During the human history there were many attempts to treat fractures and injuries of extremities. Since Mathijsen and his plaster cast there was many attempts to make immobilization at the fracture site, to protect obtained reduction. Hugh Owen Thomas invent traction which greatly decrease mortality in the patients with femoral fractures during the war. External fixation was used from the time of Malgaigne, Lambote, Parkhill in 19th century, and Anderson, Hofmann, Ilizarov in 20th century. This kind of fracture fixation still has place and role in the treatment of open, compound fractures, and in the patients with multiple fractures. Along with invention of antisepsis, antibiotics, X-rays, ant metallurgy, the internal fixation become widely used, from the Lane’s plate at the beginning of 20th century to the biogredable materials and new designed internal devices. Special problem of hip fracture treatment was solved by fixation dated from Hey Groves, Smith Petersen, while intramedullary fixation of long bones was introduced by Kuntscher. Clinical and biomechanical investigation during the 1950 and 1960 was established by members of AO group.

Key words: fracture fixation, internal fixation, external fixation, history

**INTRODUCTION**

There is a long history of the bone fracture treatment from the time of bone setters to the era of modern orthopaedic surgery. The main innovations which improved the outcome of operative fracture treatment were the founding of the X rays (1895), antisepsis (1865), use of antibiotics (1936 sulfonamides, streptomycin 1944) and alloys in the manufacturing of the fixation devices.

The modern treatment was a necessity, since the way of life, development of industry, machines and car traffic led to the increase in injuries, and the increased number of patients and enormous costs of the treatment, which have a great impact on economy of any state. Thus, orthopaedic trauma is of interest. The knowledge of proper treatment is important in order to achieve fracture union without complications and to return the person to a normal life and job.

In the fracture treatment, there are numerous methods which were popular in the different times, and some of them still have their place in the orthopaedic practice. Plaster of Paris-POP (a), skeletal traction (b), external fixation (c), internal fixation and intramedullary fixation (d) and each of them are efficient in the treatment of a certain kind of fractures or in some patients or age
groups. The main data about methods, as well as portraits of renowned figures in orthopaedic surgery should be presented.

a. Despite the development of the orthopedics surgery, there are still controversies about the best method for fracture treatment. After the reduction of fracture, the immobilization could be obtained by the plaster cast in many cases. Thus, even nowadays there is still room for the conservative management of certain fractures. The invention of the POP by Antonius Mathijsen, Dutch surgeon, is of the outmost importance. Although he described his invention of plaster cast in 1852, Nikolai Pirogoff, Russian surgeon, independently found the plaster bandages at approximately the same time. This immobilization was easy to apply, was effective in the fracture stabilization, available and cheap. Nowadays, for many stable, non-displaced fractures in elderly patients, the plaster casts are used as a definitive method of treatment.

Antonius Mathijsen (1805-1878) (Figure 1), came from a doctor’s family: his 3 brothers were physicians and his father wished his son Antonius to become a military surgeon. Indeed, he joined the army 1828 and got degree of Doctor of medicine in 1837. He became well known for his efficient method of making a plaster cast, which he described in his monograph published in 1852. The main advantage was that the plaster cast could be easy to applied, became hard in a few minutes, allowed access to the wound, was adaptable to the shape of the extremity, porous, and was not heavy or expensive. His plaster cast was more practical and economical than others and it was accepted in the Netherlands, Vienna and the United States where he presented the plaster cast in Philadelphia. His life was not disturbed and he became honored (Knight of order of the Netherlands, Major surgeon of the Dutch Army) and he was member of many societies.

On the other hand, Nikolai Ivanovich Pirogoff (1810-1881) (Figure 2) had a more dramatic life, changing places and positions: he was born in Moscow where he studied medicine at University of Moscow. After the graduation, he had training in Estonia for five years, and in Berlin and Gottingen for two years. In 1835, he became a professor of surgery in Moscow, later in Dorpat and 1840 in St. Petersburg. He became a leading surgeon and teacher. He introduced new things in Russia: with the support of Grand Duchess Elena Pavlovna he allowed female nurses into the military hospitals at the same time as the United Kingdom. He also was one of the founders of the Russian Red Cross. He introduced plaster cast dressing at field hospitals. He became most famous for his osteoplastic amputation (under the name Pirogoff’s amputation).

