The archaeological evidences, found in many countries of the world show that people have started the treatment of human injuries from the high antiquity times. There are many evidences that traumas gained by our remote ancestors during work and in the period of wars were one of the main triggers of the folk and later scientific medicine formation and development.

In the IV century BC (460–356 BC) the great scientist Hippocrates outlined his knowledge in medicine (“On Fractures”, “On joints”, “On lever”). In the I century AD the Roman doctor Aulus Cornelius Celsus wrote the treatise “De medicina”, in which he deepened and complemented the Hippocrates knowledge. Almost at the same time with Celsus scientist Galenus elaborated the issues of deformations and injuries in human skeleton (131–206 AD). The great contribution in the study of injuries and diseases of musculoskeletal system made Avicenna (Ibn Sina 980–1037 AD), Ambroise Pare (1510–1590), Glisson (1597–1677) et al.

In the Ancient Rus until the end of XVII century there was no hospitals, so the medical care was provided by healers. The doctors were only from abroad, they were invited for privileged persons. Eventually some part of healers started to specialize in bones and joints injuries treatment, so folks called them bonesetters. In 1654 tsar Alexey Mykhailovich (Peter’s I father) ordered to establish the bonesetter school in Moscow. In one year during the war with Poland the bonesetters of the school was conscripted to provide a medical aid to injured soldiers of the army. In 1707 due to an order of Peter I the building of the hospital was over, the first Medical surgery school in Russia was established there. It initiated the setting of hospital wards in the country and medical education institutions establishment.

The term "orthopaedics" was suggested first in 1741 by the dean of medical faculty in Sorbonne (Paris) Nicolas Andry, who published the book “Orthopaedics or the art of correcting and preventing deformities in children with facilities available for fathers and mothers and all persons, who grow up children”. Describing the process of possible deformations correcting Andry pictured the tree with distort trunk fixed by a pole and tied to it. Eventually this became the symbol of orthopaedics.

The term "traumatology" (the study of injuries) occurred much later, when it became obvious that the number of gained injuries in orthopaedics science is much higher than for congenital or gained diseases, so the discipline was called “Traumatology and orthopaedics”. There are 3 periods distinguished in the development of orthopaedics, traumatology and prosthetics during the two and half centuries from the moment of new surgical specialty symbol occurrence.
The progressive development of the new discipline components in strict surgical frames was an important feature from the middle XVIII till the end of XIX century. During many decades the teachers of general surgery lectured the musculoskeletal pathology diagnostics and treatment issues in universities and the Emperor Medical-surgery academy of Russia. At the beginning of the XIX century the two country traumatology and orthopaedics schools – Moscow and Saint Petersburg – have distinguished as part of one surgical discipline. The dean of Moscow University Mukhin A.E. headed the Moscow traumatology school; he was the first in Russia who published thematically thesis "The beginning in bonesetter science" (1806). The book was devoted to the issues of fractures and dislocations diagnostics and treatment. It was valued as first textbook in Russian. In Saint Petersburg the basics of desmurgy and mechanurgy education for military doctors was settled by Bush I. F. – the first surgery department professor in Medical-surgery academy. The first in our country manual for students “Orthopaedics course” was published in 1885 by the docent of Kazan University Studenski N. I.

In the first half of the XIX century the general principles of patients with bone fractures treatment were established, it was based on many-years-experience of medical aid supply as well as on medical scientific achievements worldwide. This included: apposition of fractured bone fragments (reposition), restraint of traumatized limb (immobilization) for keeping of repositioned fragments for the essential period for recovery of the fracture, prevention of complications development and treatment directed on limb function recovery.

In the early 1850s the Mathijen from Holland and Pirogov contemporaneously and independently of each other suggested an anesthesia and one of four existing nowadays methods for bone fractures treatment – single step fragments reposition with further immobilization of limb with plaster bandage. This became an achievement of the first period of orthopaedics and traumatology development and found a fast implementation in common the practice of treatment institutions worldwide. Even nowadays some part of patients with bone fractures are treated using this method.

N. I. Pirogov – the genius scientist, thinker and visionist, the whole epoch of medicine development is connected with him, specifically – the study on trauma and trauma disease as general reaction of the organism on mechanical trauma. His papers on traumatology and military field surgery were of high importance, some of them are even still notable. The description of anatomical samples of limb for estimation of surgical incision topography, ether narcosis, first used in military field conditions, the methods of subcutaneous tenotomies widened the possibilities of trauma treatment, while bone plastic amputation of foot is still used nowadays.
The further development of fractures studies is connected to scientific method of traction; a special tools for skeletal, ferrule, glue or leucoplast traction provided fragments reposition and immobilization of traumatized limb. This fact afforded ground to surgeons for calling this method as functional as contrast to previous immobilization. The elaboration of general principles of continuous traction (B. Bardenheuer, 1887) and study on fractured patients functional treatment (J. Lucas – L. Championniere, 1889), the introduction to clinical practice the definition of medial physiological limbs position (H. Zuppinger) facilitated the establishment and development of functional methods of fractures treatment. The skeletal method was the best among the methods of continuous traction. However it's usage technique was elaborated only in the first decade of XX century, in the 2nd stage of the specialty development.

Orthopaedics and traumatology has developed as part of the general surgery at the beginning (more than 100 years) in classical evolution way. The quality changes in the development of orthopedics began to occur at the turn of XVIII and XIX centuries, when specialists of this sphere started to treat musculoskeletal deformations and other diseases not only in children but also in orthopaedics hospitals. In 1888 the orthopaedics hospital was opened in Odessa, in 1896 the hospital for children with different deformations was opened in Kharkiv. In many cities, the enthusiasts traumatologists-orthopaedists worked on the base of hospitals specialized on general surgery.

The distinguishing feature of orthopaedics on its first stage of development (in the before aseptic era) was mainly usage of conservative methods of patients treatment (redressing, wide usage of casts, tutors and apparatuses for traction or immobilization). In the same years the interest in balneotherapy occurred in orthopedists as well as to other treatment factors (thermal and mineral waters, sunlight and see positive effects, massage, physical activities etc.).

The further progress in its development the orthopaedics and traumatology gained in the second part of XIX century at the background of high speed industrialization and social-economical modernizations of the most of developed European countries. So with help of Louis Paster's (France) papers and chemists of many countries the new methods of analgesia and aseptic of operations, surgical instruments, surgeon's hand and operation field was adopted to clinical practice. This enabled to achieve better anatomical and functional results, shorten terms of children and adults treatment. Such achievements facilitated fast grow of the specialized clinical centers number in Europe, as well as the formation of proper conditions for distinguishing of orthopaedics and traumatology in separate surgical discipline.

In the last decade of XIX and first years of XX century the process of differentiation started in Europe. One of the first disciplines that have divided separately was orthopaedics and traumatology. The new method of surgical diagnostics X-ray has facilitated this considerably. The usage of X-ray improved the process of determination of features and localization of pathology in bones, it enabled to watch the dynamics of reparative regeneration of bone tissue.
TRAUMATOLOGY AND ORTHOPAEDICS AS INDEPENDENT SURGICAL DISCIPLINE

This stage of traumatology, orthopaedics and prosthetics development in the first half of XX century was marked by many features:

- It was tree times shorter than the previous period;
- The final formation of new clinical discipline took place;
- The implementation of new progressive methods of fractured patients treatment occurred: conservative (skeletal traction) and operative (internal fixation for fractures);
- The new prevention systems and complex treatment of patients with polio and bone-joints tuberculosis was formed;
- Elaboration of pathogenesis based treatment of the gunshot wounds methods, on the ground of scientific assessment of the wound ballistics features, pathomorphology and pathophysiology of the gunshot wound.

The beginning of the second stage of traumatology and orthopaedics is connected to the opening of the first in the country hospital and department of orthopaedics in Saint Petersburg in Medical surgery academy in 1900 on the base of functioning department of desmurgy and mechanurgy. Professor Turner G. I. – the pioneer of country orthopaedics was its founder and constant head of it during 46 years. In the time of his activity he improved a plaster technique and some bandages, suggested plaster splint for shoulder fixation named after him, improved method of fractures traction treatment, march foot fractures, old patella fractures and spine pathology: tuberculous spondylitis, spondylolisthesis, lumbalgias.

In 1906 in Saint Petersburg the first orthopaedics state hospital in the country was opened, it was headed by professor Verden R. R. (1867–1934) former educatee of Medical surgery academy and it was led by him during his life. In 1924 the hospital was renamed traumatology institute, and in 1934 named after Verden R. R. He was active and creative surgeon, he modified existing operations and suggested many new, elaborated hip and knee-joint arthroplastics methods, simplified the surgical approach by a resection of great trochanter, run the resection of ribs exaltations in case of scoliosis, suggested arthrodesis of wrist and ankle joints and operations for medium deformations of toe, metaplasia of hip in flexion joint contractions, described new symptoms in case of meniscus abruption.

The Medical surgery academy occurred to be third center of country traumatology and orthopaedics, opened in Kharkiv in 1907 of the means of Russian miners for colliers with industrial injuries treatment. It can be understood from the name of the new institution that it was not similar by its scientific and clinical interests to the tutoring institutions in Petersburg. It can surely be named as the first traumatology and orthopaedics institute (nowadays Institute of skeleton and joints pathology). Vegner K. F. was its founder and first director until 1925. After his removal to Moscow PhD of medicine Sitenko M. I. became the director of Ukrainian State Clinical Institute of Orthopaedics and Traumatology, which was named by him after his death. Consequently the basics has established for a higher scientific orthopaedics and traumatology institutions in Ukraine. Sitenko M. I. has played a key role as well-known surgeon, representative of new scientist generation, organizers of medical science and public health practice, his talent opened in the highest level in the period of orthopaedics and traumatology service in Ukraine formation. An improvement of fractures treatments methods, dysarthrosis, varied types of bone plastics, treatment of patients with tuberculosis of bone and joints, rehabilitation and prosthetics of patients as well as prevention of orthopaedics diseases was made under his leadership. He founded a journal “Traumatology and orthopaedics”, which started to
be published in 1927. In 1929 in Kharkiv the examination of newborns by orthopaedics started to be essential.

The period of prosperity for the Kharkiv Institute of Traumatology and Orthopaedics named after Sitenko M. I. was headed by Professor Alexey Alexandrovich Korzh.

It should be noted that until 1934 the influence of the institute as central scientific traumatology and orthopaedics organization in the republic was spread not only to treatment and prevention institutions of left-bank Ukraine, but all USSR territory for that period.

In September 1996 the Institute was headed by the honored worker of science and technology of Ukraine, doctor of medical science, Professor Korzh N. A. He continued the creative development of scientific and practical activities of the University, dictated by needs of practical public health issues, the population health condition and the level of musculoskeletal system morbidity.

In September 2000 the Institute became to be subjected to the National Academy of Medical Sciences of Ukraine and was renamed Institute of spine and joints pathology named after prof. Sitenko M. I.

In the last years the basically new scientifically justified technologies for treatment of spine and joints injuries and diseases was formed in the Institute, as well as instruments for its performance. The number of new methods of operations in case of trauma and spine & joints diseases was elaborated and implemented.

The history of formation and development of traumatology and orthopaedics base in Kyiv begins from 1919, when the new institution for the treatment of orthopaedics patients was opened, named “The House of Lame Child”. Dependently on the tasks and direction of the activities the name of the institution changed. In 1934 after shifting of the capital and People’s Commissariat of Public Health of Ukrainian SSR from Kharkiv to Kiev, Ukrainian Institute of traumatology and children’s orthopaedics in Kyiv was reorganized to Ukrainian Institute of Traumatology and Orthopaedics. From that moment both Institutes continued to develop an ambulatory and stationary network of specialized services – each in its own sphere of influence. Today it is subjected to Academy of Medical Sciences of Ukraine and is called State Institute “Traumatology and Orthopaedics Institute of Academy of Medical Sciences of Ukraine”.

At the beginning of its existing and before the II World War the main scientific works was directed to the studying of bones and joints tuberculosis, congenial and acquired deformations, defects of musculoskeletal system in newborns, elaboration of effective methods of its prevention and treatment. First in the country the method of operative treatment of congenital dislocation of the hip was developed and applied (Frumina A. E.).

After the II World War the scientific works of the Kyiv Institute concerned the problems of limb amputations and its prosthetics, development of plastic operations, wound shot osteomyelitis treatment and recovery surgery, standard medical examination and treat-
ment of the invalids of The Great Patriotic War. The studies of congenital and acquired deformations and defects of musculoskeletal system in newborns and children were recovered. The research of bones and joints tuberculosis was continued, the research of haematogenum and trauma osteomyelitis was started. In 1976 on the basics of the Institute the Republic Center on Osteomyelitis was founded.

