TREATMENT IN TRAUMATOLOGY

Methodical indications
in discipline "Traumatology and orthopedics"
for self-study of 5th year students of medical faculties

Міністерство охорони здоров'я України
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ЛІКУВАННЯ В ТРАВМАТОЛОГІЇ

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Compilers H. H. Holka,
O. G. Fadeyev
A. O. Oliynyk,
D. A. Istomin,
V. V. Burlaka
M. A. Harkusha,
V. V. Vesnin

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Упорядники Г. Г. Голка
М. А. Гаркуша
А. О. Олійник
О. Г. Фадєєв
В. В. Бурлака
Д. А. Істомін
В. В. Веснін

METHODS OF TREATMENT OF FRACTURES

The main tasks of treating a patient with fractures are restoration of bone integrity, anatomical shape of the joint, function of the injured limb and the patient's working capacity. To implement the tasks, these principles must be followed:

- reposition of bone fragments;
- restoration of length and limb axis;
- reliable fixation of bone fragments;
- the possibility of functional loading of the limb until the end of the consolidation period.

There are two main methods of fractures treatment - conservative and operative.

Conservative methods of fractures treatment

There are only two conservative methods which are *fixative and extensional.*

Fixation method

The essence of the fixation treatment method is a one-step closed manual repositioning of bone fragments and their retention with a fixative bandage, more often gypsum. Closed single-stage manual reposition is widely used in the treatment of fractures in the ankle joint, fractures of meta epiphysis of the radial bone, etc.

Closed repositioning should be performed as soon as possible from the moment of injury. The optimal time is up to 6–12 hours, since it is likely that the edema of soft tissues increases rapidly, making it difficult or impossible. Reposition of bone fragments should be completely painless. The technique of performance consists in traction along the axis of the limb, manual manipulations performing in reverse order to the mechanism that caused the fracture. Hitting into the interfragmentary fissure of soft tissues (interposition), the presence of a hematoma, soft tissue edema may be the causes of un-successful repositioning and inefficiency of the fixative method of treatment.

The plaster cast was first applied in 1851 by the Dutch doctors Matisseen and Vanderlo. The gypsum bandage is successfully used in traumatological practice and has a number of advantageous properties: it is evenly and tightly attached to the body; it retains fragments well; it is easily removable.

Medical plaster is calcium sulfate, dried at a temperature of 100–130 °C, which has hydrophilic properties. The disadvantages of fixation with a plaster bandage are: the probability of a secondary displacement of bone fragments; probability of compression of soft tissues with edema; presence of postfixation contracture in adjacent joints; the possibility of deep and superficial veins thrombosis. In modern conditions, synthetic bandages are used in clinical practice, but they also have practically the same disadvantages.

Extension method

The essence of the extensive treatment method is constant traction with the help of a load that acts gradually and dosed, overcoming the muscle retraction. Thus it allows to remove the displacement of bone fragments, and therefore, to perform their reposition. In addition, constant retention can be carried out by - to keep bone fragments in the desired position. Permanent stretching is divided into adhesive, adhesive tape, cuff and skeletal.

After the invention in the United States in 1839 of an adhesive patch based on rubber, the adhesive tape stretching became widespread. In 1907, Steinmann unveiled the results of treatment of 160 patients with fractures of the femur, passing through the condyles of the hip nail and manipulating a weight of 5–15 kg. It is this fact that is the beginning of the history of permanent skeletal traction.

When treating fractures of the bones of the extremities by the method of permanent skeletal traction, five basic principles must be followed:

1. The stretching should be carried out in the middle physiological position, i.e. the position of the limb, in which the movements in the joints in the direction of flexion and extension are the same.
2. The stretching should be carried out in a state of absolute physiological rest. Absolute physiological peace is the minimum and even tension of all muscles in the complete absence of gravity. However, it is impossible to eliminate tension in the muscles of one limb segment, if the muscles of other segments are not relaxed.
3. The principle of counteraction. The stretching is always carried out for the peripheral fragment, therefore, the counteraction must be carried out by all the weight (mass) of the patient's body. In some traumatology manuals, to implement this principle, it is recommended to raise the foot of the bed 30–70 cm, depending on the weight of the load. However, this position of the patient is non-physiological, which manifests itself in the violation of venous circulation, increased CVP, displacement of the abdominal cavity organs to the diaphragm, and a decrease in pulmonary ventilation. Therefore, such manipulation is not possible in elderly and senile victims and patients with multiple and combined injuries.
4. The principle of fragments comparing. This principle is realized by setting a distal fragment relatively to the axis of the proximal one. Displacements widthwise and at an angle are eliminated with side loops and lateral skeletal traction, which is especially indicated in central hip dislocations.
5. Gradualness of the load. The weight is increased dosed by 0.5–1 kg. On the second day, an X-ray examination is performed and, if necessary, correction of the position of the bone fragments continues until 3 days. The maximum weight (10–12 % of body weight) is kept on average to two weeks, after which the load is reduced to the original. X-ray control is performed

during the entire period of using the extensional treatment method, namely, from insertion of bone fragments to the first signs of bone callus formation and sufficient consolidation of bone fragments.

The method of skeletal traction has the following advantages:

- ease of implementation;
- simple technical equipment;
- the possibility of visual control of the injured limb;
- availability of the application;
- low traumatism.

Significant disadvantages of constant traction (which makes its use narrowly limited) are:

- hypermobility of bone fragments;
- impossibility of repositioning in the presence of soft tissues in the interfragmental fissure (interposition);
- the non-physiological position of the patient in bed;
- hypodynamia;
- hypokinesia;
- difficult evacuation of the patient;
- inconvenience in hygienic toilet;
- the likelihood of developing hypostatic complications (pneumonia, pressure sores, etc.);
- a significant impairment in the quality of life during treatment.

Operative methods of fractures treatment

Osteosynthesis is an operative joining of bone fragments in fractures and their consequences. The term is proposed by A. Lambotte in the XIX century. The aim of the operation is to eliminate the displacement of bone fragments, their stabilization for the period of consolidation, restoration of shape and function of the limb. Osteosynthesis does not accelerate fracture healing, but only optimizes the course of reparative bone regeneration. That is, the operative connection of bone fragments minimizes the incidence of disregeneration (delayed fusion and non-healing of the fracture, formation of false joints and neoarthroses). However, the rate of complications after osteosynthesis is 5–15 %.

Metal fixators made of titanium, titanium-cobalt alloys, food grade steel or metal-polymeric structures are used for osteosynthesis.

Indications for osteosynthesis are:

- inefficiency of conservative treatment;
- unstable fractures;
- isolated fractures of the radial and ulnar bones, fractures of both bones of the forearm;
- Galeazzi's and Monteggia's fracture-dislocations;
- false joints and neoarthrosis;

- intra-articular fractures;
- open or complicated fractures;
- multiple and combined injuries;
- fractures in of elderly and senile age persons;
- fractures in patients with mental disorders.