He wrote a three-volume book on clinical surgery (1851-1854) and cross sectional anatomy. But he had to resign and became an inspector. Later, he must retired and he went to Berlin and Heidelberg. Upon returning to Russia, he was in a conflict, he retired again and died.

b. Beside the immobilization in the cast, especially for the femur fractures, a very useful and popular method in the past was traction, inaugurated by Hugh Owen Thomas (Figure 3). At that time, traction was a great innovation which decreased the mortality rate from 80% to 20% during the World War One. Thomas splint dates from 1876, when he published the paper by himself. This device was used in many modifications as Bryant trac-
tion, Hamilton Russell's traction (1860-1933). In the Balkan wars, this type of immobilization was also used.

Hugh Owen Thomas (1834-1891) (Figure 4) was born in a family whose three generations had practice in treating bone fractures and bone dislocations. After using the pulley to put the fragments in good position, they protected the bone in wooden splits. He lived with his uncle Dr. Owen Roberts where he started to study medicine at the University of Edinburgh in 1855, later moved to London where at the age of 23 he became a member of the Royal College of Surgeons. After that, he moved to Paris and later joined his father's practice. Hugh Owen Thomas started his own practice in 1859. In 1866, he established a private hospital where he had a workshop with the leader-worker who made splints. In 1875, he published his first book entitled "Diseases of the hip, knee and ankle joint" where he also described the hip and knee splints. He also used a collar. Until the end of his life, he had no holiday for 30 years. In the end, he was overworked and died at the age of 57.

c. External fixation as a method is a further step from skeletal traction to the internal fixation of fractures. This method started with the name of Jean-François Malgaigne (1806-1865). In the 1840. He constructed "Pointe métallique", the apparatus with semicircular frame (Figure 5). He also constructed the external fixator for the patellar fracture reduction and fractures of olecranon. In 1851, Chassin modified Malgaignes apparatus for the clavicular fixation. In 1893, a British surgeon, Keetley, described a fixator where pin passed through both cortices of the bone. The first commercial marketed fixator in human medicine was invented by Parkhill (Clayton Parkhill) from Denver, U.S.A. There, two pins passed through the bone, above and beneath the fracture, and pins were connected by a "unique clamp" (Figure 6).

Malgaigne Joseph François (1806-1865) (Figure 7) started medical education at the age of 15. At the age of 19, he left for Paris to study but without funds. At the age of 24, he organized a voluntary hospital to support the Polish army against Russians. In 1835, he entered the faculty of medicine. At age of 34 (1840), he founded the "Journal de chirurgie". He became a professor of operative surgery at Charite, in 1850 and held that position until he died in 1860. Malgaigne introduced the statistical comparison and experiments in the evaluation of surgical procedures. He was a great surgeon and teacher. In 1847, he wrote "Traite des fractures et des luxations" in two volumes, and that was the most complete book about fractures at the time. He also published surgical anatomy and completed the work of Ambroise Pare. He described ischemic contracture of the forearm 34 years before Volkmann. He designed the previously mentioned apparatus with the hooks for fixing the patella fracture.

Parkhill Clayton (1860-1902) used his fixator for the treatment of open fractures, nonunions and delayed unions. He reported success in 14 patients treated for the humerus nonunion after 11 months after the injury. Parkhill was the Dean of Colorado Medical School and he died due to the septic appendicitis during the American-Spain war (1898) at the age of 42, making the wrong decision not to be operated.

A similar fixator-apparatus was made by a Belgian, Albin Lambote (1986-1955) in 1902; he used metal alloys, connected with a heavy metal frame, described in Anglo-Saxon literature and he became known as the inventor of modern external fixators. Codvella from Italy was the first to use an external fixator for the
elongation of an extremity. Before him, external fixators were reserved for trauma, not for elective surgery.