In 1960s in Kyiv Institute of Traumatology and Orthopaedics the method of complex orthopaedics treatment of nonspecific infectious (rheumatoid) polyarthritis was first developed and implemented, the methods of conservative and operative treatment wasexplained. The clinical-radiomorphological classification of degenerative-dystrophic disorders of the joints was developed and the methods of conservative and operative treatment were improved. The endoprosthetics of hip joint was implemented. The basic aspects of ethiopathogenesis of scoliosis disease were studied. The methods of operative correction of severe forms of spine deformations, koiosternia and tropec chest deformations was improved and elaborated. The methods of shortening vertebrotomy, decompression operations in spine and spinal brain, microsurgical operations were developed and applied.

The widening of traumatology service in country continued. In 1921 by the decision of People’s Commissariat of Public Health of USSR the medical faculty of Novorussian University was reorganized into the medical university in Odessa. At the same time by the direction from People’s Commissariat of Public Health the department of orthopaedics surgery was opened in Odessa Medical Institute. The first head of the department was Kefer N. I., who has a great achievement in its foundation and further development. As Wold War II started the department stopped its activity as scientific institution and was recovered in 1960. Professor Gertsen I.G. was chosen as head of the department.

Consequently, orthopaedics in contrast to surgery of skeleton deformations distinguished first and became independent discipline. However complete social and professional (from surgeons) acknowledgment of the new surgical specialty happened only in 1920s and the first half of 1930s, when the international societies were founded, in 1929 the SICOT was organized – International Society of Orthopaedics Surgery and Traumatology (Societe Internationale de Chirurgie Orthopedique et de Traumatologie).

In Russia by a suggestion of Polenov A. L. and then in Europe the surgery of injuries was named traumatology, which soon with orthopaedics and prosthetics became the main new surgical specialty in its nowadays meaning. In 1918 in Petrograd Polenov A. L. organized first in the country department of traumatology as part of State Institute of Medical Knowledge (nowadays the department of traumatology, orthopaedics, military field surgery and stomatology named after Mechnikov I. I.).

Before the World War II, the main country traumatologists and orthopaedists, except the formation of scientifically research and treatment institutes, achieved an implementation of an obligatory
system of measurement and registration of the trauma (1922) and in 1927 they organized the health posts in the factories: in 1932 in Leningrad and then in Moscow the first traumatology posts were organized, the service of first medical aid was formed.

The decision of XXII USSR assembly of surgeons (1932), which united orthopaedics and traumatology and acknowledged it as independent specialty, had a special importance in the list of tasks before war. A problem of organization of orthopaedics and traumatology aid to injured on different stages of medical evacuation was a key issue in 1939 in the II assembly of orthopaedics and surgeons and prosthetics workers in Ukraine. Staff of Kharkiv Traumatology and Orthopaedics Institute summarized their experience in four monographs, published before war by Kyiv special district – Novachenko M. P., Eliashberg F. E. “Continuous skeletal traction”, Marks V. A. “Examination of patients with injuries and diseases of support and movement organs”, Pogorelskyi M. A. “Plaster technique”, Prychod’ko A. K. “Funktional treatment of injuries and diseases of movement apparatus”.

The great importance of the specialty was acknowledged in the years of the Great Patriotic War. The decision was made by USSR government in 1944 to form 10 new National Research Institutes of Orthopaedics and Traumatology on the base of major specialized evacuation hospitals as well as on organization in each district, land, republic the hospitals for treatment of invalids of the Great Patriotic War. Despite the fact that surgery and traumatology had two conservative fractured patients treatment methods (plaster and skeletal traction), anatomical and functional results of the wounded patients treatment in hospitals occurred to be much better than general surgical.

The first post-war decade ended the second period of traumatology, orthopaedics and prosthetics development not only in USSR but also worldwide. The timeliness of the problem of traumatic injuries in human was driven not only by society needs but also by occurrence of entirely new injuring factors appearing for example during road traffic incidents or various industrial accidents.

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**N.B.** Eventually the directions of clinics activities widened, arthrology developed with orthopaedics treatment of rheumatoid arthritis, Marie-Strinipell disease, Systemic lupus erythematosus, osteoarthrosis. With the help of Institute’s scientist papers the new direction rheumoorthopaedics was founded by professor and it’s leading specialist Skliarenko E.T.

Many outstanding scientists worked within the walls of University. An important contribution to its development was made by professor Shumada I.V., who headed this Institution for many years. Nowadays the director of State institution "Institute of traumatology and orthopaedics of National Academy of Sciences of Ukraine" is an outstanding scientist, academician, prof. Georgiy Vasilevich Gayko.


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The main achievements of the period are the following:

- New operative treatment method of trauma patients – intra-medullary (M. N. Smith-Petersen, G. A. Kuntscher, J.G. Dubrov et al) and extra-cortical osteosynthesis (M. Venable, S. Sherman, A.V. Kaplan et al);
- The experience of the Great Patriotic War 1941–1945 united organizers, morphologists, physiologists, surgeons, physicians and narrowly focused specialist in a circle of co-thinkers, who achieved not only to show the success and goals but also to maintain the disadvantages, losses and ways of further development of traumatology and orthopaedics.

Until the middle of 1950s 19 scientific research institutes of traumatology and orthopaedics functioned in USSR and 6 institutes of prosthetics, all physicians’ continuing education institutes had the departments of traumatology and orthopaedics, the same departments was in 39 medical institutes of the country.

Till the end of 1950s the departments of traumatology and orthopaedics were recovered in Ukraine in higher medical institutes of Kharkiv, Odessa, Dnipropetrovsk and new departments was formed in Donetsk, Simferopol, Zaporizhja, Lugansk, Poltava and other cities. In 1957 Donetsk scientific-research institute of traumatology and orthopaedics was established, Professor Revenko T. A. was the head. Consequently, the conditions for application of new forms of aid from institutes of traumatology and orthopaedics for public health organizations occurred.

The period of traumatology, orthopaedics and prosthetics prosperity is concerned to be 1960s. The Central Institute of Traumatology and Orthopaedics (Moscow) and its director prof. Volkov M.V. initiated the I USSR assembly of traumatologists and orthopaedics in 1963 and played the key role in revealing the traumatology and orthopaedics as one independent clinical discipline, which can develop progressively.

On the ground of assembly’s decisions the new organizing staff structure of traumatology service was formed with the main traumatologist-orthopaedics of the country as a chief. Traumatology departments were opened in every medical institute of the USSR. The traumatology hospital units were formed in cities and big towns, in small towns – a district traumatology posts for population of 100 thousand people. A legal status, administrative and methodical subordination was maintained for each treatment institutions. In 1977 21 scientific-research institutes, 91 departments of traumatology and orthopaedics in higher medical institutes and in physicians’ continuing education institutes functioned in USSR, there were at least 9000 participants of union of traumatologists and orthopaedists, the number of traumatology beds increased significantly.
In scientific and clinical aspects the prosperity of traumatology and orthopaedics period was enriched by implementation of range of new technologies, which speeded the progress of specialty:

- The method of internal stable-functional osteosynthesis was strongly implemented into the practice, which enabled to remove external limb immobilization (M. Muller, M. Allgower, H. Willenegger, S. S. Tkachenko, V. P. Okhotskyi, I. M. Rublennik et al.);
- Modern traumatology and orthopaedics enriched by a new method of external osteosynthesis with compression-distraction apparatus, which became popular quite quickly. The creator of the method Ilizarov G. A. discovered the biological growth of tissues with the influence of traction, immobilization of bone fragments on base of dosed distraction instead of compression, which enabled extension of limb with liquidation of dysarthrosis with simultaneous recovery of segment length, elimination of visible bone deformations etc.
- Great success was achieved in spine surgery (transpedicular and anterolateral stabilization), major joints (stable-functional osteosynthesis, endoprosthetics of major joints, minimally invasive internal joints operations under arthroscopy control), microsurgery and plastic surgery, bone matter surgery, oncology orthopaedics, recovery treatment and prosthetics.


Professor Khvisiuk Nikolai Ivanovich is one of the founders of Ukrainian vertebrology and creator of Kharkiv Vertebtology School, which has leading position nowadays worldwide.

N.I. Khvisiuk studied and explained a syndrome of unstable spine, proved a possibility of reduction of spinal bones in various types and displacements (spondylolisthesis, dislocation fractures), developed range of methods of anterior spondylodesis (auto-, allo-, ceramoplastics). Nikolai Ivanovich was first to begin studying of osteochondrosis features in children and elderly, elaborate classification of spine osteochondrosis, explained a number of treatment methods with distraction, manual therapy, criodestruction, chemonucleosis.
N.I. Khvisiuk and his co-workers developed a number of surgical approaches to spine bones, as a result the monography was published “Surgical approaches to spinal chest and lumbar bones”, which is still a resource book for specialists vertebrologists.

In the present time one of the leading center in endoprosthetics of major joints in Ukraine is specialized clinic in Dnipropetrovsk, headed by professor member of NAMS of Ukraine, honored worker of science and technology of Ukraine, laureate of state prize of Ukraine Loskutov A. E.

In the conditions of high industrial and domestic traumatism in 1956 in Donbas on the base of district traumatology hospital the Institute of Traumatology and Orthopaedics was organized.

For a long period the Institute was headed by prof. Revenko T. A. In 1996 the Institute was included into the Donetsk National Medical University named after Gorkiy M. and it’s director was laureate of the state award, doctor of medical sciences professor Klimovskiy. A work in large industrial district enabled to solve the issues of studying and development of modern first medical aid, used in aid supply for injured in emergency field and industrial incidents, their frequency is constantly increasing in different districts of Ukraine.

No doubts, as time goes by the history of modern traumatology and orthopaedics will enrich with new names of talented scientists and doctors, who will continue commendably the duty of their outstanding predecessors.
Traumatology (from Greek trauma – “injury” and logos – “science”) – the discipline of clinical medicine, which studies pathogenesis of mechanic injuries of musculoskeletal system and develops methods of its prevention, diagnostics and treatment.

Orthopaedics (from Greek orthos – “straight” and paedia – “child”) – the discipline of clinical medicine, which studies prevention, diagnostics and treatment of congenital defects, diseases of musculoskeletal system and acquired deformations, associated with various pathologic processes and injuries consequences.

Traumatology and orthopaedics – an independent clinical discipline, concerned with a development of measures on traumatism prevention, sufferers and patients with mechanical injuries and musculoskeletal diseases treatment, as well as with its consequences in peace and war time.

The main sections of traumatology and orthopaedics are:

- organization of specialized orthopaedics-traumatology aid for injured persons with fractures of limbs bones, pelvis and spine;
- elaboration of prophylaxis measures for population traumatism prevention together with state organs of administrative territory management;
- the perspective reconstruction-recovery operations technologies development and its implementation in clinical practice;
- treatment of ill and injured with complications and consequences of bone fractures, joints traumas and other injuries of musculoskeletal system and implementation of optimal programs of patients recovery treatment in ambulatory and in-patient hospitals practice;
- prophylaxis and treatment of musculoskeletal diseases in children and adults.

1.1. METHODS OF CLINICAL EXAMINATION IN TRAUMATOLOGY AND ORTHOPAEDICS

The clinical examination of patients with traumas and diseases of musculoskeletal system is the basis of professional occupation of traumatologist-orthopedist. The methodically correct examination of the patient enables to diagnose the diseases accurately, execute medical records (case reports) – the main document, which confirms the legality of doctors’ acts in case of juridical disputable issues settling. Besides, the examination must be performed according to concrete acts algorithm, which helps to form the diagnosis accurately and to assess the probability of diagnostic errors occurrence.
The examination of patients with injuries and diseases (or injuries consequences) of musculoskeletal system is realized in different conditions and therefore has a number of features.

These features are connected not only to specific manual techniques and symptoms, but also the examination methodology itself, used by a doctor, comparing to the general clinical exams of surgical patient.

THE PROCEDURE OF EXAMINATION OF PATIENTS WITH MUSCULOSKELETAL SYSTEM TRAUMAS

The examination of injured persons with “acute trauma” is based on the general principles, which are approved in medicine – those are the knowledge of propaedeutic medicine with traumatology clinical features taking into account. The clinical diagnosis (from Greek “recognition”)- is essential factor for correct medical aid supply and treatment of traumatology patient. V. O. Marks (1978) notes: “The high quality hospitals equipment with modern apparatuses paradoxically leads to conviction of some doctors, that full clinical examination of patient may be missed. Such acts cannot be concerned as correct, as this is more likely a step back rather forward”.