Contraindications for osteosynthesis are:

- stable fractures (nested, subperiostal a "green branch" type in children);
- presence of severe concomitant pathology (cardiovascular failure, decompensated diabetes mellitus, syringomyelia, etc.), when the degree of anesthesia and operational risk is very high;
- terminal state of the affected.

There are four methods of osteosynthesis: bone, intramedullary, reposition and extra-focal. *Extra-cortical osteosynthesis*

This is osteosynthesis with the help of plates. Osteosynthesis with plates was developed and introduced by A. Lane in the late XIX – early XX century. In the XX century, due to the ideas of R. Pauwels, who proposed to pull a bone on the side opposite to the compression forces, and ideas of R. Danis, who formulated the principle of primary fracture healing under compression as a biological need, a theory of this method of operative fracture treatment was created. In 1958, M. Muller, M. Allgower, R. Scneider and H. Willenegger created an association for the study of internal fixation (AO/ASIF) and the theory of osteosynthesis, which was based on the flawless repositioning of bone fragments, their connection with plates and early function. A universal instrumentation and implants of high quality were created. R. Mathys, Swiss designer of metal cases for watches, is the designer of cortical screws and instruments for performing osteosynthesis. Plates for osteosynthesis are constantly being improved (*fig. 1*).

Fig. 1. Plates for osteosynthesis

Extra-cortical osteosynthesis is used for transverse, oblique, oblique-transverse, multi-fragment fractures of the humerus, tibia, femur, forearm bones. Short plates are indicated in fractures of small tubular bones. To fix periarticular and intra-articular fractures, plates of various shapes are provided.

Modern designs of plates allow to provide a stable fixation of fragments that allows to avoid gypsum immobilization in the postoperative period.

Advantages of extra-cortical osteosynthesis are:

- stability and functionality;
- implementation of the core-generating process by direct type;
- preservation of intramedullary circulation;
- in timely manner restoration of the muscular carcass;
- the possibility of simultaneous healing of fracture and restoration of movements in adjacent joints.

The disadvantages of extra-cortical osteosynthesis are:

- impossibility of implementation without special tools;
- traumatic performance, damage to the muscles and periosteum;
- the probability of purulent-infectious complications, osteomyelitis;
- traumatic removal of plates.

Intramedullary osteosynthesis

This is an intraosseous fixation with metal and metal-polymer rods (nails). Such a method of osteosynthesis can be used for all diaphyseal fractures, fractures of the proximal and distal sections (intra-articular and periarticular), fractures of the proximal tibia, fractures of the surgical neck of the humerus.

For many years, various intramedullary rods for osteosynthesis of fractures of long bones were used in Ukraine. The rods of Sivash, Dubrov, Bogdanov, CITO, Okhotsky-Suvalyan, Kuncher and their numerous modifications received the widest spread (*fig. 2*). Author's technical solutions to improve such metal structures did not significantly affect the stability of osteosynthesis and the potential reparative capabilities of bone tissue. Today, all these fixatives have a historical meaning and as a modern method of intramedullary osteosynthesis are practically not used

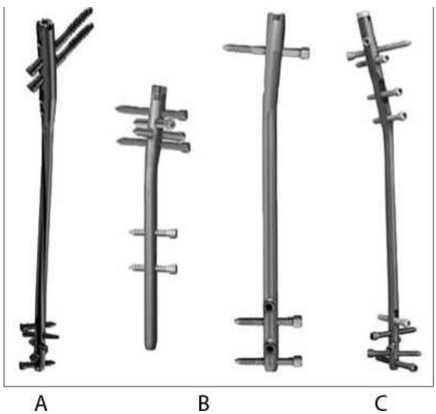


Fig. 2. *Rods for intramedullary fixation (scheme)*

On March 28, 1940, the Congress of Surgeons of Germany was held, where Gerhard Kuncher in his report changed the concept of treatment of fractures of long bones, and this time is the beginning of the history of intramedullary osteosynthesis. Kuncher's method was based on the reaming of the medullary canal for the diameter of the stem, which gave a stable fixation to the bone fragments.

R. Maatz (1942) also was a supporter of this surgical concept. Gaston Pfister carried out stabilization of bone fragments of the femur using the Kuncher's method.

In the Soviet Union for the first time intramedullary osteosynthesis of diaphyseal fracture of the femur was performed by J. G. Dubrov in 1948. G. Kuncher in 1961 has changed the possibilities of intramedullary osteosynthesis, by performing it according to a closed procedure without opening the interfragmental zone. It was a turning point in the history of osteosynthesis, since the advantages of closed osteosynthesis don't cause any doubts.

Consequently, for decades the intramedullary osteosynthesis with the reaming of the medullary canal was the "gold standard" in the treatment of diaphyseal fractures.

However, this method of osteosynthesis also had significant disadvantages, such as:

- the possibility of rotational displacement of bone fragments;
- impossibility of early statokinetic and dynamic load of the limb, which is due to the design capabilities of the retainers;
- the need for additional plaster immobilization.

In 1972, such surgical technology of osteosynthesis was improved and named *"Verriegelungsnagelung"* – osteosynthesis with blocks – and has become widespread in the world. In Russian literature, the name "blocking osteosynthesis" is used, and in English – "interlacing" (*fig. 3*).

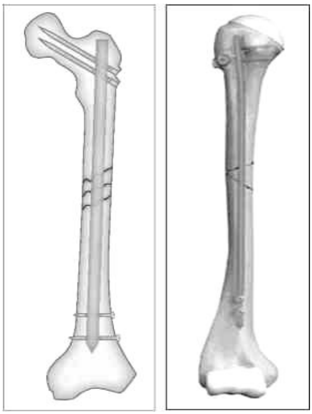


Fig. 3. Intramedullary blocking osteosynthesis

The advantages of blocking intramedullary osteosynthesis are:

- low-traumatism technology by closed technique; minimal disorder of extra-osseous circulation;
- the inner layer of the periosteum is remained which is the source of osteoreparation;
- non-traumatic operation to remove the metal structure;
- intramedullary osteosynthesis by blocking rods is, in fact, a mechanism for splicing bone fragments.

The disadvantages of blocking intramedullary osteosynthesis are:

- destruction of bone marrow;
- disorder of intramedullary circulation;
- possibility of fat embolism;
- if infected, the infection spreads to the entire bone cavity;
- the necessity for careful pre-operational planning, selection of the length and width of the nail, the length of the screws;
- with an inadequate orthopedic regime, a nail break is possible.

