in the surgical practice daily.

Key words: fractures, internal fixation, history of medicine

INTRODUCTION

The term "Osteosynthesis" has origin in Greek words "osteo", which means "bone" and "synthesis" as "combining separate materials or elements into a united entity". Osteosynthesis is a term for surgical techniques to treat fractures of bone using specially designed metal plates, screws, nails and other devices which is usually removed after the fracture union. All these procedures have one aim - to achieve the bone union, mobility and return to normal function and to avoid complications associated with conventional methods using plaster cast or skeletal traction.

Although one of the first description of the fracture management dates from Ancient Egypt (2600 B.C.), the first description of the real fixation was in the 18th century 1. Rapid industrialisation in the 1900’s, the appearance of the first car and road traffic accidents (RTA), World War I resulted in increased needs for fracture treatment worldwide. At XIX century, conservative treatment was preferable and the pioneer of the conservative treatment was the Austrian physician Lorenz Böhler. His method was based on the reduction of the bone, immobilization using plaster casts or skeletal traction and early physical exercises in order to avoid complications such as joint stiffness and/or muscle atrophy 1-2.

Bohler methods were popular because in the first half of the nineteenth century, surgery was compromised by pain and infection, which resulted in the lethal outcome in many of the cases. The possibility of the operative treatment of fractures was enabled by the four major inventions: anaesthesia (1846), antisepsis (1865), X-rays (1895) and antibiotics (1936,1944). In the following years, the orthopaedic surgery was dramatically improved. Radiology became an integral part of bone and joint surgery. All types of osteosynthesis-devices, i.e. plates (Hansmann 1886), external fixation (Parkhill 1897) and intramedullary nails (König 1913) were introduced into clinical practice 3-4. Extrenal fixation still remains the usefull device for treating open fractures, in compression of non-union, or distraction. But, this is special kinds of external fixation, and this concept is different to the internal fixation one. Basic experiments were undertaken, surgical approaches described and the first textbooks on osteosynthesis published by Hey Groves in 1916 (textbook: "On modern method of treating Fractures")5. Because of the anti-septic technique, anaesthesia and x-ray, introduction of alloys in 1912, and innovation of stainless steel (1926) made real improvement in internal fixation. Afterward, the real inert material were founded, like titanium.

Beginnings - early stages of fracture treatment. It is generally considered that the first fixation of the fragments were done by wire ("cerclage")6. According to the Mal-
The first such procedure was performed in 1770 in Toulouse in France, by Lapujode and Sicre. The fixation of bone fragments using an iron wire was mentioned for the first time in a French manuscript in 1775. Nevertheless, the first internal fixation of a fracture using an iron wire was contributed to Kearny Rodgers in 1827, who resected the pseudoarthrosis of the humerus and than connected the fragments with silver wire. The use of cerclage wires remained popular in this period. The father of the well-known French writer Gustav Flaubert, dr Achille-Cléophas Flaubert, had done 1838 the cerclage of the open fracture of the humerus. Jozef Lister is not only the father of asepsis, he also used metal wires to fix even closed fractures since 1870.

This technique was adopted by Trendelenburg in Germany and by Lucas Championnire in France. In all those cases, "osteosynthesis" consisted of an open reduction of the fracture followed by a very unstable fixation with cerclage wires. (Figure 1)

The first book, where the internal fixation has been mentioned, was published 1870 with the title "Traité de l'immobilisation directe des fragments osseux dans les fractures" ("About direct immobilisation of the bone fragments in fracture") by Bérenger Féraud (1832-1900). In this book he described the three cases of tibia fractures, which he treated by cerclage after conservative treatment failure.

**SCREW FIXATION**

The methods of screw fixation was first described by the group of French surgeons in the case of patients with sternum and olecranon fracture. This was the improvement compared to the fixation with the cerclage. This was the interfragmental fixation, which was exactly denoted to the fracture.

**PLATE FIXATION**

The first fracture fixation with plate had been performed in 1886 by German surgeon Hansmann. The plate could bend distally under right angle, and after the plate was placed on the bone, it protruding from the skin and this enabled its easier removing. The screws were also similarly designed, they protruded above the skin in order to make the removing easier (Figure 2). This was the half way to external fixation.

The man who introduced the term of osteosynthesis and the father of internal fixation was the Belgian surgeon Albin Lambotte (1866-1955) (Figure 3). His father was an army surgeon, and often studied in the dissecting room. Lambotte became the surgeon in Antwerp in the year 1890 and in 1902 he started to dealing with fracture treatment. Earlier he faced cholera, diphtheria, he performed spinal surgery, cerebral hematoma drainage, treated ostearticular tuberculosis. In 1892 he introduced the "no touch" technique, which makes surgery safe (Figure 4). His first fixation was the fractured tibia when he fix it with the plate, but corrosion occurred. In 1902, he performed osteosynthesis of the femur. During this period he spent a lot of time, both in the operating room and his workshop, producing his own internal fixation devices and instruments for fracture treatment. Afterward he started to use it in the patients. Lambotte pushed his students to train in the workshop, believing that this is an excellent opportunity for the orthopaedic training. His relationship to students and residents was dedicated. In 1905 Lambotte begin to use plates. And in 1908 he published the results of his work of the internal fixation of the 35 femur fractures. He was known as a very skilled surgeon and he also play violin. Privately he also made 182 violins. Actually he was hard working person who told the important sentence, before he died: "the greatest crime a man commits against himself and humanity is to be inactive." But he died in poverty at age of 90 years. Beside Lambotte, another doctor who was responsible for and contributed to the use of internal fixation in the fracture treatment was is Scottish surgeon Sir William Arbuthnot Lane (1856-1938) (Figure 5). In 1915, Sir William Arbuthnot Lane published his classic work about fracture treatment "The Operative Treatment of Fractures" (Figure 6).
The first interfragmental fixation was done by him and from 1892 he treated every fracture with internal fixation. He wrote: "Therefore I decided to treat the bones as one would the broken leg of a table or chair. The surfaces were brought into accurate apposition, and kept in their normal relationship with lion forceps. Holes were drilled above and below the forceps, and screws were driven in". (from "A method of treating simple oblique fractures of the tibia and fibula more efficient than those in common use.", W. Arbuthnot Lane, M.S, 1894). He also introduced "non touch" technique in the orthopaedic surgery of that time. Thus Lane in 1883 wrote on fractures, making conclusion that the open reduction with rigid fixation was necessary. That was very brave for that time. Actually he started the new era in orthopaedic surgery in 1905, he used plates (Figure 7). Despite the criticism of some colleagues for "unjustifiable procedure", he continue with his work - operative treatment of fractures. He treated the nonunion of the neck of the femur with two long screws from the greater trochanter, through the neck into the femoral head, achieving union.