The clinical examination of patients with “acute trauma” has quite accurately elaborated system which involves collection and study of subjective complaints and objective symptoms of injuries. The conditions of medical examination of injured patients may differ a lot. In this way, the diagnostics of injuries in patients with “acute trauma” is different, as it is time constraint activity, absence of complete clinical and instrumental examination possibility. It is not always possible to presume on the cooperation with patient, who can be inadequate, aggressive, obtunded or even unconsciousness.

The scheme of traumatology patient examination:
1. Complaints.
2. Anamnesis:
   - history of present disease (anamnesis morbi);
   - history of life (anamnesis vitae).
3. Estimation of patient’s state:
   - General visual and physical examination of the patient (status praesens);
   - Visual examination and checkup of injured area (status localis).
4. Noninvasive additional examination methods (radiography, computed tomography and magnetic resonance imaging, ultrasonic examination, etc.)
5. Invasive additional examination methods (puncture, arthroscopy, etc.).

After examination of the patient the diagnosis must be established.

Due to general principles of medical diagnostics, the meeting of doctor with patient begins from passport data review (name and surname, gender, age, address, occupation, etc.) which enables doctor to determine the social state of injured and possible connection of trauma with professional activity. Than complaints must be determined.

Complaints (molestia)

The detailed investigation of complaints and its distinguishing to major and minor has great importance in the beginning of examination. A contact with patient, who describes the complaints dis-
tinctly, significantly simplifies a diagnosis establishing. The set of complaints of patients with injuries is not great (pain, claudication, deformation, extremity or spine malfunction, cosmetics defect), so each of them requires specification. On the basis of typical injury symptoms awareness, it is very important for a doctor to be able to emphasize major complaints, specify its character and onset moment, connection between the movements and strain. The most common complaint of musculoskeletal trauma patients is pain, which may have variable character. Pain is a defense reaction of the organism or a signal of problem in some of the morphofunctional branches of human organism. It is required to determine its precise localization, irradiation, intensity, duration and connection to a physical activity, body (extremity) position; it must be remembered at the same time, that localization of the pain may not correspond to injury location.

It is important to keep in mind that pain, after executing of its initial defensive-informational role in human organism, changes its direction and becomes a focus of central nervous system activation, the trigger agent of neurodystrophic changes development and disorders, and as a result it becomes a cause of physical and psychoemotional drain of the organism. The pain must be fixed, but completely it should be eliminated after the diagnosis establishing. During further examination it is needed to compare patient complaints and objective data, and determine its correspondence.

The history of the disease (anamnesis morbi)

Thoroughly and expertly collected anamnesis and patients’ complaints detailing are the basic of further treatment and diagnostic process. Thoroughly and expertly collected anamnesis and patients’ complaints detailing are the basic of further treatment and diagnostic process. It is well known, that one who asks properly, determines diagnosis correctly. “The art of anamnesis taking is concluded of skilled distinguishing of all false and minor information, and detachment of reliable facts, which enables correct diagnosis establishment” (R.R. Verden, 1938). However doctor is not a detective and cannot insist on receiving data, which patient would like to cover. Anamnesis must be taken only with purpose to assist an effective medical aid.

The following aspects should be noted:

1. **What happened and where it took place?** The circumstances of trauma define the further direction of diagnostic research. At the same time determining trauma circumstances as well as the amount and character of first aid, character of extremity immobilization and features of transportation of patient to the hospital has not only medical but also legal significance. All this data, obtained according to words of injured or accompanying persons are written to the case report. The information given to the doctor about work trauma, road traffic accident, car number plates, names and appearance of people, who made a trauma, sometimes, has a great importance in determining responsibility of citizens and material damage of the patient assignment. The collecting of such information and its fixing in medical documents is responsibility of medical staff, it is important to perform this highly responsibly.

2. **How did the injury occurred?** Clarification of the mechanism of trauma and duration of posttraumatic period maintains the technique of clinical examination. A doctor has possibility to ascertain in details how the patient fell, what he felt and whether he could stand up by himself. During patient inquiry, it is needed to pay attention to the intensity of trauma agent, position of the patient during trauma, psychical state and sense of the trauma; whether a mechanism was direct or not.

There is a range of trauma mechanisms on the basics of which it is possible to suppose some of the common types of injuries. Virtually every anatomical area of the musculoskeletal system has its
own typical mechanism of trauma. So, the knowledge of the injuries helps to direct the diagnostics search in the right way and avoid many mistakes.

3. **Date and time of trauma.** Information about the time, which went from injury occurrence may significantly facilitate diagnostics and treatment strategies elaboration. So, information about a time of foot swelling onset (immediately, after half an hour or gradually increased during a week after trauma) may help to estimate the severity of trauma. A long period of time (more than 2 weeks) after the injury affects significantly, for instance, the assessment of possibility of closed reduction, fragments reposition, primary nerves and tendons suture performance.

4. **Character of primary medical aid or treatment.** Medical aid supplied to patient in first minutes and hours after trauma effects significantly on the clinical performance. In case of supply of inadequate or late clinical aid the symptoms related to further complications may occur – such as peripheral circulation or innervation disorders, because of suppression by incorrectly applied dressing, plaster, splint, epidermal vesicles formation (phlyctenas) as a result of increasing swelling, perforation of the skin with bone fragment in case of immobilization incompetence, etc. Inversely, on-time reduction and precise reposition of bone fragments may significantly affect patient's complaints character, decrease or neutralize the intensity of pain.

   It is important to prepare full description of previous treatment of the patient, follow the sequence or modify it.

**History of life (anamnesis vitae)**

Regardless of pathology character, commonly, the data and ascertainments are necessary (date of birth, personal development, sustained diseases, allergic anamnesis, bad habits, labor and lifestyle conditions and others).

**During examination of orthopaedics traumatology patients it is important to pay special attention to:**

- health condition and diseases which may cause reparative malfunction or its changes (diabetes, thyrotoxicosis, collagenases, tuberculosis, hormonal therapy, climax, pregnancy, occupational hazards);
- bad habits (especially systemic alcohol and drugs usage) which may lead to osteoporosis, development of psychiatry and neurological disorder, etc.;
- previously sustained traumas, their consequences, functional results after end of treatment;
- labor and lifestyle conditions (sports activity), related to microtraumas, increased or significantly decreased physical and functional musculoskeletal system workload;
- allergic reactions, caused by general and local analgesics, antibiotics (as drugs most commonly used in traumatology), and skin diseases (eczema, contact dermatitis);
- previous operations, blood transfusions;
- tuberculosis, virus hepatitis, HIV.

Work anamnesis – if patient is capable of working, it is needed to provide him with sick-leave certificate; in case the patient is incapacitated for long period of time it is required to state the duration of sick-leave certificate and appropriate changes in working conditions due to trauma or disability. It is important to ascertain a social status of the patient, which involves conscious collaboration with doctor during the treatment, motivation towards recovery and workability & life normalcy. It is advisable to study patients' medical records with information on previous diseases and operations.
Status of patient (status praesens)

**Visual and physical examination**

At the beginning of examination it is necessary to draw attention to the features of the patient's injury, patient's appearance, face expression, walk, figure, body proportions. It involves assessment of:

- general condition (satisfactory, poor, grave, terminal);
- the level of consciousness and grade of psychical adequacy (attention should be paid to possible drugs or alcoholic intoxication – in case of suspicion on this, the required clinical and laboratory examination must be carried out, and special documents must be prepared);
- type of constitution and body weight features (normosthenic, asthenic, hypersthenic, cachectic, overweight);
- representation of organs of different systems (skin and subcutaneous fat, breathing, circulation, digestion, urogenital, endocrine, nervous system).

In case of injury to any of this systems its description is led to the description of the injury locus (status localis).

Examination of injured area (status localis)

The detailed and systematic examination helps to avoid many diagnostic mistakes. General appearance, position, face expression, skin color of the patient may help to assess the severity of patient's state and dominating localization of pathology focus. An experienced doctor can establish diagnosis only based on typical posture and specific position of the extremity “with one look”. However, this doesn't exclude necessity for complete examination. Passive position of extremity may be caused by contuse, fracture, paresis, paralysis. Forced position can be observed in case of severe pain syndrome (sparing set) in fracture area, inflammation focus, in case of mobility disorders in the joints (dislocation, contractures), as a result of compensatory shortness of extremity (pelvic obliquity, scoliosis).

During examination malformations and changes of outlines of extremities, joints and body parts can be found. The abnormality of extremity segment axis, angular or rotational deformation evidence on fracture. Patient with “acute trauma” may be examined standing, sitting or lying depending on the character of obtained trauma and general patient's state. It is necessary to compare symmetric parts of the body and extremities. The examination may only be considered as completed if it was carried out in fully uncovered patient.

The position of the patient or injured segment in the moment of examination may be active, passive or forced. Active position evidences on relatively good patient condition, when the injury didn’t affect significantly on musculoskeletal function. Passive position means full immobility and in most cases evidences on severe brain (coma) or spinal (paralysis) affection. Passive position of separated segment may be so indicative that studied in line with typical symptoms of concrete injury (for instance, passive foot position in case of fibular nerve injury – “horse foot”). Forced body or segment position is obtained by patient consciously or unconsciously for reducing or suspending the pain.

The forced position is distinguished due to reasons, by which it may be caused:

- pain syndrome – “sparing set” (for instance, position of upper limb in shoulder dislocation, semi sitting position and chest excursion limitation during ribs fracture);
- morphology changes in tissues (contractures, fracture malunion, scar tissue);
• compensatory or pathology settlements, which often are found distant from injured area (hyperlordosis of lumbar nerve at background of contraction of hip joint, oblique pelvis at background of fracture malunion of the ankle).

Examination of the skin is performed comparing to uninjured parts of the body, paying attention to different injuries (wounds, abrasions, erosions, fistulas, scars, epidermal vesicles, traumatic skin baring), bruises (for instance, paraorbital hematomas may occur in case of brain injury, perinea hematomas – during pelvis injury), skin rash (for instance, petechial under lipid embolism), asymmetry of skin folds. In case of some bone fractures especially superficial, generalization and localization of hematoma may be typical, so the fracture character may be established correctly.

Palpation is very important and informative method of examination. It is performed with entire hand, the fingertips of one or both hands and with the tip of one finger. A special attention should be paid to the occurrence pain during palpation. In most cases this helps to determine the localization of injury during clinical examination. The pain may be local or generalized, severe or slight, continuous or related to special body or segment position. With the help of palpation in many cases the bone fragments beneath skin, its disposition character, pathological mobility, and reposition effect may be determined. Due to disposition of certain bony prominences or joints’ extremities, the existence and character of bone disposition can be determined, while it’s impossible to do with visual examination and palpation due to its deep location. The presence of local pain after trauma may lead doctor to assume fracture even in case of X-ray data absence. Palpation of joints and pararticular tissues may help to determine fluid presence in the joint (hydrarthrosis), find joint outline abnormalities and relationship of anatomical orients.

Information about analgesics use in pre-admission stage is also very important.

Determination of crepitation, which character and intensity may vary in different conditions, has the great importance.

Reasons of crepitation onset may be:
• rubbing of bone fragments during fractures;
• inflammatory and scar changes of tendon sheathes and joint capsules (tendovaginitis and bursitis);
• deformative arthrosis of joints, internal joints injuries and foreign matters existence;
• presence of free air in subcutaneous fat – subcutaneous emphysema (chest trauma with lungs injury, gas-gangrene).

Decreasing or absence of percussion sound during auscultation and percussion of bone may evidence on fracture. However, since the advent of modern highly informative methods of observation appeared (X-ray firstly), the auscultation and percussion became very limited in their use. These methods are important for diagnostics of complications of hemopneumothorax, pneumonia, free fluid existence in abdominal cavity, etc.

Clinical signs of fractures. Two types of fractures signs are distinguished: significant (absolute) and indirect (relative), which are determined by doctor during clinical examination of injured patient.

Significant (absolute) signs are relevant only for the fractures:
• pathological mobility of bone fragments in the area of supposed injury,
• crepitation of bone fragments;
• pathologic deformation of the axis of tubular bone with change of its length;
• palpation of bone fragments under the skin;
• protrusion of bone fragments in the wound in case of open fractures.

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The presence of at least one significant (absolute) sign is sufficient for fracture diagnosis confirmation. It should be remembered, that artificial formation of pathologic mobility, crepitation of bone fragments may cause additional trauma to tissues, increase the pain and lead to many severe complications – injury of peripheral vesicles and nerves. Hence such symptoms may be found only incidentally during patient examination, application of transport splint and transportation. It is inappropriate to cause crepitation and pathological mobility of bone fragments symptoms by purpose!