Repositioning osteosynthesis

This is osteosynthesis with screws. Cortical screws are used for diaphyseal fractures of the tibia and humerus, in cases where the fracture line (long and oblique) is 2 times larger than the width of the bone. With the correct insertion of the screw, the latter can stand a load of more than 40 kg. Before inserting the screw, the thread is taped. Appropriate for diaphyseal fractures is the introduction of three screws: one perpendicular to the fracture line, the second perpendicular to the axis of the bone, the third – along the bisector between the perpendicular to the bone and the fracture line.

Cancellous screws are used to fix the condyles of the femur and tibia, the fractures of the anatomical and surgical neck of the humerus, the neck of the femur, the posterior edge of the tibia.

Malleolar screws are used for osteosynthesis of fractures of the ankles, collarbone, olecranon, with ruptures of clavicle-acromial junction.

Repositioning osteosynthesis with screws is unstable, in which the use of plaster cast is always indicated. Plaster immobilization should continue until the fracture is completely healed. All the disadvantages of the fixative method of treatment are inherent in this method of osteosynthesis. This method of osteosynthesis is basically hybrid, because it is the result of a combination of operative and conservative methods.

Osteosynthesis by external fixation devices

This is an extra-osseous osteosynthesis with devices on a spinal or rod-like basis. This method of osteosynthesis is the result of using orthopedic devices in the acquired and congenital deformities of extremities bones. Such orthopedists as A. Lambotte, J. A. Andersen, D. Hofman, J. Charnley, have created a devices fracture treatment system. In 1950, the treatment of fractures with external fixation devices became recognized in the world.

G. A. Ilizarov, K. M. Sivash, N. D. Florensky, N. V. Volkov, A. V. Oganesyan, V. K. Kalnberz, S. S. Tkachenko and others have made a great contribution to the development and creation of compression-distraction devices in our country (*Fig. 4*).

Ilizarov's device consists of three basic elements - intersecting wires, which are led transosseously, stretched and fixed in rings or arcs. The latter are connected together by threaded rods. The device allows carrying out a closed repositioning of bone fragments, performing, if necessary, their compression or distraction. Ilizarov's device has unlimited indications for use, especially with open fractures, multiple and combined injuries, etc.

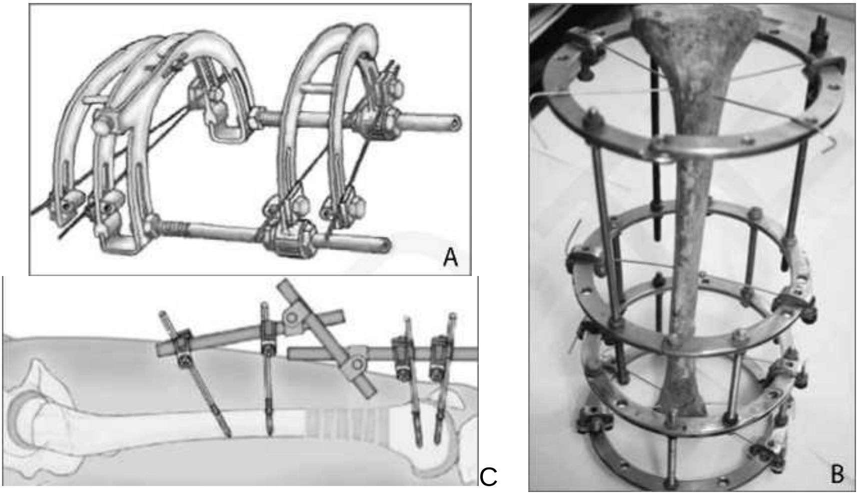


Fig. 4. External fixation devices:
A – Gudushauri; B – Ilizarov; C – the apparatus of AO

The device of Volkov-Oganesyan is based on the X-shaped passage of wires fixed in arcs. The indications are intra-articular and periarticular fractures. The authors also developed a hinge device for the purpose of the subsequent restoration of function in the joints.

Gudushauri's device consists of three arcs, one of which is corrective; it is connected by rods with a ribbon-like thread.

Advantages of external fixation devices on a wire basis are:

- significantly lower risk of infectious complications;
- simplicity of installation;
- low-injury and minimally invasiveness;
- the possibility of improvisation;
- reposition of bone fragments is possible in the postoperative period.

The disadvantages of extra-focal compression- distraction osteosynthesis are:

- possibility of damage to blood vessels and nerves;
- infectious-purulent inflammation of soft tissues around the wires;
- fractures of the wires;
- ring-shape bone burn with excessive reaming;
- soft tissue sores from indenting the rings and arches of the apparatus;
- limited hygienic toilet and transportation.

The devices of external fixation on a rod base are perspective. They are constantly being improved and have many authors' design features.

Rod devices have a number of advantages:

- simplicity of design;
- minimal installation time;
- unlimited number of input options;
- the possibility of partial or complete rewiring of external supports during the treatment without weakening the fixing properties of the device;
- the ability to connect to other external devices.

Disadvantages in treatment are the same for all devices methods of osteosynthesis.

Thus, each method of osteosynthesis has specified indications for implementation, its advantages and disadvantages.

Operative treatment of arthritis

As the disease has progressing course, the issue of the possible operative treatment should be decided in early terms for preservation of the intact cartilage areas, providing the even load at all joint areas, congruency renovation, hemocirculation activation in subchondral areas and others. In patients with late disease stages (III–IV) an issue of prosthesic replacement or stabilizing (arthrodesis) operations performance.

Surgical interventions in degenerative-dystrophic diseases of joints are represented by the following types:

- Arthroscopic treatment of joints, lavage.
- Correction osteotomy.
- Prosthesis arthroplasty and arthroplasties.
- Arthrodesis.

Arthroscopic operative treatment of joints. Arthroscopy development originates from 20–30s years of the XX century. This method was initially used only as the experiment, but with the occurrence of the optic device in the 1931 year owing to the professor Kenji Takagi, that has a diameter of 4.0 mm, it became possible not only to examine the joint, but also to perform biopsy; the special device was in the set for this.

Arthroscopy method allows performing operative interventions on the joints with minimal injuries of the surrounding tissues (*Fig. 5*). At the articular fissure projection (knee, shoulder, ankle, elbow, and other joints) several, usually two-three, small sections (punctures) are made. Thin optic device is introduced in one of them – arthroscope, that has a diameter from 2 to 5.5 mm, length of 12–14 cmM, that is connected with a digital camera. Special probe or thin devices (manipulators) are introduced through another port. Surgeon controls the operation progress at the monitor, that provides image zooming in 6–8 times in comparison with the real size of all intraarticular structures. This method provides high accuracy of the manipulation in the joint and their carefulness. This type of surgery allows avoiding large sections and opening of the patients joint, that has the principal value for the enhanced recovery of the patient after the operation.