In Germany, external fixators were invented and used by Bier August, the head of Prussian University clinic in Berlin in 1902. His younger associate Rudolph Klapp served as a surgeon during the Second Balkan War in Belgrade Military hospital. In 1930, Klapp published the book entitled “Treatment of the bone fractures with use of tightened wires” together with Verner Block (also Biers resident). The Blok’s apparatus was a precursor of the Ilizarov’s fixator. August Bier reported elongation of the bone up to 11cm, although these fixators were primarily devoted to the fracture treatment. In the USA, in 1934, a group of orthopedic surgeons around dr. Roger Anderson used half-pins and whole-pins in the treatment of fractures of all long bones, but also for the arthrodesis and extremity elongation. By incorporation of the pins in the plaster casts, early weight-bearing was allowed. This method was associated with numerous complications (pin infections, ulcerations), so the external fixation was not popular in the USA until 1950. At that time, the AAOS proposed ex-fix or the limited indications in well-trained surgeons. Meanwhile, 1938, in Switzerland and France, the external fixation was well known by the names of Raul Hoffman and Vidal by whose fixators a dislocation could be corrected in all three planes. In 1950, Ilizarov Gavril used circular frame fixators and obtained distraction osteogenesis. The external fixation gained popularity during the Vietnam war and post-WWII conflicts all around the world, as a temporary or definitive method of fixation. This fixation was successfully used in all around world in war and every trauma in damage control and primary stabilization of fracture.

In Kurgan, Russia, Gavril Ilizarov, in 1950 successfully used ring frame fixator to obtained distraction osteogenesis.
d. Since all immobilizations and tractions were followed by joint stiffness and patient immobility with all its disadvantages, in the 20th century, the open reduction and internal fixation became widely used under the name Open Reduction and Internal Fixation (ORIF), or in Germany as Osteosynthese.

The internal fixation was initially performed by cerclage by French surgeon Lucas Championniere. The first book about fixation of fractures was published in 1870 under the title “Traite de l’immobilisation directe des fragments osseux dans les fractures” by Berenger Feraud. The internal fixation with wires was popular after Lister, who was not only the father of antisepsis, but also the surgeon who put metal wires on the fractures. Many fractures were fixed by cerclage (Figure 8).

The fixation by the screws followed, or the fixation of the olecranon, by French surgeons. The first fracture fixation with the plate was performed by the German surgeon Hansmann in 1886. The screws protruded over the skin which resembled the external fixation (Figure 9).

The father of internal fixation and of the term osteosynthesis was Albin Lambotte (1866-1955) from Belgium.

Albin Lambotte (1866-1955) (Figure 10) was a leading surgeon of his time and also a great figure in medical history. Although he was a doctor, surgeon, pioneer in the surgery of fractures and osteosynthesis, inventor of instruments, he was not efficient with money. He was a surgeon in Antwerp in 1890, and he treated fractures from 1902. In 1908, he published the results of 35 patients treated for femoral fractures. He invented many
plates and instruments for fracture treatment as well as violins which he made and played. Despite all his hard work, he died in poverty at the age of 90. Nevertheless, he wrote: “the greatest crime a man commits against himself and humanity is to be inactive”. This was his life motto.

In Scotland, William Arbuthnot Lane made a great contribution to the fracture management. He invented plates and had a great influence on bone surgery.