Indirect (relative) signs may be caused not only by a fracture but other injuries or diseases.

**Fracture diagnosis may be established only in case of few indirect (relative) signs combination, which most commonly are:**

- local pain (at rest, movements or functional load, palpation or percussion),
- malfunction;
- segment outlines changes, edema of soft tissues (swelling), skin color change, local hyperthermia, epidermal vesicles (flattens),
- presence of wounds, bruises, subcutaneous and intracutaneous hematomas;
- disorders of peripheral circulation and innervation,
- body asymmetry (may be related not only to injury but also to pathological pain set).

Symptoms of axis stress (local pain in area of assumed fracture during routine workload directed to the axis of bone) is most commonly found in cases of fractures but also is related to indirect signs, as it can be observed also during local pathologic processes (tumor, osteomyelitis).

In case of dislocations and fracture-dislocations (combination of fracture and dislocation) the symptoms of barrel fixation during movements effort in the joint, fluid inside the joint (hydroarthrosis, hemarthrosis) as well as external landmarks symmetry disorder may be found.

The own specific symptoms exist for each location of the injury, that will be described in specific chapters of the textbook. In this case the following methods are used: estimation of walk and anatomical outlines, palpation, percussion, auscultation, examination of peripheral circulation and innervation of extremities, estimation of deformations and movements’ amplitude in joints.

**Features of examination of patients, injured with multiple trauma**

Patients in severe condition may complain very insignificantly or not complain at all. It is important to remember about stress condition of the injured after gained trauma, though they may be unable to estimate their condition adequately and express complaints. In case of multiple injuries patient may complain of pain only in focus of the highest trauma of tissues, with no attention to other locations – pain dominant effect. Therefore general condition must be estimated firstly, the severe life threatening disorders must be found (shock, bleeding and acute respiratory insufficiency) and parallel to diagnostics the urgent measures for vital functions support and recovery must be performed.

Sometimes the patient cannot tell about trauma circumstances because of severe state or retrograde amnesia at background of brain injury. Hence anamnesis must be complied not only from patients’ words, but also from evidence of the relatives, eyewitnesses, first aid workers, policemen. Data obtained from different sources sometimes complementing each other may form the entire picture of the accident.

Injured patients with multiple, associated and combined traumas in severe state must be examined with no changing from stretcher to gurney, combining diagnostic and reanimation and antishock measures. It is better not to undress patients, but to cut the clothes with scissors, to avoid the risk of aggravating the condition and causing additional trauma. Examination and palpation of injured must be
performed with both hands as soon as possible and in a specific sequence: head, neck, chest, abdomen, pelvis and extremities, with aim to determine a principal injury. After the stabilization of condition, less significant injuries should be found – bruises, aching areas, hematomas, asymmetry, malfunctions, skin desquamation, distension, muscle, tendon raptures, etc.

PROCEDURE OF EXAMINATION IN ORTHOPAEDICS DISEASES AND MUSCULOSKELETAL TRAUMA CONSEQUENCES

Diagnostics in case of orthopaedics diseases or injuries consequences differs in the way that patient has no life threatening conditions, which demand fast medical aid, while doctor has sufficient time for conversation with patient, for detailed examination and necessary complex of additional exams performance. Main methods of examination are: visual inspection, palpation, percussion, auscultation, measurement of movements' amplitude in joints, survey and local radiography. An assessment of morphofunctional changes during dosed workload is also included to the examination scheme, as well as analysis of laboratory data, invasive procedures (puncture, biopsy). The main instruments of traumatologist-orthopaedist during patient examination are tape measure and goniometer. Comparative measurement of extremities length (relative, absolute), axis lines, circumference, active and passive movements' amplitude in joints must be performed on all patients.

In the beginning of conversation with patient, before complaints collecting, it is required to observe the passport data of patient's case report. The description of the disease and doctor's questions about the disease onset, its development and character are related to anamnesis.

Anamnesis. A significant number of important facts, related directly to the disease, may be obtained during anamnesis ascertaining. The time and conditions of first symptoms onset may be determined, as well as cause of the disease, external and internal factors' effects on the disease progression process – rest or workload, chilling or warming, different treatment measures impacts, obesity and underweight of the patient, etc. In many cases anamnesis can give evidence about some objective symptoms that were presented earlier but absent on the moment of patient examination. Data, obtained from the patient, whether acute or chronic was the onset of the diseases (e.g., in sustained arthritis), predisposition to bleeding at hemophylic arthrosis, should be considered as objective symptoms by a doctor. During anamnesis obtaining it should be approached to achieving a full picture of the disease from the moment of its onset, i.e. the dynamics of the disease. Single examination of orthopaedics patient with physical methods, as well as short period of patient supervision, somethimes doesn't give the important evidence about dynamics of the disease process, which can be obtained commonly from anamnesis.

Complaints. An account of patient, the complaints and questions of doctor are interlinked to each other, they are repeated often in process of patients evidence, so it's difficult to distinguish them. However, the sequence and plan of the investigation enable the separation of complaints from anamnesis (memories), which are reflected in conventional cases reports.

Visual inspection. The patient visual inspection is one of the main methods of patient examination. However, it requires knowledge and skills of doctor – not only to see but also to detect the smallest deviations from the normal state, to notice not only flagrant disorders in body constitution but small symptoms, which can hide significant changes. The patient should be examined up close and afar, at rest and during movements. Spine and lower extremities are examined with and without workload exercises. The patient exam always must be comparative. In some cases comparison must be made with symmetric healthy body part and extremity. In other cases due to generalization of the injury to the symmetric parts of the body, the comparison must be performed with normal human body, taking into account age-related features. Organs of support and movement are singlular functional system, though any deviation of

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each part will cause changes in other parts of the trunk and extremities, compensating the defect. Uncovering of orthopaedics patient is required not only to determine changes in injured body part, but also to establish changes in other parts. Diseases of upper extremities and pectoral girdle require uncovering of the entire upper half of the body. In many diseases patients take specific postures (malposition) or keep extremities in some positions. The reasons for malposition are different but in most cases it is response to a pain.

During extremities inspection a quite complete data may be obtained, if inspection is performed in specific sequence. At the beginning the most obvious deformations and extremities changes are determined, followed by inspection of injured area (e.g., joint) and finally by observation of changes in other body regions, noticing a state of muscular system and character of compensatory changes.

The flagrant changes are:
- pathological sets or the joints and movements disorder;
- changes in length and axis of extremity;
- changes in joint outlines.

Pathological sets, which maintain extremity in malposition, may be caused by pathologic process in joint, as well as its consequences (contractures, rigidity and ankylosis). Curvature of sagittal surface may be observed within area of diaphysis, e.g., in deformation of crus with an apex of angle in backwards direction – recurvatum, towards – antecurvatum. Curvatures may be constant (in fractures malunion, rachitic deformations) or occur during workload (tight fake joints). The normal extremity axis in frontal surface may stay normal in such forced sets. Curvature of extremities in frontal surface is determined with so called axis.

Axis of lower extremity normally passes from spina iliaca anterior superior, through the middle of patella (or its medial border) and first interdigital space (or first finger). In the absence of lateral curvatures this three points must be situated in a line (fig. 1.1A, 1.2A). Connection of this three points if not in a line but as a curvature is evidence of deformation in the frontal surface. It should be noted, that normally the axis of lower extremity stays unchanged in flexed and straightened legs in knee and hip joints. In deviation of the crus in area of knee joint to the middle (genu valgum), the axis of the extremity will be deviated to the medium side of patella. In deviation of the crus within the area of knee joint to the lateral side (fig. 1.1B) the axis is deviated to the lateral side from patella (genu varum).

Axis of upper extremity is the line directed through the center of headlet of humerus (caput humeri), headlet of radial bone (capitulum radii) and headlet of elbow (capitulum ulnae). Around this axis hand performs rotatory movements: rotation in shoulder joint, pronation and supination of forearm. In deformation of upper extremity in frontal surface axis line becomes a curve. In deviation of forearm in area of elbow joint to the middle (cubitus valgus) axis deviates externally from the headlet of the radial bone (fig. 1.1B). In deviation of the forearm in area of elbow joint externally (cubitus varus), the axis deviates to the middle from headlet of radial bone (fig. 1.1B).

An enlarged joint, its deformation and curvature of the extremity in area of joint or diaphysis of long tubular bones, occurred due to sustained disease or fracture malunion, may be found during examination.

Deformation may be caused by different reasons: injury of epiphysis, destruction of some condyle, disorder of epiphysis development and its delay in growth. Bilateral deviation of elbow joints externally is called bow-leg, to the middle – X-shaped leg (fig. 1.2B, C).

Often enough in case of rachitis, the deviations may be found on the level of knee joints of both extremities in one direction: genu valgum in one leg and genu varum – on the other. By the character and level of the changes the following conditions can be distinguished: disorder of de-
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Development of joint or dysplasia (in this case normal interrelation between adjoining extremities is saved, but joints surfaces does not have normal contact due to underdevelopment of epiphysis) and dislocations (luxatio), if articular surfaces congruence disorder (partial or complete) is present.

Examination of joints and separate extremity segments

Ankle, knee, radiocarpal, elbow and partly shoulder joints are the most available for detailed examination due to their superficial position. Hip joint is covered with sick folder of soft tissues, so its direct examination is ineffective. The volume of joint will increase due to changes in the joint, in periarticular swelling, local capsule or tendon sheath swelling. Most of the time, the joint is enlarged due to hemarthrosis, exudate or productive inflammation. Bleeding or fast exudate occurrence change the shape joint making it round. Chronic effusion and granulation tissue development make the joint fusiform. Tumors make the shape of joint irregular, torous. Diaphyses of the bones are available for direct examination in the different degree. In some segments of extremities (shin, forearm) diaphysis are superficial, allowing for examination of the injury area in details. In fracture malunion the bone deformation, thickness and callus is observable; in ununited fracture and false joints a pathologic mobility in diaphysis can be determined. After examination of injured area, the examination of other upper or lower situated segments must be started, its musculature assessment, absence of atrophy, etc. Muscular atrophy develops in paralysis, long period immobilization (inactivity atrophy), functional disorders of joints due to acute or chronic arthritis and degenerative or posttraumatic changes.

Examination of traumatology patients is performed within specific scheme, which helps to avoid diagnostic mistakes. During first examination the patients or injured segment position may be active, passive or forced. Example of examination of the back is on the fig. 1.3.

Fig. 1.1. Assessment of axis of upper extremity. A – normal axis, B – valgus deformation (cubitus valgus), C – varus deformation (cubitus varus) – highly uncommon

Fig. 1.2. Assessment of the axis of the lower limb: A – normal axis, B – varus deformation – genu varum, the bilateral deformation is called O-shaped, C – valgus deformation – genu valgum, the bilateral deformation is called X-shaped

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Palpation

After inspection enables to make some conclusions, the visual impressions should be verified and complemented by palpation data. During examination of osteoarticular system the palpation helps to determine the position of epiphyses and some separate bone prominences, covered by soft tissues, though, unavailable for visual inspection. Palpation enables to find local hyperthermia (in inflammatory processes) or hypothermia (in peripheral circulation disorders), swelling, fluctuation, infiltration, blood pulsation in vesicles, dislocation or skin dimpling. By comparing the results of examination with sensations obtained during palpation, the pattern of anatomical interrelations should be reproduced, and it must be determined, if there any deviations from norm in the examined organs of musculoskeletal system exists. At the same time, the character and grade of the declinations must be determined. The correctness of conclusions is controlled by observation of correspond symmetrical body part. Orientation lines helps significantly (fig. 1.4), examined deep organs project on the lines normally: Roser-Nelathon’s line (in hip dislocation, fractures of neck of the femur) Schemaker’s line (pathology of hip joint etc.), Marks’s line (elbow trauma, humerus fractures), Gunter’s triangle (forearm dislocation), Brian’s triangle (dislocations of pelvis and neck of the femur).

Changes in periarthric soft tissues, pathological fluid collection (exudation, hemarthrosis) in joint cavity or its occupation with granulation tissue, free or fixed intra-articular chondromatous bodies can be determined with palpation. All this information is obtained during examination of joint at rest.

Auscultation

The method of local audition may be used during recognition of certain injuries and diseases of joints, periarticular mass lesions, tendon sheath diseases and for some malignant bone tumors diagnosis elaboration.