Arthroscopic operative treatment of the knee and elbow joints are most widespread nowadays. Arthroscopy of the elbow joint, wrist joints, hip, ankle joints have mainly diagnostic character, but indications and possibilities of the arthroscopic operation performance become wider with the arthroscopic technique development.

Arthroscopic surgery of osteo-arthritis is characterized by the following possibilities. First of all, it gives a great diagnostic opportunity to determine the treatment tactics: for example, if the cartilage is absent in external and internal parts of the knee joint – its total arthroplasty is indicated, if one of the part is preserved, then the indications for correction osteotomy or monocondylar arthroplasty are determined, that are performed immediately after arthroscopic operation or later.

Fig. 5. Arthroscopy of the knee joint

Chondromatous and other bodies, free as well as attached a removed during arthroscopy. Injured menisci are removed, as well as hypertrophic and fibrous changed parts of the synovial membrane and lipid body in the anterior part of the joint, which usually impacts the complete extension. Sometimes these allow removing flexion contracture. Lateral release of the patella is performed with use of the electric device. Contracture is sometimes conditioned by the osseous deformations of the femoral condyles; arthroplasty is not performed in such cases, because it can lead to the articular surfaces trauma and will not reach the clinical effect. In osseous outgrowths or osteophytes presence in the intercondylar area, which causes discomfort, their removal is indicated. If the area of damaged cartilage is found, which is characterzied by its softening, garnetting and irregularity; its polishing is performed using shaver. Mentioned above operations in "arthroscopic" literature are called arthrolysis. debridement or abrasive arthroplasty.

Performing of arthroscopic operations gives a possibility to use efficiently correction osteotomies, as the joint examination allows assessing condition and localization of the preserved cartilage areas and accurately determined the indications presence and directly the osteotomy type.

Synovectomy is indicated in pigmentovillous synovitis and in cases of productive inflammative processes, with chondromatosis in particular. In chronic reccurrent synovitis, that are not treated conservatively, total synovectomy is recommended to be performed, complete radicalism is necessary for such situations, because a high level of recurrence exists. Anterior as well as posterior approaches are recommended if necessary for reaching the radicalism of the arthroscopic intervention.

For the prevention of the articular cartilage destruction progressing in osteoarthritis in arthroscopy performance, the series of operative methods are used, that are directed at the replacement of the articular cartilage defect with the regenerants. Regenerants properties depend directly on the operative intervention technique. Regenerant, that has properties close to the hyaline cartilage, is formed in certain conditions of the operative treatment performance. Among these methods the following are used more often: abrasive chondroplasty, microfractures and forage of the articular cartilage defect bottom, osteoarticular autografting (OATS, mosaicplasty) and osteoarticular allografting.

Abrasive chondroplasty (*Fig. 6*). Advantages of its use are the technical simplicity and satisfactory clinical results of the treatment. This technique the use excludes use of other methods. To disadvantages refer, that defects are filled exclusively with the fibrocartilage. *P. Angermann* with colleagues assessed clinical results of the treatment during 6 years. All patients reported about the positive effect of the abrasive chondroplasty: 69 % assessed the knee joint condition as good or very good, 77 % assessed the treatment effect as constantly positive. Technique of the arthroscopy performance with abrasive chon- droplasty provides for the damaged cartilage parts removal and careful polishing of defect margins.

Microfracturing – microfractures, forage of the articular cartilage defect bottom performance (*Fig. 7*). Advantages of this method are economic efficiency, technical simplicity, good clinical results of the treatment. Use of this method excludes using of other methods.

Method of arthroscopic microfracturing provides for primary processing (polishing) of the cartilage defect. Bottom of the defect should be processed for the removing of the calcified cartilage layer. Then 3–4 perforations at the square centimeter are performed, that is performed from the periphery to the center. Early movements in the knee joint with limited for 6 weeks loads are indicated to the patient in the postoperational period.

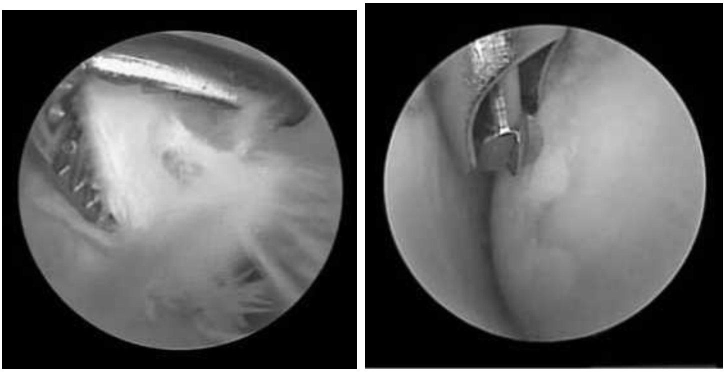


Fig. 6. Technique of the abrasive chondroplasty performance (damaged cartilage fragments removal and margins polishing)

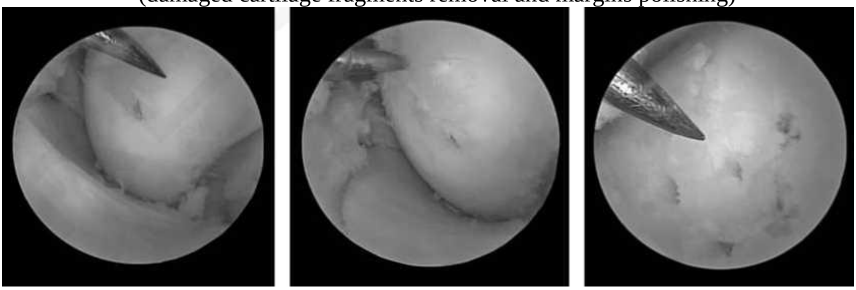


Fig. 7. Arthroscopic microfracturing

Osteoarticular autograft ing (OATS, mosaicplasty). Osteoarticular autografting was initially described by H. Wagner in 1964. Technique of this method under the arthroscopic control was developed by Y. Matsusue in 1993. Following developments of the arthroscopic technique and devices were introduced in studies of L. Hangody and V. Bobic.

Mosaic chondroplasty – single stage procedure, that provide relatively fast recovery, can be an alternative in the treatment of small and medium defects (*Fig. 8*). It is recommended for the treatment of cartilaginous and osseo-cartilaginous defects of the knee joint as the safe procedure for recovery of the injured articular surface and providing its properties similar to the hyaline cartilage. This method preserves integrity and function of the injured joint, providing promising results in plane of prevention of the early osteoarthritis development in young people. Good clinical results, low expenses on treatment and short recovery time are main advantages of this method.