To obtain reduction and control of the fracture, Lane used two pairs of bone forceps with long handles, which kept the hands well away from the wound. No-touch technique was the base of Lane's fracture surgery. But, Lane was eccentric, and some called him dangerous man, because he treated people with bone tuberculosis and rheumatoid arthritis with illeocolonectomy because he thought the cause of these diseases was constipation. This was quite strange, but anyhow he made the basis of fracture surgery. After he retired he start to promote healthy life, and in 1913 become Sir.

Another famous name in the field of internal fixation is Ernest William Hey Groves (1872-1944), an English surgeon. Before the days of the Smith-Petersen nail, he fashioned pins from beef bone and horns to made fixation of the fractures of the neck of the femur.

The great contribution to the modern treatment of hip fractures was given by Austin Talley Moore (1899-1963). Austin Moore was a pioneer in the use of the femoral-head prosthesis which enabled many elderly patients a chance to survive.

OSTEOSYNTHESIS

The term "osteosynthesis" was used by the Belgian surgeon Robert Danis (1880-1962). His work "Théorie et pratique de l'ostéosynthèse" had a great influence on the future German-Swiss AO school. In the 1949 he described the main principles of internal fixation: "In order to be completely satisfactory, internal fixation must fulfill the following three requirements. (1) Enablement of immediate, active movement of muscles in the affected region and the adjacent joints. (2) Complete restoration of the original shape of bone. (3) Direct union of the bone fragments without the formation of visible callus."

Pioneers of the surgical treatment of the fractures were Albin Lambotte, Robert Danis, Fritz König, William Lane and Gerhard Küntscher enable the AO school. Actually, the founders of this school only refreshed their ideas...
and made them more "scientific" in terms of modern language.

AO school is a German-Swiss group who provided a systematic approach to the fracture treatment which can be reproduced by surgeons all over the world. AO (Arbeitgemeinschaft für Osteosynthesefragen, ger.) was founded in the 1950s in Switzerland by Maurice Müller, Martin Allgöwer, Hans Willenegger, Robert Schneider and many other general and orthopaedic surgeons, engineers and metallurgist. The first one, Maurice Edmond Müller (1918 - 2009) was a Swiss orthopaedic surgeon who develop internal fixation techniques. The basic principles, as already mentioned, refresh the old ideas of anatomical reconstruction of fracture fragments, stable internal fixation with preservation of the blood and aim to obtain early active mobilisation of the operated limb and the patient in order to avoid "fracture disease".

The interfragmental compression, originally described by Robert Danis, became extremely popular due to the work of the Swiss AO-group in 1950s. During the time, the disadvantages of internal fixation became evident, because damage of the muscle, periost and vascularization with additional plate interfering with bone blood supply led to anything but the union.

The good thing was that those observations led to the development of the "biological plate osteosynthesis".

NEW IDEAS - BIOLOGICAL PLATE OSTEOSYNTHESIS

"Biological plate osteosynthesis" is a new term which was introduced in 1985 and includes a number of new techniques of osteosynthesis. The primary aim was to create a plate fixation without disturbance to the soft tissues and the periosteum. To achieve this result, the Wave Plate or the Limited Contact Dynamic Compression Plate (LCDCP) was developed. The LC-DCP is an improvement of the Dynamic Compression Plate developed by Perren in 1969. Extrenal fixation is still method of choice for the treatment of open fractures, and fixateururs with rings are suitable for compression or distraction at fracture site. Intramedulary nailing is method, primarily reserved for femur and tibial fractures, when compression effect can be obtained. But, in this article the main idea is to present internal fixation.

Stainless steel was replaced by titanium and the design of the plate was also changed. Due to the new design, bending of the plate, the vascularisation of the bone fragments is minimally destroyed and callus formation is better.

THE FUTURE

Nowadays, minimally invasive surgery, computer assisted surgery, and introduction of new (biological) implants will certainly find their place in the fracture treatment. These methods decrease the surgical dissection at the fracture site and maintain bone perfusion, to enable a "biological internal fixation."

SUMMARY

Još od davnina je čovjek bio suočen sa problemom lečenja preloma kostiju, o čemu svedoči i prvi zapisi iz starog Egipta. Od tada su razvijane mnogobrojne metode lečenja, ali je revoluciju u lečenju preloma donela unutrašnja fiksacija. Od kad je prvi put opisana, krajem 18. veka, ova metoda se neprestano usavršava i razvijala.

Ključne reči: frakture, unutrašnja fiksacija, istorija medicine.

REFERENCES


10. Simić PV, Simić AP. Istorija Medicine, Službeni Glasnik 2008; pp 311-312.


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