Joints auscultation is performed during passive movements of peripheral segment of extremity with hands of examining doctor. At the moment of murmurs appearance the position of joint is registered with angle meter fixed to the joint. For the auscultation a locations free of hair covering must be used. Inaccuracy of data obtained with auscultation method is explained by variety of sounds which is hard to describe accurately, combination of different sounds in the same diseases; it is very difficult to distinguish murmurs joints from external and extra-articular sounds, appearing during movements. It is not easy also to determine the source of audited sound. However, audition of the joint in the combination with other clinical examination data (inquiry, examination and especially palpation) complements clinical presentation of the investigation.

Normal murmurs in the joint. In healthy children in the first decade of life the movements of joints are usually soundless. In juvenility during correct audition in passive movements usually any sounds are not recognized, excluding slight scratch and little click, appeared accidentally during complete flexion or extension. In adults more or less soft screech may occur in normal conditions.
Pathological murmurs are divided due to character of sound and its duration. Pathological murmurs occur in joints during passive movements, they can be crepitate – quiet and slight, which are heard during any movements; creaky – rough enough, they are loud, long and clicking, create the impression of sharp crack or thump, which is heard every time when the surface of joint had achieved some certain position. Murmur of thump may be short-term, instant. A crack may be short-term or long-term periodically occurring in moving joint from one limiting position to another. In chondropathy of knee joint it can be possible, for example, to audit sustainable long enough crack, which increases and decreases dependently of joint position; rapture of meniscus may present a thumb in the moment of complete flexion and extension.

Auscultation is performed with directly applying of ear to the joint (Dietrichs, 1937) or with phonendoscope applied to joint space closely but without pressure.

Significant data can be obtained during auscultation of bone tumors. Bone tumors are soundless excluding rapid osteogenic sarcoma growth, which in some cases enables to recognize during auscultation expressive pulsing murmurs of widely developed vasculature of neoplasma. It should be noted that in present time ultrasound scintiangiography or bone tumors angiography is used.
Estimation of joint range of movements

Motions in joints are the main functional indicator of musculoskeletal system activity.

A staged examination is performed for the extremity:

- joint range of motions;
- presence or absence of pathologic set of extremity;
- muscular strength;
- general function of the joint and extremity.

The joint range of active motions is always estimated, in case of its limitation – also of the passive ones. The range of motions is measured with angle meter, which axis is settled in correspond to joint axis, that forms a joint, while the angle meter branches – to axis of segments which form a joint. Measurement of movements in joints of extremities and spine is performed due to international method SFTR (neutral – 0°, S – movements in sagittal plane, F – in frontal plane, T – in transversal plane, R – rotational movements).

The measurements are noted in degrees: for example, normally the movements’ amplitude in ankle joint is S: 25°–0°–45°. The measurement reference is performed from initial position of extremity. For different segments it’s variable: for shoulder joint the initial position is hang loose hand along the body, for elbow, radiocarpal, hip, knee joints and finger it is extension position to 180°. For ankle joint the initial position is when foot is sited on the mitre 90° to the shin.

For determination of the functional state of musculoskeletal system in joints the range of active (movements in joints are performed by patient himself) and passive (movements in joints of patients are performed by examiner) movements is measured. The limit for possible passive movements is pain feeling, occurred in patient. Active movements sometimes are significantly dependent on the condition of tendomuscular system, not only changes in joint. In such cases significant difference occurs between range of active and passive movements. For example, in case of tendon of triple muscle of arm rapture the active extension of forearm is limited significantly, while passive movements are possible in normal limits.

Physiological movements in joints

During measuring the joint range of motions it is necessary to know range of physiological movements in joints.

In the shoulder joint the physiological movements are flexion up to 90°, extension up to 45°, abduction up to 90°, further abduction occurs with shoulder blade involving and can be up to 180°. In shoulder joint the rotary movements are possible (fig. 1.5). If its entire range is saved, examinee can easily lay a hand on the occiput and hang it down between the scapulae (rotation outwards) or to reach the loin with hand’s dorsum and pass the hand over the shoulder-blades (rotation inwards).

Movements in the elbow joint are possible within the range of: flexion – up to 150°, extension – up to 0°. Pronation-supination movements of the elbow joint are determined in the position, shown on fig. 1.6 and are possible within the range of 180°.

For estimation of the rotatory movements’ range of extremities the rotatometes are used (fig. 1.7).

In the radiocarpal joint the movements are performed within the range of 60–90° for dorsum flexion and 60–90° for palmar flexion. The lateral movements are also determined – radial abduction within the range of 25–30° and ulnar abduction within the range of 30–40° (fig. 1.8).

In the fingers of the hand extension is possible within the range of 180°, extension in the metacarpophalangeal joints is possible up to the angle of 90°, in interphalangeal joints – up to 80–90°.
The lateral movements are also possible in the fingers. It is especially important to determine abduction of the I finger and ability of opposition between I and V fingers (fig. 1.9–1.16).

In the hip joint the range of the movements is normally: flexion – 140°, extension – 0°, hyperextension – 10°, abduction 30–45°, adduction 20–30° (fig. 1.17–1.20).

During examination in position of 90° hip flexion, the range of rotatory movements increases up to 90° (fig. 1.20). Mentioned numbers are determined for human in the position of lying on the back.

Fig. 1.5. Determination of the volume of movements in the shoulder joint: A – flexion and extension; B – abduction and adduction; C – external and internal rotation

Fig. 1.6. Determination of the volume of movements in the elbow joint: A – flexion, extension and overextension; B – pronation and supination

Fig. 1.7. Rotatometer

Fig. 1.8. Determination of the volume of movements in the radiocarpal joint: A – dorsal and palm flexion; B – radial and ulnar deviation

Fig. 1.9. Internationally recognized designations of the joints of II-V fingers:
DIP – distal interphalangeal joint;
PIP – proximal interphalangeal joint;
MCP – metacarpophalangeal joint

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The movements range decreases in standing position. The movements range in the hip joint in flexed knee joint is higher than in extended knee.

In the knee joint the movements are possible within ranges: extension 0°, flexion 120–150°. A slight hyperextension exists – up to 10°. The lateral and rotatory movements of the shin are impossible in extended knee. During 45° knee flexion the rotation of shin is possible within the range of 40°, during 75° knee flexion, the range of shin rotation reaches 60° and slight lateral movements become possible (fig. 1.21–1.23).

The range of movements in ankle joint is within 20–30° of dorsum flexion (foot extension) and 30–50° of plantar flexion (fig. 1.24). Adduction of foot is as a rule associated with supination (rotation of foot inwards), abduction is associated with pronation movements (rotation of the foot outwards) (fig. 1.25).

During foot examination it is necessary to evaluate the shape, movements range and condition of the foot arch. The typical conditions, which can be found in clinical practice, are shown in fig. 1.26.
Fig. 1.16. Opposition of the I finger:  
A – starting position; B – the beginning of the movement; C – the position of opposition

Fig. 1.17. Determination of the volume of movements in the hip joint: flexion and extension in the supine position

Fig. 1.18. Determination of the volume of movements in the hip joint: overextension in the supine position

Fig. 1.19. Determination of the range of rotational movements in the hip joint: external and internal rotation in the supine position

During estimation of foot movements, except of finger movements range measurement, it is necessary to perform evaluation of calcaneal bone axis and shape of toes.

**Movement disorder in the joints**

When mobility in the joint is impaired, depending on the degree of restriction and the features of the changes, which disrupt the normal mobility of the joint, the following conditions are distinguished:

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Fig. 1.21. Determination of the range of movements in the knee joint: flexion, extension and overextension.

Fig. 1.22. A clinical example of determining the range of movements in the right knee joint with the help of a protractor: A – flexion, B – extension. A restriction of flexion in the right knee joint exists.

Fig. 1.23. A clinical example of determining the range of movements in the right knee joint with the help of a protractor: A – flexion, B – extension. A restriction of flexion in the right knee joint exists.

Fig. 1.24. Determination of the range of movements in the ankle joint: A – pronation, B – supination, C – dorsal and plantar flexion.
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Fig. 1.25. Determination of the range of movements in the joints of the toes: A – assessment of mobility in the toes; B – flexion measurement; C – extension measurement

Fig. 1.26. Examination of the foot. Common versions of the anterior foot structure: A – Greek; B – square, C – Egyptian. Evaluation of medial longitudinal arch of foot: D – norm; E – lack of arch, or flat feet; F – an abnormally high arch, or an empty foot. Assessment of the position of the posterior foot: D – normal position with valgus deviation of the calcaneus from 0 to 6°; H – if the angle of the valgus deviation exceeds 6°, this is the valgus foot (in the case of any varus deviation in the calcaneus, the varus foot is ascertained). The most important deformations of the toes: I – hammer-shaped finger in the proximal interphalangeal joint; J – hammer-shaped finger in the distal interphalangeal joint; K – clawed finger (according to JD Lelievre)
1) ankylosis or complete immobility in the injured joint;
2) rigidity – sustaining of movements in the joint at most 5º;
3) contracture – restriction of movements in the joint, that can be found with general examination methods;
4) excessive mobility, i.e. expansion of the limits of physiologically possible movements;
5) pathological mobility – mobility in atypical surfaces that do not conform to the shape of articular surfaces of this joint.

After determining the degree of mobility impairment in the joint, it is necessary to clarify the character of pathological changes that caused movement disorders and the functional availability of the affected extremity in case of this joint movement changes.

The ankyloses can be: bone, when immobility in the joint is caused by bone synostosis of articular surfaces (fig. 1.27); fibrous ankylosis develop as a result of fibrosis, scar changes between articular surfaces (fig. 1.28); extraarticular ankylosis, when the reason of joint immobility is extraarticular masses of synostosis between adjoining bones or joint surrounding soft tissues ossifications, with reserved joint space.

Roentgenology plays a critical role in determination of ankylosis nature. In bone ankylosis the joint space is absent (fig. 1.27), bone tissue passes through the area of joint space, connecting articular ends of bones in one. In fibrous ankylosis the line of joint space is visualized (fig. 1.28). There are functionally efficient and non-efficient ankyloses differentiated.

The functionally efficient are also such positions in joint, when due to mobility of adjacent joints the maximal functional availability of extremity can be achieved.

**Functionally efficient positions:**
- for shoulder joint: abduction of shoulder to 60–80º, flexion to 30º and rotation externally to 45º;
- for elbow joint: flexion to 75–80º, forearm in position of semi supination;
- for radiocarpal joint: hand is set in position of dorsum flexion (extension) to 25º with ulnar abduction to 10–15º;
- for joints of II–V fingers: flexion to 45º in metacarpophalangeal joints, flexion to 60º in interphalangeal joints, I finger is set in position of opposition with slight flexion of distal phalange;
● for hip joint: flexion of the hip to 45° in case of sedentary profession and to 35° in case of standing occupation, abduction to 10°;
● for knee joint: flexion to 5–10°;
● for ankle joint: plantar flexion of the foot to 5°.

Rigidity is caused by formation of scar tissues and changes of articular surfaces. It differs from bone ankylosis by sustainment of slight movements in the joint up to 5°.

The determination of contractures, occurring in joints, has a great importance. Due to character of tissue structural changes the following contractures may be distinguished: arthrogenic (scar changes of joint capsule and intra-articular structures of the organ), myogenic (degeneration of muscular tissue), desmogenic (wrinkling of fascia and ligaments), dermatogenic (scarring changes of skin), psychogenic (hysterical), neurogenic (cerebral, spinal, reflexive, etc.). More often, the contractures are mixed, because contracture, formed initially as a result of changes in certain tissue (myogenic, neurogenic), subsequently leads to a secondary changes in the tissues of the joint (ligaments, intra-articular capsule, etc.).

Isolated contractures (due to single etiological factor) occur only in the early stages of development. Due to character of mobility restriction in the joints, the following contractures are distinguished: flexural, extensor, abductive, adductive and combined. Discordant and concordant contractures are distinguished.

Example of determination of contractures in the hip joint:
● flexural contracture is characterized by flexion position of leg in a certain angle, patient cannot straighten out the leg completely;
● extensor contracture is characterized by possibility of extension in the joint to a normal level, while flexion is restrained;
● adductive contracture is characterized by adduction of the leg, while it’s impossible to abduct it to normal ranges;
● abductive contracture is when the leg is abducted and its adduction is impossible
● combined contracture, for example, flexural-adductive (in this case extension and abduction to normal level is impossible).

In opposition to mentioned changes in the joints, which manifest by restriction or absence of movements in the joints, in many cases hypernormal or pathologic mobility is presented. Examination of lateral mobility in two articulation surfaces (simple) joints (elbow, knee, ankle and interphalangeal) is necessary to perform during complete extension in joint.