Also to advantages refer potentially high survival degree of grafted chondrocytes: recreated tissues is similar by its characteristics to hyaline cartilage. Disadvantages are defect formation of the grafted areas, treatment result dependence on the surgical technique, the limited size of the work defects, the risk of the surface congruency trauma with the bone-cartilage block in its incorrect placement. Operation technique consists in the grafting of cylindric osteoarticular blocks, taken from the articular surface, that does not bear loads (usually from the anterior surface of the lateral condyle).

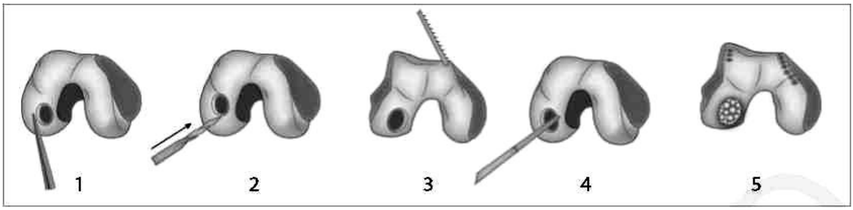


Fig. 8. Scheme of mosaic chondroplasty technique:
1 – polishing of defect margins; 2 – chanels forming for grafts; 3 – taking of oseoarticular grafts, 4 – moving of oseoarticular blocks, 5 – view after the grafting

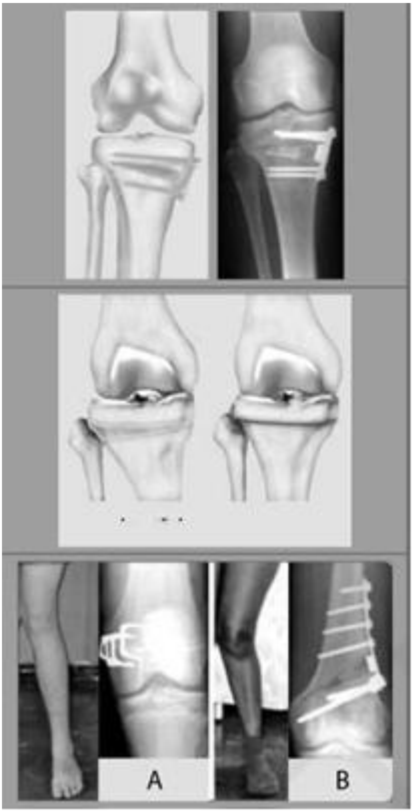
These blocks are mechanically fixed like a mosaic, in order to cover 80–90 % of the defect. This method is recommended for cartilage defects with the area from 1.5 to 3.0 square centimeters.

Correction osteotomy. Purpose of osteotomy is the renovation of the limb axis and joint biomechanics, load normalization at articular surfaces, renovation of the supporting ability and due to these, decreasing the dystrophic process progression in the joint (*Fig. 9*).

Till recent times, correction osteotomy has the leading role in the surgical treatment of osteoarthritis even at the 3rd stage of the disease. Histological facts of the cartilage tissue formation in the area of cartilage defects, at the area of femoral and tibial condyles in particular after the sustained operation, indicates the possibility of osteoarthritis progressing slowdown. Positive influence of osteotomy is also confirmed by the facts of intraosseous pressure decrease and microcirculation renovation.

Two main types of osteotomies are defined: correction and medicinal *(osteotomia medicata).* Among correction osteotomy, the following are defined: angular (wedged and osteoplastic) and arched. V-shaped osteotomy is their combination. There are a big amount of surgical approaches in this intervention and fixation methods.

Correcting osteotomies of the knee, hip and ankle joints are performed more often in osteoarthritis. Indication to performance of such an operation are I,II and even the beginning of third osteoarthritis stage on the background of the biomechanical joint axis impairment. Use of the correctional osteotomies is especially actual in presence of the mentioned above indications in young patients. This is conditioned by the fact, that endoprosthetic replacement is limited in young age, because it connected with risk of series of complications and the possible necessity of further multiple revision of endoprosthesis.



Tibial "Opening Wedge" osteotomy
for the varus deformation correction
at the level of the knee joint

High correction tibial osteotomy
for the "genu varum" correction high tibial
osteotomy

Osteotomy types "douse" (A) and
«opening» (B) at the femoral bone level

Fig. 9. *Correction osteotomy*

Knee joint osteoarthritis is mainly (up to 90 %) accompanied by varus deformation of the limb axis, so antivarus and valgus osteotomies of the femoral and tibial bones. Supracondylar V-shape antivarus osteotomy is performed for the correction of the varus deformation that is localized at the level of the femoral bone. Antivarus osteotomies of the femoral bone is not used frequently. Antivalgus osteotomy of the femoral or tibial bones are biomechanically grounded in the knee joint osteoarthritis with valgus deformation. Antivalgus osteotomy of the femoral bone is more often performed at the deformation localization at the hip, which is indicated in valgus deformations less than 25°, movements range in the joint of up to 90° and absence of significant flexion contracture of the knee joint. The main osteotomy type is V-shaped. Antivalgus osteotomy of the tibial bone is perfomred in the deformation localization at the shin. V-shaped osteotomy is more common. Indications to the osteotomy performance are valgus deformation less than 15°, medial incline of the articular surface up to12°.

For good postoperational result, osteotomy should be combined with other interventions, that are directed to the liquidation of other morphological (for example, cartilage or meniscus injury) or functional (for example, instability) impairments in the joint.

Endoprosthetic replacement or arthroplasty – surgical operation, during which destructed by the disease parts of the joint are replaced by artificial, that reduplicate the normal joint form and reproduce the joint function. Replacement of the affected parts of the joint with new leads to the complete pain elimination or its significant decreasing and recovery of the mobile limb function with preservation of its support ability. Endoprosthetic replacement is often the only method, that can recover lost joint mobility and eliminate pain in it. In one-two months after endoprosthetic joint replacement patients can return to active life.

Modern endoprosthesis have long exploitation period and can serve during 15–20 years, in some endoprosthesis parts wear they can be replaced. Around one billion of hip and more than half of a billion of knee joints are replaced now each year. Endoprosthesis for shoulder, elbow, ankle, fingers interphalangeal joints also exist and are used.

Construction of endoprosthesis underwent significant changes during its 30-year history. Modern endoprosthesis consists of high-strength and bioinert metallic and polymeric parts (sometimes ceramics),the form of which reduplicate the joint form, where the endoprosthesis should be placed.

In healthy human joint friction occurs between articular cartilage. In artificial joints rubbing surfaces are often made from:

- metallic compositions and high-strength polymer, which is called high-density polyethylene (rubbing couple "metal-plastic");
- ceramics (rubbing couple "ceramics-ceramics");
- metallic compositions (rubbing couple "metal-metal").

The most widespread rubbing couple is "metal-plastic". Such combination of materials provides the long joint functioning, but has disadvantages: plastic wear. Plastic microparticles, get to the surrounding tissues and promotes loosening of endoprosthesis components. This leads to the necessity of new operation – artificial joint replacement.