Sir William Arbuthnot Lane (1856-1943) (Figure 11), lived in the same time as Lambote. He entered to the Guy’s hospital as a student in 1872, at age of 16, with the even younger outlook. He was attached to the anatomy, and that was the place to be recruited to surgery. Moreover, he was a “thinking” person, writing that the bone is adapted to the forces, or, as Lane put it, to the “crystallization of the lines of the forces”. In 1905, he published a classic work about fracture treatment “The Operative Treatment of Fractures”, working in anatomy room as well, and introduced the mechanics into the field of surgery. He was a brave, ambitious but eccentric person and he made the basis for orthopaedic trauma and made plates (Figure 12). But he also performed abdominal surgery, and pointed that toxemia was responsible for tuberculosis, duodenal ulcer, cholecistitis, and he performed extensive colectomy. Wrong, but “internal splintage” of fractures was wright and successful. In 1894, he inserted the bending screws on 34-old patient’s fractured tibia. Upon Lister’s work, Lane introduced rigorous antiseptic technique and that was the “no-touch technique”. He was successful, became Sir, retired and promoted healthy life.

Intramedullary fixation was well known by the name of Gerhard Kuntscher, but this kind of fixation way tried by famous Langenbeck (Bernhard von Langenbeck) in 1850s in patients with hip fracture (femoral neck fracture). He concluded that elephant or other bone is insufficient for fracture stabilization. Later, Hey Grooves and Smit-Petersen were dealing with intramedullary nailing of hip fracture. A new idea for hip fracture treatment was introduced by Austin Talley Moore (1899-1963) with the prosthesis hip replacement.

Ernest William Hey Groves (1872-1944) (Figure 13) as a son of an engineer was born in India, returned to England at the age of 3, finished medicine at St. Bartholomew’s hospital in 1895. He was working as a general practitioner and later had a private practice, but he was by vocation a surgeon and joined the stuff of Bristol General Hospital. In 1905 he became FRSC, but due to the infection after the internal fixation of the fractures he was called “septic Erni”. In 1917, he was one of the founders of British Orthopaedic Association (BOA). He was also in the editorial board – secretary of J Bone and Joint Surgery, president of Association of surgeons of Great Britain and, BOA. He was a surgeon and a teacher. He made internal fixation of the hip fracture—neck fracture with the beef bone, many years before Smith Petersen nail invention.

Smith-Petersen (1886-1953) (Figure 14) was born in Norway, but schooled in the USA. He worked in the famous Massachusetts General Hospital where he was chief of orthopaedic service 1929-1946. He introduced anterior approach to the hip joint, named after him. Also, he invented the three-flanged nail in internal fixation of the femoral neck fractures. He was a member of BOA, Canadian AOS, and Italian orthopedic society. But, he was firstly an operator, meticulous and had a special warm relation and empathy for the patients.

Gerhard Kuntscher (1900-1972) (Figure 15) introduced the cloverleaf nail for intramedullary nailing of the femoral shaft in 1930. Before the Second World War, he made experiments, and during the war, he worked a lot with wounded German soldiers, treating effectively fractures with the intramedullary nail in the Eastern front. In 1942, he got the rank of professor. His work was available and well known after the war. He worked with intramedullary fixation since the 1930s, but after publishing his first book in 1942 he investigated stability of fracture, closed reduction under X ray control without opening the fracture site. He designed a nail (Figure 16) which expanded in the femoral channel, achieving stability at the fracture site. He wrote the book “Practice of Intramedullary Nailing”. He also designed the nails for comminuted fractures, with interlocking nails, which is nowadays widely used under the manufacturer name, although Kuntscher was the inventor.

In intramedullary nailing Kempf designed nails as well as many other authors.

After the Second World War, 1950, in Germany and Switzerland a group of orthopaedic surgeons founded the AO group, which was inspired by the work of Robert Danis (1880-1962) and his work “Théorie et pratique de l’ostéosynthèse”. They proposed rigid internal fixation, to obtain direct fracture healing. The AO founders were Maurice Muller, Martin Allgower, Hans Willenegger and many other surgeons, engineers and metallurgists. This, quite dogmatic group, was not fully accepted in England and America, but with compression and other advantages it become used all over the world.
Only putting together the work of all these pioneers, can we fully and truly form the picture of surgical fracture treatment, and understand limits and advantages of one type of fixation without ignorance.

SUMMARY


Ključne reči: fiksacija preloma, spoljašnja fiksacija, unutrašnja fiksacija, istorija

BIBLIOGRAPHY