Additional mobility can be caused both by changes in soft tissues of the joint (ligaments rapture, changes in ligaments with flaccid paralyses), wond destruction of articular surfaces of ad joining bones (fracture of the joint surfaces, destruction after epiphysis osteomyelitis, etc.).

Joints, in which the pathological mobility reaches a high range, are called loose or flail. Examination of hypermobility in joints is performed by the following procedure. Examiner fixes proximal extremity segment with one hand, and with other hand holds a distal segment in position of complete extension in the joint. He determines movements which are abnormal for the joint (fig. 1.29).

In some cases pathologic mobility is determined by specific methods. So, for example, during injury of cruciate ligaments of knee so called "drawer sign" is presented, which is consisted in anterior-posterior dislocation of shin. For determination of this symptom a patient lays on the back, flexing the affected leg in the knee joint in sharp angle and setting a foot against couch. Muscles have to be completely relaxed. A doctor holds shin directly below knee joint with his both hands. He tries to dislo-
cate it by turns forward and backward. The ante-
rior-posterior dislocation of shin relatively the hip
becomes possible in rupture of cruciate ligaments.

Measurement of extremity length

This is a very important method of obtaining
of additional information on musculoskeletal sys-
tem condition. Examination should be performed
be comparing affected and healthy extremities
on the basics of result of measurement with tape
measure (fig. 1.30, 1.31). During examination of
patient the length and circumference of extrem-
ity must be measured. The measurement is per-
formed on both affected and healthy extremities.
Obtained results are compared, that enables to
understand a level of anatomical and functional
changes. The length and circumference of extrem-
ity is measured with simple tape measure. The
identifying points during comparative measure-
ment of extremity length are bone prominences.
Patient should be laid properly during measure-
ment: attention should be drawn to patient's
pelvis, which can't be distorted, while line, which
connects both anterior superior iliac spines, must
be perpendicular to body median line. During de-
termination of lower extremity length a distance
between anterior superior iliac spine and lower
margin of medial malleolus is measured. During
measurement of the thigh length a distance be-
tween greater trochanter and joint space of the
knee joint is determined. A length of shin is de-
termined by measurement of a distance between
joint space of the knee joint and lower margin of
lateral malleolus (fig. 1.31).

The measurement of extremity circumference
is performed at the equal levels from particular
bone reference points.

The length of upper extremity is measured as
distance between acromion process of shoulder
blade and styloid process of radius or apex of III
finger. A length of upper arm is measured from
margin of acromial process to the apex of olecran-
on. A length of forearm is measured from olecranon apex to styloid process of ulna (fig. 1.32).

During record of results of changes it is necessary to mark points from which a measurement of
extremity or its segment was performed.

Fig. 1.29. Investigation of lateral mobility in the
knee joint

Fig. 1.30. Example of measuring the length of
the lower limb: A – the first stage of setting the
symmetrical position of the pelvis by determining
of the distance between the xiphoid process and
the anterior superior iliac spine; B – if the pelvic
position is symmetrical, the length of the lower limb
is measured from the anterior ili
ac spine to the medial malleolus

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Following kinds of extremity shortenings are distinguished:

Genuine or anatomical shortening is caused by anatomical changes of extremity. It is determined by comparison of summarized data of the thigh and shin length measurement (upper arm and forearm) on affected and healthy extremities.

It is determined during anatomical length measurement in segments (thigh, shin, etc.). This shortening is presented during bone growth delay, fractures with fragments dislocations, etc.

Projection (apparent) shortening is caused by pathological set of extremity as a result of contracture or ankylosis in the joint.

Relative (dislocation) shortening is occurred during dislocations, when one of articular bones is displaced relatively another (for example, during hip dislocation and its displacement above coxal cavity is determined a shortening of extremity, despite equal anatomical length of lower extremities).

Total (functional) shortening can be measured with planks (boards), which have certain thickness. These planks are placed under shortened leg till the moment, when a pelvis takes up a right position (line that connects anterior superior iliac spines has to be horizontal). Due to height of malleolus (distance from heel to floor surface) a summarized shortening of lower extremity is determined (fig. 1.33).

The circumference of extremities (affected and healthy) is measured in symmetric areas on certain distance from bone recognition marks: for lower extremity – from anterior superior iliac spine, great trochanter of the femur, articular space of the knee joint, head of peroneal bone etc.; for upper extremity – from acromial process, medial epicondyle of humerus etc.

Estimation of muscle strength. Functional capacity of musculoskeletal system significantly depends on condition of muscles. An examination of muscular strength is particularly important for elaboration of correct treatment strategy during unbalanced injury of different muscular groups (polio, children’s spastic paralysis, paresis, etc.). A technique of active movements with resistance from examiner’s hand overcoming is widely used.
in a clinical setting during examination of muscular strength. A patient is suggested to perform a flexion, extension and adduction of extremity, while examiner tries to make a resistance, opposition to the movements. Comparing data obtained from affected and healthy leg, a condition of muscle strength can be figured. The muscle strength is estimated by five-point system:

- 5 – normal muscle strength;
- 4 – muscle strength is decreased;
- 3 – muscle strength is distinctly decreased;
- 2 – muscle strength is significantly decreased;
- 1 – complete paralysis.

During performance of specific examinations of objective determination of muscle strength a dynamometer is used. It is fixed immobile from one side, and from other side to a collar, which is fixed in examined extremity (fig. 1.34).

Examination of traumas and diseases of the spine. Clinical, roentgenology, electrophysiology, instrumental and laboratory methods are used for diagnostics of traumas and diseases of the spine. The main technique is clinical, that presuppose a certain system of consecutive doctors acts. The following order to hold is recommended: maintain complaints, anamnesis obtaining (trauma mechanism), patient inspection, presumptive diagnosis establishing.

Complaints. During complaints clarification, the major complains should be distinguished. Most of the trauma patients complain of pain in injured area, which increases during movements, motions restrictions, visible segment deformation.

Anamnesis. A trauma mechanism must be clarified from patients’ words. Based on its typical mechanism some of the injuries kinds can be assumed. Inquiry of patient and his or her relatives about onset and first signs of the disease, its dynamics, previous treatment must be conducted in detail. There are diseases and injuries, in which correctly collected anamnesis enables not only to suppose, but also to establish a correct diagnosis. In some patients with the lapse of time many objective symptoms may vanish and it’s not possible to determine them during examination.

As in case of other diseases, a life anamnesis must be collected: innate health condition, living conditions during childhood, juvenility and adult age, working conditions, occupational hazards, sustained diseases, allergic anamnesis.

Objective examination. The spine must be examined in standing, sitting and lying position, in rest, as well as in movement (of the head, trunk, extremities). Level of the spine injury is determined by counting a number of spine bones from
certain anatomical landmarks or according to special scheme. For examination of patient standing, he should turn his back to the light. The examinee should stand steady, with a relaxed musculature, barefoot, hands should hang down along the trunk freely.

In normally constituted adults the spine has its curvatures such as two lordoses in cervical spine and one kyphosis in thoracic spine. Development of the spine ends until adulthood and remains till 45–50 years, than thoracic spine starts to become rounded approaching senile kyphosis. In adult women lordosis of lumbar spine is more apparent than in men. A line of spinous processes (median sulcus of dorsum), lower angles of shoulder blades, iliac crests, lateral outlines of waist and neck, acromions’ position, deviation of gluteal sulcus from the vertical line are marked with essential mark or at a glance (in sufficient examiner's experience). During inspection of spinous processes their protrusion is identifies; distinct protrusion of one of spinous processes relatively to others is not presented normally. During inspection of the back, the attention should be paid to outlines of muscles, located near the spine.

In practice, besides normal constitution of spine, the following types of posture are used to be distinguished: flat, sway and round-shouldered back. In thoracic spine the kyphosis becomes quite apparent even due to a slight deformation. Occurrence of kyphosis in cervical or lumbar spine evidence on severe pathological changes: protrusion of one or several spinous processes in angular kyphosis forms the hunchback (gibbuss), that may be presented in case of partial or complete damage of vertebral bodies. Lateral curvature of spine is called scoliosis. It is appeared due to deviation of spinous processes from vertical axis of the body. The axis of spine is a vertical line, drawn from inion through all spinous processes of vertebrae to gluteal sulcus.

Functional scoliosis, caused by significant shortening of single extremity, becomes apparent in the standing position, and vanishes in the lying position. In thoracic scoliosis on protruded side a costal eminence occurs, which is appeared good enough during flexion. Tension of long muscle of the spine is presented in form of protrusions on the sides of spinous processes; particularly often this symptom is presented in discogenic radiculitis.

Traumatological patients are examined due to certain scheme; this prevents injury signs missing. After inspection and detection of key symptoms the spine is examined by segments. At the moment of initial examination the position of patient or affected segment may be active, passive or forced.

Active position as a rule evidence on relative well-being, passive in most cases evidence on severe trauma or spine injury, complicated by paralysis. It is necessary to draw particular attention to forced position of the body: this is as a rule compensatory, adaptive or pathological sets. Apparent lordosis of lumbar spine in vertical or horizontal position of the patient may be caused by flexure contracture in the hip joint.

**Palpation**. Palpation of the spine enables to complete inspection data, determine localization, grade and character of painfulness. It should be remembered that normally spinous process of II lumbar vertebra is protruded more backwards, than other spinous processes. For determination of painfulness during pressure on spinous process the thumb is settled on it and pressed, moving from superior to inferior processes. In case of pathological process, in which articular and transverse processes are involved, a pain occurs during pressure in paravertebral trigger points on the line, passing parallel to spinous processes to 1.5–2 cm laterally (in lumbar spine – to 2–3 cm). For detection of pain, one should percuss on spinous processes, press on them on one side. Other special diagnostic methods are also used, such as, weight load across the axis of spine (to the head or shoulder girdle). During palpation the tension of muscles, located near the spine is also noted, as most of the traumas and diseases are followed by muscle tonus increasing. Palpation of anterior surface of the spine on the level of II-IV cervical vertebrae is performed through the mouth, usually with the examiner’s index. On the level of cricoid cartilage in front of sternocleidomastoid muscle the tubercle of VII cervical
vertebrae is palpated. In thin people during bimanual palpation of the abdomen the bodies of lumbar vertebrae are accessible for palpation. Sacral spine and coccygeal spine are palpated from the front through the rectum.

Sparing palpation of tissues in areas of injuries, apparel deformity, painfulness enables to determine local temperature, turgor of soft tissues, their swelling, distribution of induration area. It helps to establish the correlation between inflammatory process with superficially and deeply located tissues, irradiation of pain during pressing. Examination with palpation enables also to detect neoplasms and deformities. Palpation may be performed with entire hand, finger tips of one or both hands, tip of second finger during in hands palpation performance – it is called two-hand or bimanual palpation.

Determination of movements range is presented in fig. 1.35–1.37. Techniques of palpation – fig. 1.38, 1.39.

![Fig. 1.35. Determination of the range of movements in the cervical spine:
A – slope ; B – flexion; C – extension](image)

![Fig. 1.36. Determination of the range of movements in the thoracic spine:
A – slope; B – Ott’s symptom, which is used to measure the range of movements in the thoracic spine. Above the spinous process with the C, the first point is marked, the 30 cm is measured down and the second point is put. During bending, the distance increases to 32 cm in norm, and during extension it decreases to 28 cm; C – rotatory movement](image)
FEATURES OF EXAMINATION OF CHILDREN WITH TRAUMAS AND ORTHOPAEDIC DISEASES

Diagnostics of injuries and orthopaedic diseases in children, particularly, in younger children, may cause some difficulties. A doctor can make mistakes during diagnostics of diaphysis fractures, as they often occur in the form of "greenstick" fracture without apparent shortening of the extremity. It’s difficult even for experienced doctor to diagnose orthopaedics diseases, which are taking course

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at the background of neurological disease. In cases, when doctor cannot detect a pathology, while child's complaints remain, a detailed clinical and instrumental examination is needed.

A history taking is performed with presence of parents or the closest relatives; it is a difficult task. Doctor has to understand a mechanism of trauma, gained by child. In case of presuming orthopaedic pathology, the peculiarities of pregnancy and delivery course the important. It should be ascertained, whether some pathologic changes in child were presented right after the birth or developed later, as well as features of overall development of a child: period of head lifting, sitting, standing, walking. In orthopaedic deformities it should be ascertained a heredity of the disease.