Rubbing couple "ceramics – ceramics" is void of these disadvantages, but has its own: insufficient mechanical strength and complexity of production. That's why these endoprostheses are used significantly rarer.

In rubbing couple "metal-metal" high strength is combined with minimal wear, that guarantees the greatest service period of such endoprosthesis (up to 20 years and more). Metal type, from which the prosthesis is made, is the most significant, because metal microparticles in prosthesis wear can provide negative impact, when getting to the organism.

There are two types of endoprosthesis fixation: cemented and uncemented. In the first case, joint components are fixed to bones with polymethyl-methacrylate (PMMA), that is called bone cement. In the second case, ceramic is sprayed on the endoprosthesis surface (more often hydroxyapatite), to which adhere surrounding bones. Both fixation methods provide reliable adherence of endoprosthesis. But it is considered that uncemented endoprosthesis pass better to young physically active patient with strong bone tissue, whereas cemented pass better to elderly people, that have osteoporotic changes in bones. A lot of other factors also impact the choice of the endoprosthesis, so only doctor can choose endoprosthesis type correctly (*Fig. 10*).

Endoprosthesis, as well as any mechanical construction, has a predisposition to wear. Service period depends on the load in some extent, that occurs during the exploitation period. It is obvious, that the younger patient is and the more active way of his life, the more intensive will be the endoprosthesis wear. And in the opposite, in elderly patients, when physical activity decreases, exploitation term of the endoprosthesis increase.

Usually, if the doctors recommendations are respected, then more than 95 % of endoprosthesis function normally during 15 years, in some cases – more than 20 years. After this period the possibility of mechanical destruction or endoprosthesis loosening in the bone significantly increase. Usually, it manifests with the articular pain. Repeated endoprosthesis replacement is needed in such case (as called revision), when the instable endoprosthesis is replaced with new.

Som elderly patients can avoid repeated revision endoprosthesis replacement. Necessity of the revision endoprosthesis replacement is practically unavoidable in middle age and especially in young patients, that should be remembered in individual treatment methods selection.

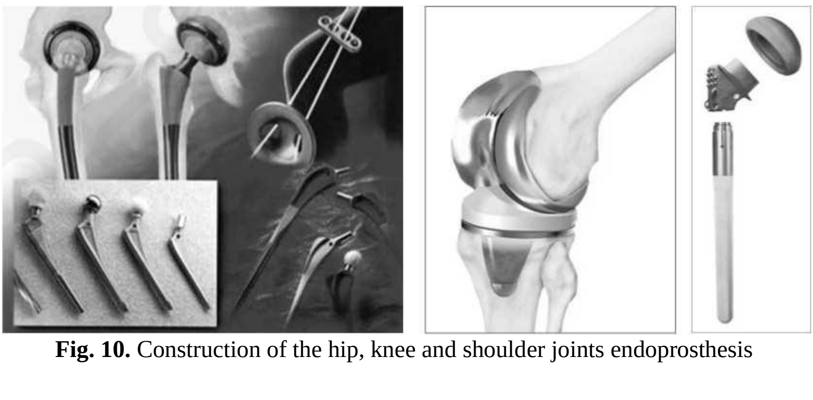


Fig. 10. Construction of the hip, knee and shoulder joints endoprosthesis

Indications for endoprosthetic joint replacement:

- severe forms of degenerative-dystrophic and inflammative diseases of the joints;
- posttraumatic, dysplastic osteoarthritis of III-IV stage;
- joints affection in Strumpell-Mari disease, rheumathoid, psoriatic and other non-specific arthritis;
- false joint of the femoral, humeral necks;
- irregularly healed fractures with the joint function impairment;
- bone tumors.

Following accompanying diseases can be referred to contraindications to such types of operative interventions:

- acute and chronic osteomyelitis;
- tuberculosis of bones and joints;
- severe cardiovascular diseases;
- psychoneurological diseases.

Patients age is not a contraindication in the absence of severe accompanying diseases.

Hip joint endoprosthetic replacement. The biggest part of endoprosthetic replacement operations is related to the hip joint. Destructed by the disease joint is removed irreversibily frim the organism. Endoprosthesis is implanted at its place after this (*Fig. 11*).

Fig. 11. Patient A., 1964 dob. X-rays of the affected hip joint before (A) and after (B) the endoprosthetic replacement

Indications to the hip joint endoprosthetic replacement:

- hip joint osteoarthritis (coxarthrosis) of III, IV stages;
- Strumpell-Mari disease with main affection of the hip joint;
- hip joints affection in psoriasis;
- femoral head avascular necrosis;
- ununited fractures and false joints after femoral head fractures;
- fresh fractures of the acetabulum and femoral neck in patients older than 65 years;
- rheumathoid arthritis with the hip joints affection;
- tumors of the femoral head, femoral neck in patients of any age.

Dense capsule around the endoprosthesis is formed during 4–6 weeks after the operation, that does not allow the endoprosthesis dislocation. Risk of endoprosthesis dislocation. For this complication prevention patient should follow some limitations during 6 weeks after operation: Do not flex operated leg in the hip joint more than 90 degrees; lay in bed only on the back or health side with the pillow between legs, do not rotate the operated leg inside. These limitations are usually taken off after 6 weeks and the patient returns to normal life.

Movements in the joint are started on the first day after the operation. Respiratory gymnastics, exercise therapy for limb muscles with isometric exercises are indicated on the second day. Flexion movements in the hip joint with small amplitude are performed. Walking with crunches is recommended on the third day after the operation. Special attention is paid to the leg positioning during walking for the luxation prevention. Patient should limit loads on the joint after discharge (walking with crunches) up to 6–8 weeks after the operation. Then it is recommended to walk with the stick. It is recommended to walk with crucnhes for up to 3 months in uncemented joint fixation. It is recommended to limit lifting of significant weight, runing, squatting after the hip joint endoprosthetic replacement.

Knee joint endoprosthetic replacement. Knee joint endoprosthetic replacement is technically more complicated operation than the hip joint endoprosthetic replacement. During operation de- structed parts of the knee joint are removed with the use of special devices, lower limb axis is recovered.

Than endoprosthesis is implanted, that reduplicate the normal knee joint form (*Fig. 12*). Endoprosthesis components are fixed with the bone cement. Insertion of a special polymer material is placed between them in the articular surface. Function of this insertion – to improve slipping of the articular surfaces. It is also a damper between the endoprosthesis surfaces. Then the plastic regulation of the articular ligaments tension is performed. Own articular ligamentous apparatus is usually managed to be preserved with correction of the ligaments tension. In case, when own patients ligaments are injured or degenerative changes, then their prosthetic replacement is performed.