**General inspection of the child.** If presuming some orthopaedic diseases a proportionality of constitution, child's position and walk must be determined. Child's height is measured. Its normality is estimated due to age equivalent scale. Growth retardation is typical for systemic spine diseases. During examination of a newborn the extremities seem to be shortened, which isn't pathology for large babies with birth weight around 4 kilos. Such disproportion of constitution disappears until 2–3 years. During general inspection an asymmetry of body and extremities can be determined. In orthopaedic diseases, changes of the skin may occur in form of vascular or pigment spots, skin hemorrhages, hypertrichosis, hyperkeratosis, scars, enhanced veins' pattern, etc. A sign of arch of lumbar vertebrae nonunion can be excessive hairiness of rhomb of Michaelis.

During examination, attention should be drawn to symmetry of skin folds. It is known that in dysplasia of hip joint, congenital hip dislocation the asymmetry of gluteal folds is detected. Moreover, additional skin folds may be presented, which evidence on congenital pathology. So, in Turner syndrome unusual skin folds are presented on the neck (“webbed neck”). During examination of child older than 1 year age it's already possible to estimate walk. A waddling gait occurs in children often during decreasing of femur neck-shaft angle, hip dislocation, rachitis and other diseases.

In bilateral congenital dislocation of the hip a lumbar lordosis is appeared in child during walk, abdomen bulges out. Sparing claudication is occurred at walk due to reduction of time and extremity resentence forces. Such walk is presented during arthritis of various etiology, misdiagnosed fractures, start period of Perthes' disease. Claudication may be consequence of different length of lower extremities. This condition may be compensated by flexure of longer limb in hip and knee joint or lengthening of shorter limb due to plantar flexion of foot with further set in position of “tip foot”. Such position of extremity is often presented during development of contractures and ankiloses in lower limbs' joints. A walk is severely disordered during organic affections of CNS and peripheral nerves. Spastic, paralytic and ataxic walk are typical. After general inspection a doctor starts detailed inspection of the body parts.

**Inspection of the head.** At the beginning attention is drawn to compliance of head's size with child's age, correlation of cerebral and facial parts of skull. Cerebral part of the head may be deformed, presented as tower-shaped skull (craniosynostosis) or in other form, skull can be elongated in anterior-posterior axis. In different areas of head cephalohematoma may be detected. These changes are not pathological as they disappear with age. Swelling, local pain, indentions are presented in skull trauma. Nasal passage or external auditory meatus hemorrhage remains may evidence on open head injury. In systemic or metabolic diseases the decreasing of cranial vault bones density is possible. In such cases palpation helps to determine their compliance, which is close to parchment paper. As a rule, the significant increase of fontanelles is presented.

During examination of facial part of skull the attention should be paid to symmetry of face, auricles shape, size and configuration of the nose and its bridge. Inspection of oral cavity is necessary. The height of hard palate, its cleft, presence of teeth, their number, color and shape must be determined.
**Inspection of the neck.** In children of first months of life the attention is paid to head and neck position, movements range: normally the head rotates freely to 90° in both sides. In restriction of movements in the neck a sternocleidomastoid muscles are palpated from both sides. In congenital myogenic torticollis induration and shortening of this muscle is presented. In children of older age a myogenic torticollis is followed not only by restriction of movements in cervical spine but also by turning of the head to opposite side and face asymmetry. In case of the slightest presuming of a neck trauma, at the beginning it should be checked a presence of local pain of spinous and transverse processes of cervical vertebrae, as well as presence of muscle defensive reaction during palpation of paravertebral spots. Shortening and thickening of neck, low position of hairline on the head and their passage on neck are often presented in Klippel-Feil disease. The mobility of the neck is restricted in this case.

**Inspection of the shoulder girdle.** In trauma the attention must be drawn to symmetry of shoulder girdles. In fractures and dislocations of clavicle the deformity and shortening on the affected side are presented. In case of “greenstick” fractures a change of configuration may occur due to increase of curvature on the border of external and medial third, smoothing of supra- and subclavicular fossae. Presence of hematomas, intense painfulness in area of clavicle and sternum adjoining may evidence on its injury. During examination of scapulae, attention must be drawn to their shape and position. Normally scapulae bear against chest. For more precise determination of position of scapulae the spines and lower angles should be pointed by marker. Congenital elevation of scapula is featuring for Sprengel disease, when movements in shoulder joint are restricted. Elevation of scapula from chest is presented in scoliosis and called "alar scapula".

**Inspection of the chest.** Normally both halves of chest are symmetrically participate in breathing. During injuries of chest and fractures an injured half of chest decelerate during breathing. During superficial palpation a subcutaneal emphysema can be presented – sign of complicated ribs fractures. Inspection must be performed not only on the back and front but also laterally. Deformities of chest may be initial such as funnel or keeled chest. Secondary deformities occur during diseases (most often in scoliosis) or after surgeries. Painless indurations may be presented in case of rachitis in children under the age of 3, called rachitic “rosary” and located at the area of transition from rib bone to costal cartilage.

**Inspection of the spine and pelvis.** In children of first months of life the spine has a shape of flat kyphosis. In a one-year-old baby the spine approaches to straight line and remains like this approximately until the age of 7.

**Inspection of the extremities.** During comparing of extremities length in children under the age of 3 years old, a juxtaposition technique is the most available, because it’s difficult to palpate bone landmarks for measurement with type measure. The length of lower extremities can be easily compared in position lying on the abdomen. If the length is equal, gluteal and popliteal folds concur and medial malleolus are located on the same level. A skin folds asymmetry is presented in case of shortening of one of the extremities.

Skin folds asymmetry is also presented during spasticity. Therefore for extremities length determination a “shortened” leg should be drawn gently. In case of apparent limb shortening the gluteal and hip skin folds become symmetric then. In cases of true leg shortening a gluteal fold descends lower. In older children a comparison of lower extremities is performed in standing position. In shortening of one of the extremities a pelvis distortion and gluteal folds asymmetry are presented.

The length of upper extremities is determined in position of arm hanging down due to tip of III finger. The difference of upper arm length is assessed during inspection from the back by a level of olecranon position in 90° angle flexed forearms. For estimation of forearms length the both child’s elbows must be settled on the table and the forearms must be pressed with palmar surfaces. The level of shortening is estimated due to position of styloid process of ulnae and tip of III finger. Precise in-
formation may be obtained during measurement with a tape measure. The technique of measurement of length and circumference is the same as in adults.

**Determination of the extremity axis.** It is performed with the same landmark points as in adults. It should be noted that children have typical deformities of extremities axis, which are not pathological. So in supination the axis of upper arm forms with forearm directed externally physiological valgus deviation of forearm, which approaches 10° in boys and 15° in girls. Normally hand is located relatively forearm in the way that line directed through III finger and III metacarpal bone is passing through the middle of radiocarpal joint.

In the early childhood medial surfaces of knee joints are not contiguous, physiological varus deviation of shin is presented, which disappears spontaneously at the age of 5–7 years. As a rule, in boys a straight axis of extremity remains, while in girls a slight valgus set of extremity is considered to be normal.

**Determination of movements range in the joints.** Determination of movements range in the joints is performed due to general algorithm. In children some increasing of movements range is normal. Therefore, in the elbow and knee joints a 10–15° recurvation normally is possible.

### ADDITIONAL METHODS OF INVESTIGATION IN TRAUMATOLOGY AND ORTHOPAEDICS

These methods include:
- instrumental methods: radiology, computer tomography (CT, magnetic resonance image (MRI), ultrasonic diagnostics (US), etc.);
- laboratory: biochemical, immunological, serological and other investigations;
- morphological: puncture, biopsy.

**Radiological investigation.** One of the most important non-invasive methods of investigation in traumatology and orthopaedics is radiology, which is carried out with purpose to diagnose, control course of fragments union, position of the fragments and treatment results assessment in long terms. In fractures of some bones an additional radiographs in oblique projections and functional positions (for instance – constriction) must be done, for example, in case of spine injury.

**In order for the X-ray to be complete and not a source of error the following technical conditions during radiography should be pursued:**
- an injured area must be located at the center of image, otherwise besides blurred image an incomplete capturing of injured area is possible;
- in case of injuries an image must be taken capturing neighboring joint;
- during injury of two-bone segment (shin, forearm) image should be taken capturing two neighboring joints. If this rule is not followed, errors in diagnosis are possible, because often level of bones injury is not coincided, while fracture may be followed by dislocation or subluxation;;
- images of all bones and joints must be taken necessary in at least two projections;
- in some diseases and injuries symmetrical images of affected and healthy sides must be performed;
- a conclusion of disease or injury character shouldn’t be made according to blurred images or images in one projections;
- a proper position of patient is one of the main conditions for obtaining an image of high quality.
X-ray is useful for pre-recognition of flagrant bone changes and determination of bone fragments. If image converter tube is available, this enhances radiological images more than 1000 times and thereby decreases radiological load to the patient and medical staff, than a role of radioscopy in diagnostics of injuries and diseases of musculoskeletal system increases.

Arthrography – a contrasting technique of joints investigation. A chemical substance is injected into the joint cavity. This makes significant contrast and enables to determine changes of soft tissues outlines (synovial capsule, menisci, etc.) in X-ray images made in several views.

Computer tomography (CT) is a technique of layer-by-layer nondestructive investigation of inner structure of the object. It was suggested in 1972 year by Godfrey Hounsfield and Allan McLeod Cormack, who were awarded with a Nobel Prize for this. The technique is based on the measurement and complex computer processing of the difference in the attenuation of X-ray irradiation by tissues of different density.

X-ray computer tomography – the technique of investigation of human inner organs with X-ray exposure. It is based on the concept of organs’ and tissues’ radiology image making. In addition to the high-quality layer-by-layer image of the area under investigation, using computer tomography, it is possible to determine (with display of digital indices) the size and density of the pathological focus, comparing them with the indicators of a healthy adjacent tissue. CT is the most informative technique of investigation for estimation of bone tissue condition. In fractures of spine and pelvis CT performance is necessary standard procedure of patient investigation (fig. 1.40–1.44). Possibilities of CT widen if contrast is used. Also use of CT is very important in multiple trauma, which enables estimate noninvasively an integrity of bones, skull as well as internals condition.

Magnetic resonance image (MRI) – a complicated highly informative noninvasive diagnostic technique. The essence of the technique is that the signals, which are generated by the nuclei of hydrogen atoms in the human body, when exposed to radiofrequency impulses in a magnetic field, are received as an echo and used for creating images of internals in any plane. The processing of these images enables to determine correct diagnosis and prescribe the treatment. By applying MRI the condition of bone tissue, ligaments (fig. 1.45), muscles and other tissues is estimated. MRI is a standard investigation in diagnostics of inflammatory processes, bone tumors and soft tissues. MRI facilities increase if apply special contrast, when vessels visualization im-

Fig. 1.40. 1 – radiography of an explosive fracture of the body L3 vertebrae – an increase of the anterolateral size of the vertebral body. 2 – CT allows to clarify the nature of bone injuries of the spine: A – vertebral body fracture, B – presence of fragments of the body in the canal of the spine, C – narrowing of the anterior-posterior size of the spinal canal

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Fig. 1.41. Example of CT of the spine at the level of the disk L₅–S₁ in the upper image (picture), the posterior disc hernia is well visualized.

Fig. 1.42. Normal disk L₄–L₅ for the same patient.

Fig. 1.43. Compression fracture of the body L₁.

Fig. 1.44. Three-dimensional reconstruction of the compression fracture of the body L₁ of the same patient.
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proves and contrast accumulation in tissues can be estimated. It is particularly important for tumors investigation.

It’s not always possible to determine a degree of bone mineral density decrease due to X-ray image. According to G. M. Ardran (1951), only in case of 30 % Calcium decrease, discrete changes, which are distinctive for osteoporosis, will be presented in X-ray.

Nowadays the most precise noninvasive instrumental technique for determination of bone mineral density is densitometry.

Densitometry is instrumental noninvasive investigation, which gives an opportunity to assess bone tissue condition and detect local as well a system osteoporosis.

The functioning of densitometer is in essence based on registration of power flow reduction in bones and soft tissues. Depending on type of applied densitometry and zone, which must be investigated, different types of densitometry can be applied.

The main unit of measurement in densitometry is a content of minerals in bone – bone mineral content (BMC), which shows minerals content in investigated tissue and for 95 % is determined by Calcium salts. It is expressed in grams (g).

A second indicator for densitometry is bone mineral density – bone mineral content density (BMD), which is assessed by a formula:

\[
BMD = \frac{BMC}{\text{Area}}
\]

Area is an investigated bone region area. BMD is expressed in grams per square centimeter (g/cm²).