Fig. 12. Patient M., 1947 year of birth. Radiographs of the affected knee joint before (A, B) and after (C, D) endoprosthetic replacement

Indications for the knee joint endoprosthetic replacement:

- knee joint osteoarthritis of III, IV stage;
- severe lesions after intraarticular fractures;
- persistent lesions after knee osteonecrosis;
- severe joint affections in rheumatoid arthritis, podagra, psoriasis, Strumpell-Mari diseases;
- tumors at the knee joint area.

Main differences of the recovery period in knee joint endoprosthetic replacement are early regular movements in the operated joint. This procedure starts in the first days after the endoprosthetic replacement and lasts for at least 3–4 weeks after it. respiratory gymnastics, exercise therapy for the lower limb muscles with isometric exercises are indicated on the second day. Slight flexion movements in the replaced joint are performed. Patient can sit up in the bed. Walking with crunches is recommended on the third day. Patient should limit the load on the joint after the discharge (walking with crunches) for 4–6 weeks after the operative treatment depending on the endoprosthesis features. Then walking with stick is recommended for up to three months, Full loads on the joint are possible after this.

Shoulder joint endoprosthetic replacement. Shoulder joint endoprosthetic replacement is effective and often the only method of the lost limb function recovery. Two types of the shoulder joint endoprosthesis are suggested nowadays – humeral head endoprosthesis and total endoprosthesis, ie replacement of both joint components. Almost all movements, that are typical for the shoulder joint can be performed in the artificial joint. Endoprosthesis is chosen individually, taking into account patient's features, character and stage of the pathologic process, etc.

Indications for the shoulder joint endoprosthetic replacement:

- shoulder joint osteoarthritis of Ill, IV stage;
- consequences of the glenoid cavity of scapula and/or humeral head;
- congenital dysplasia of the shoulder joint;
- tumors of the proximal part of the humeral bone.

Health bone tissue is tried to be maximally preserved in the shoulder joint endoprosthetic replacement. Endoprosthesis components, that reduplicate the articular surfaces form are placed instead of articular surfaces destructed with the pathologic process, that are removed during operation. Implants are fixed to the bone with the help of bone cement (*Fig. 13*).

Fig. 13. X-ray films of affected shoulder joints before *and after the endoprosthetic replacement*

Movements in the joint are started on the first day after the operation. Respiratory gymnastics, exercise therapy for the limb muscles with isometric exercises are indicated on the second day. Slight movements in all directions are performed in the replaced joint. Patient should limit loads on the joint for the terms, that are indicated by a doctor, after discharge. Then dosed loads are recommended with the transition to the full load on the joint.

Rehabilitation after the endoprosthetic replacement

Patient usually starts to walk with the help of special frame ("go-cart") on the next day after the endoprosthetic joint replacement. Patients walk only in the nit during first 2–3 days and then gradually increases the walking duration. Approximately in 5–7 days crunches are recommended instead of a go-cart. Patient usually stay in the department for 10–14 days after the endoprosthesis replacement. Postoperational wounds heal in this period and patient is discharged home. Till the dishcharge patient should walk confidently with crunches.

Patient continues to do exercises, which he/she was educated by the doctor or physical therapist, every day at home. Most of the patient also continue to intake anticoagulants, because the risk of thrombosis is preserved during 3–4 weeks after the operation.

Possibility to walk with the full load on the lower limb is allowed in 1–1.5 months after the cemented endoprosthesis fixation and in 2–2.5 months after the uncemented. General terms of rehabilitation depend on the patients age and features of the operative intervention. It usually consists around 3–4 months. Most of the patients return to the normal life during this period.

It should be mentioned, that physiotherapeutical procedures after endoprosthetic replacement are contraindicated in the area of operative treatment: electrophoresis, magnet, UHF, heating, pelotherapy, etc. These methods are not able to improve the artificial joint functioning and should not be used in any term after the operation.

Arthrodesis. Arthrodesis – surgical operation, that consists in the bones fixation in the joint and leads to the complete immobilization of this joint (ankylosis). Arthrodesis is performed in the case, when the joint is rather painful, instable, significantly deformed or is affected by the chronic infectious disease, and if it is impossible to perform athroplastics or endoprosthetic replacement due to some reasons.

This type of operative treatment is the oldest from a historical point of view. A lot of experience of the arthrodesis use and significant amount of different methods of its performance is accumulated nowadays. Different fixation methods are used in arthrodesis operations: plates with screws, rods, pins, stirrups, osseous auto- and allografts, intramedullary rod, external fixation devices, plaster casts. Arthrodesis of any joint can be performed if necessary. some advantage of this type of the operative treatment is that, it does not require significant economic and technical resources, but the most significant aspect of the successful arthrodesis performance is surgeon qualification, that performs this operation.

Arthrodesis provides for preservation or recovery of the limb supporting ability in the affected joint or significant decrease or elimination of the pain syndrome, but the function of this joint is lost irreversibly. So currently this type of operative treatment is last and forced intervention and indications for its performance should be maximally grounded and justified. Arthrodesis of the ankle, rare knee, hip joints are performed for osteoarthritis treatment (*Fig. 14*).

Fig. 14. Radiologic pattern of the hip joint arthrodesis with screws (A), *knee joint with intramedullar rod (B), ankle joint with screws (C)*

References

Main

1. Travmatologiya i ortopediya [Traumatology and orthopedics] / Holka H.H, Burianov A.A. and others. – Vinnitsa : Nova Knyga, 2016.
2. Chapman MW (Ed): Operative Orthopedics – 2nd edn. – Philadelphia : J.B. Lipplncott Company, 1988.
3. Identification and resuscitation of the trauma patient in shock / M. N. Cocchi, E. Kimlin, M. Walsh, M. W. Donnino // Emergency medicine clinics of North America. –August 2007. – N 25 (3), – P. 623–42.
4. Fehlings M. G. Initial stabilization and medical management of acute injury / M. G. Fehlings, D. Louw // Am. Fam. Physician, – 1996. – P. 162.
5. Frost H. M. The biology of fracture healing. An overview for clinicians. Part I / H. M. Frost // Clinical Orthopedics and Related Research. – Nov: 1989 (248). – P. 283–293.
6. Frost H. M. The biology of fracture healing. An overview for clinicians. Part II / H. M. Frost // Clinical Orthopedics and Related Research. – Nov: 1989 (248). – P. 294–309.
7. Gowned and gloved orthopedics: introduction to common procedures / edited by Nail P. Sheth, Jess H. Lonner. – 1st ed. p.. – 2009. – Philadelphia : Saunders.
8. Gustilo R. B. Fracture and Dislocations / R. B. Gustilo, R. F. Kyle, D. Templeman. – St. Louis : Mosby-Year Book. Inc., 1992.
9. Krettek, C. Foreword: Concepts of minimally invasive plate osteosynthesis. Injury. 28 Supple 1: A1–A2. –1997.
10. Maheshwari J. Essential Orthopedics / J. Maheshwari. – 2nd Revised and Enlarged Edition Interprint New. – Delhi, 1997. – 325 p
11. McRae Ronald/ Practical Fracture Treatment / Ronald McRae; Max Esser. – 5th ed. – Elsevier Health Sciences, 2008. – p. 187.
12. Rockwood C.A. (Jr.), Green David P (Ed.): Fractures / C. A. Rockwood (Jr.), David P. Green (Ed.). – 2nd edn. – Philadelphia : J.B. Lippincott Company, 1984.
13. S.T. Marshall; B.D. Browner (2012) [1st. Pub. 1956]. "Chapter 20: Emergency care of musculoskeletal injuries". In Courtney M. Townsend Jr. Sabiston textbook of surgery: the biological basis of modern surgical practice. – Elsevier. – Pp. 480–520.
14. Stewart J.D.M. Traction and Orthopedic Appliances / J.D.M. Stewart, J.P. Hallett. – Edinburgh : Churchill Livlngstone, 1983.
15. Wilson J.N. {Ed.] Watson-Jone's Fractures and Joint Injuries / J. N. Wilson {Ed.]. – 6th edn. – Edinburgh : Churchill Livingstone, 1982.

Additional:

1. Arterial embolization is a rapid and effective technique for controlling pelvic fracture hemorrhage / S.F. Agolini, K. Shah, J. Jaffe, J. Newcomb, M. Rhodes, J. F. Reed.– J. Trauma. – 1997. – N 43 (3). – P. 395–-400.
2. Long-term outcomes in open pelvic fractures / F. D. Brenneman, D. Katyal, B. R. Boulanger, M. Tile, D. A. Redelmeier. – J Trauma. – 1997. – N 42 (5). – P. 773-7.
3. A statewide, prehospital emergency medical service selective patient spine immobilization protocol / J. H. Burton, M. G. Dunn, N. R. Harmon, T. A. Hermanson, J. R. Bradshaw. – J. Trauma. – 2006. – 167p.
4. Byrne T. The setup and care of a patient in Buck's traction / T.Byrne. – Orthop Nurs, – 1999. – N 18 (2). – P. 79–83
5. Closed reduction of Colles fractures: comparison of manual manipulation and finger-trap traction: a prospective, randomized study / S.A. Earnshaw, A. Aladin, S. Surendran, C. G. Moran. – J Bone Joint Surg Am – March 2002. – N 84–A (3). – P. 354–8.
6. Ferrera PC, Hill DA. Good outcomes of open pelvic fractures / P. C. Ferrera, D. A. Hill. – Injury 1999. – N 30(3). – P. 187–90.
7. Epidemiology of pelvic ring fractures / A. Gansslen, T. Pohleman, C. Paul, P. Lobenhoffer, H. Tscherne. – Injury 1996. – N 27(Suppl 1:SA). – P. 13–20.
8. Guyton A. Anatomy and Physiology / A. Guyton. – Philadelphia : W. B. Saunders, 1996.
9. Harvard University Dept. of the Classics: Harvard Studies in Classical Philology, Volume 8, page 109. Ginn & Company, 1997.
10. Holdsworth F. Fractures, dislocations, and fracture dislocations of the spine / F. Holdsworth. – The Journal of Bone and Joint Surgery. – 1990. – N 52 (8). – P. 1534–1551.
11. Hughston, J. C. Fracture of the distal radial shaft; mistakes in management". J Bone Joint Surg Am. – April 2007. –N 39–A (2). – P. 249–64.
12. Improved outcomes after early fixation of acetabular fractures. – Injury 2000. – N 31(2). – P. 81–4.
13. Killeen K. L. CT detection of serious internal and skeletal injuries in patients with pelvic fractures / K/ L/ Killeen, J. H. DeMeo. – Acad Radiol . – 1999. – N 6(4). – P. 224–8.
14. Angiographic findings in pelvic fractures / P. A. O’Neill, J. Riina, S.Sclafani, P. Tornetta. – Clin Orthop. – 1996. – P. 329. – P. 60–7.
15. Concomitant intra-abdominal injuries in pelvic trauma / G. S. Pajenda, H. Seitz, M. Mousavi, V. Vecsei // Wien Klin Wochenscher. – 1998. – N 110(23). – P. 834–40.
16. Clinic, diagnosis and treatment of fracture of acetabulum /

B. R. Plaisier, S. W. Meldon, D. M. Super, M. A. Malangoni. – 2001.

17. Pelvic fracture from blunt trauma. Outcomes is determined by associated injuries / G. V. Poole, E. F. Ward, E. F. Muakkassa, H. S. Hsu, J. A. Griswold, R. S. Rhodes, – Ann Surg. – 1991. –N 213(6). –P. 532–8.

18. Closed Reduction and Internal Fixation of Displaced Unstable Lateral Condylar Fractures of the Humerus in Children / K. S. Song, C. H. Kang, B. W. Min, K. C. Bae, C. H. Cho, J. H. Lee // The Journal of Bone and Joint Surgery. – 2008. – N 90 (12). – P. 2673–2681

19. Surgical Neck Fractures of the Humerus – Wheeless' Textbook of Orthopedics – Retrieved, 2007. – P. 08–16.

20. Operative management of displaced fractures of the sacrum / T. Taguchi, S. Kawai, K. Kaneko, D. Yugue // Journal of orthopedic science: official journal of the Japanese Orthopedic Association. – 1999. – N 4 (5). – P. 347–52.

21. Tile M. Acute pelvic fractures: causation and classification / M. Tile // J Am Acad Orthop Surg. – 1996. – N 4(3). – P. 143–151.

22. Tiwari A. Surgical management for late presentation of supracondylar humeral fracture in children" / A. Tiwari, R. K. Kanojia, S. K. Kapoor. – J Orthop Surg (Hong Kong). – August 2007. – N 15 (2). – P. 177–82.

23. Wubben R. C. Mortality rate of pelvic fractures / R. C. Wubben // Wis Med J. – 1996. N 95 (10). – P. 702–4.

24. Young J.W. Fracture of the Pelvis: Current Concepts of Classification / J. W. Young,; C. S. Resnik // AJR. American journal of roentgenology. – December 1990. – N 155 (6). – P. 1169–75.

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Упорядники Голка Григорій Григорович
Гаркуша Максим Анатолійович
Олійник Антон Олександрович
Фадєєв Олег Геннадійович
Бурлака Віктор Володимирович
Істомін Дмитро Андрійович
Веснін Володимир Вікторович

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Редакційно-видавничий відділ
ХНМУ, пр. Науки, 4, м. Харків, 61022
izdatknmurio@gmail.com

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