To determine condition of bone tissue for particular person, the obtained indicators BMC and BMD should be compared with averages. Thereby practically two indicators are used usually: T- and Z-criterions.

T-criterion shows how the density of bone tissue of particular patient differs from averages for healthy young adults of the same gender and race.

Z-criterion shows how the density of bone tissue of particular patient differs from averages for persons of the same age, gender and race.

In clinical practice the dynamics of T-criterion measurement is analyzed the most often. Due to WHO recommendations, T-criterion of densitometry shows level of decrease of bone tissue density

Fig. 1.45. MRI of the knee:
A – intact anterior cruciate ligament; B – injured anterior cruciate ligament

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and is recommended as a standard for determination of osteoporosis and osteopenia (table 1.1).

An ultrasound densitometry, which goes perfectly for screening investigations, and two-photon absorptive densitometry, which determines a mineral bone density precisely in any given skeleton area, are also used in clinical practice.

Ultrasound densitometry enables to measure density of bone tissue in the region of minimal soft tissues amount – calcaneal area; results are presented as T- and Z- criterions on the graph and numeric data (fig. 1.46).

Two-photon radiology densitometry enables to measure density of bone tissue (BMD) of any skeleton region and calculate T- and Z-criterions (fig. 1.47).

**Ultrasound investigation (US), or sonography.** Functioning principle of diagnostic ultrasound equipment is a registration of ultrasound waves, which are reflected from the board between two structures with different echodensity. This method enables to register echosignals from boarders of the organs and tissues, which differs slightly in their echodensity. By applying US an estimation of soft tissues is possible. US is widely used for investigations of the shoulder and knee joint, muscles of extremities and for diagnostics of dysplasia of the hip joints in children at the age from 10 days to 1 year.

Ultrasound investigation of the joint is focused on visualization of soft tissues such as cartilages, ligaments, muscles, tendons.

**US in traumas of the knee joint**

During US investigation of the joints the ruptures of lateral collateral ligaments are well visualized. The ligament thickens, the haemorrhage and structure abnormalities are recognized in it. Changes of synovial capsules, fluid in the joint space and menisci ruptures are also well visualized. US of crucial ligaments of the knee joints is not performed.

**Facilities of US in rheumatic diseases**

A presence of inflammatory process is featured for rheumatic diseases. During US a fluid is easily recognized in the joint as well as in surrounding synovial bursas.

### Table 1.1. Criterions for estimation of bone tissue density due to densitometry data (WHO recommendations)

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<th>T-CRITERION</th>
<th>INTERPRETATION</th>
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<td>Above (-1)</td>
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<td>From (-1) to (-2.5)</td>
<td>Osteopenia</td>
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<tr>
<td>Below (-2.5)</td>
<td>Osteoporosis</td>
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<td>Below (-2.5) with bone fractures</td>
<td>Severe osteoporosis</td>
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![Fig. 1.46. Graphical display of the result of ultrasonic densitometry Achilles](image1)

![Fig. 1.47. Graphical representation of the result of two-photon X-ray densitometry](image2)
Using US a presence concomitant pathology is determined. In orthopaedics a data of ultrasound venae and arteries scanning, echocardiography for heart function estimation, ultrasound investigation of internals are used.

**Conducting electrophysiologic studies.** Electrophysiological methods of investigation are used for determination of muscle movements capacities and innervation. Electromyography is used for determination of degree of nerves injury, which occurs(442,498),(989,518) in fractures and other traumas of musculoskeletal system.

**Laboratory investigations.** A wide spectrum of modern facilities of laboratory diagnostics is used today. Majority of the laboratory investigations are included in the package of necessary investigations, which enables estimate general condition of patients’ health. Urine analysis, blood tests, analysis of fluid, obtained during lumbar puncture, joint, abscess, bone infiltrate puncture samples are included in this list. It is impossible to manage without them during preparation of injured patient to surgery. However, in some variants of musculoskeletal system pathology (first of all – in hereditary metabolic skeleton injuries) laboratory investigation plays important role.

The advantages of laboratory diagnostics are facility to detect preclinical stages of the disease in particular cases (for instance, changes of parameters of calcium phosphorus metabolism in rachitis, increased level of alkaline phosphatase during formation of para-articular ossificates in spinal patients). In some cases a diagnosis cannot be considered definite without laboratory investigations results (for instance, analysis which includes uric acid in blood serum in podagra, occurrence of neutral fat in urine in case of bone tissue injury, complicated by fat embolism).

Among biochemical investigations a blood test assessment often has a practical application in diagnostic of bone tumors, inflammatory, specific (tuberculosis, syphilis) and concomitant diseases. Biochemical investigations are important for control of trauma disease course in mechanic, thermic and radiation injuries. Endocrinological, immunological and serological investigations also have a great importance.

Morphological investigation confirms a clinical diagnosis objectively. In orthopaedics it is performed in many diseases of bones and joints.

Joint puncture, performed with diagnostic aim, enables to estimate visually a cavity contents. Bacteriological investigation and cytological analysis of joint puncture give more information on suppuration, non-specific processes (gonorrhea, tuberculosis, Chlamydia infection), mineral salts and enzymes content, etc. Joint puncture may be also therapeutic, because removal of excess fluid amount from joint cavity decreases pain syndrome and increases movements range.

A sample for investigation can be also obtained with biopsy. Biopsy material can be obtained from skin surface, wound, mucous tunic, as well as after tissues dissection (intraoperative biopsy) or puncture (puncture biopsy). Puncture biopsy of deep tissues is performed under X-ray control or during ultrasound investigation. This enables to correct a direction of puncture needle pass in the process of its injection. The biopsy has a great importance in case of tumors of musculoskeletal system. Tissues extirpated during surgery are also a subject of morphological investigation in case of precancer conditions, chronic inflammatory processes, degenerative dystrophic affections of the joints.

**DIAGNOSIS ESTABLISHMENT**

The final stage of patient examination is diagnosis establishment. In many cases traumatology diagnosis is simple, but more often especially in case of orthopaedic diseases, a precise differential diagnostics must be carried out, applying all range of clinical, radiological, laboratory and other data during detailed analysis of disease development course.

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Provisional diagnosis is established on the basics of easily and fast determined reliable and if necessary also relative features of affection. Statement of provisional diagnosis must be short and give understanding of severity and localization of the injury, presence of early complications. It can require specifications and even contain questions. Over diagnostics is permitted during statement of provision diagnosis, i.e. indication of all suspected injuries. On the basics of provisional diagnosis a first aid is provided to an injured patient, as well as plan of further investigation (X-ray, puncture, laboratory investigations, etc.).

Clinical diagnosis, established after detailed anamnesis collection and inspection of the patient with additional investigation methods use, must contain data about fracture type, bone fragments displacement character and presence of concomitant diseases. On the basics of the diagnosis, a treatment plan is assigned and (if necessary) a further detailed investigation. In process of further investigation and treatment the diagnosis can be elaborated and supplemented, in some cases repeatedly.

Final diagnosis can be established not straight away, but after few days. On the basis of this a plan of comprehensive (till final result) treatment and rehabilitation are assigned. During its formulation it is required to separate accurately a fundamental illness, its complications and concomitant disease.

In trauma a correctly formulated diagnosis must describe injuries and answer a following questions: 1) whether an injury was open or closed; 2) its character; 3) which tissue is affected (muscle, bone, etc.); 4) localization of the injury; 5) presence of distortion or displacement of tissues or bone; 6) concomitant injuries (of nerves, vessels, urinary tracts, etc.). Complete and accurate diagnosis determines a therapeutic approach.

**Diagnosis formulation.** In case of inflammatory processes a character of inflammation must be determined – chronic or acute. Then an etiology of inflammation must be specified. It can be tuberculosis, rheumatic, dystrophic process, etc. After this a localization of process is specified (mono-, oligo- or polyarthritis).

### 1.2. INJURY OF LIGAMENTS, TENDONS AND MUSCLES

Soft-tissues injuries are the most common consequences of musculoskeletal traumas. A vast majority of such injuries are diagnosed and treated in the outpatient setting. Closed and open injuries are differentiated based on injury mechanism, anatomical and functional disorders occurring in this condition. Bruises, compressions, sprains and soft-tissues raptures are relevant to closed injuries, wounds of skin and subcutaneous structures. Predominant affection of some tissue leads to injuries of skin, ligaments, tendons and muscles.

During short-termed, most often a direct effect of traumatic agent on body a contusion of soft tissues occurs (contusio), severity of which depends on type, mass and speed of injuring agent, angle and area of its contact with tissues, their vascular supply amount, general condition, patient age and range of other factors. In angular blows a skin exfoliation from underlying tissues occurs with formation of cavities filled with blood.

Partial injury of small subcutaneous vessels, occurring during contusion, appears by hemorrhage in tissues. Significant subcutaneous hematomas are formed sometimes. Clinically contusion is presented with pains in area of trauma, local swallow, and bruise. In case of localization on extremities it is appeared with their partial malfunction.

Treatment of bruises includes rest providing for injured body area, local cold application, painkillers prescription. From the 3rd day of course the UHF therapy electrophoresis with anesthetics are assigned, later – thermal procedures. In occurrence of massive subcutaneous hematomas,
a puncture is performed for evacuation of cavity contents. Then a compressive dressing is applied on the wound.

During impact on the tissue of intensity of draft, which slightly exceeds physiological characteristics and doesn’t impair anatomical regularity of elastic formations (ligaments, tendons, muscles), their sprain occurs (distorsio). Sprain occurs more often in the area of joints such as the ankle, wrist and knee joints.

Injuries, occurring during contusion, are supplemented with a partial dissociation and rupture of isolated fibers of injured tissues. Therefore partial malfunction of injured segment, local pain, swelling, painful active movements would appear in clinical presentation.

In case of soft tissues sprain in the area of joints an X-ray investigation must be performed for estimation of bone structures. Meanwhile MRI and US are used for visualization of soft tissues.

Treatments includes above mentioned actions and immobilization of injured segment.

If a force, that exceeds elastic capacity of tissue, effects it, a disorder of anatomical integrity occurs – rupture (ruptura). In this case a complete mechanical injury of anatomical structure takes place, which manifests with local pain, swelling, significant hemorrhage and acute dysfunction of affected segment. If para-articular tissues are injured, a pathological increase of passive movements range in joint may occur, acute restriction or impossibility of active movements, acute disorder of extremity function, hemarthrosis. Ligaments are fast enough, so they rupture at place of its attachment to the bone, sometimes together with cortical plate. More often ligaments of ankle, collateral ligaments of the knee joint and a rotatory cuff of shoulder are injured.

In incomplete rupture of ligaments a conservative treatment is indicated. That is immobilization of injured segment with circulatory plaster with fixation of one or two neighboring joints in position of maximal relaxation of injured structures on the period of 3–4 weeks. A local hypothermia, painkillers, anti-inflammatory drugs are prescribed; in case of necessity a joint puncture is performed. UHF is prescribed from the second day. After immobilization a workload limitation to the segment at period of 1–2 weeks, exercise therapy, muscle massage, thermic procedures are indicated.

In case of complete anatomical ligaments injury (for instance – rupture of deltoid ligament with subluxation of foot outside) a surgical treatment is indicated in early periods. This includes injured structure restoration by suturing or performance of different plastic techniques.

Tendon rupture occurs most often on the level of its change to muscle belly or in the area of its fixation to the bone, sometimes with small bone plate. Injuries of tendons and muscles can be closed or open (if there are injuries of soft tissues above traumatized area). It occurs as result of direct (blow on a tight tendon) or indirect (acute overtension) injury. Also subcutaneous ruptures of tendons and muscles are divided to traumatic (as result of external factors) and pathologic (as a result of tissue features loss).

Subcutaneous ruptures of calcaneal (Achilles) tendon, caput longus of biceps muscle of arm, tendons of flexors and extensors of hand fingers and tendon of quadriceps muscle of thigh are more common.

Rupture of tendon of biceps muscle of arm is presented mainly on the right in men of working age, as it occurs during load elevation and sharp forced extension of flexed in elbow joint arm. In this case acute pain occurs. Sometimes also a cracking at the moment of rupture, weakening of muscle strength, painful movements can be presented. During examination following symptoms are presented: tonus lack and soft tissues recession under deltoid muscle, globular swelling on anterior surface of distal segment of upper arm, which increases during forearm flexion (fig. 1.48).

The treatment is only operative. A distal extreme of ruptured tendon is fixed transosseously in area of intertubercular sulcus. The extremity is immobilized on wedge-shaped pillow with plaster bandage for the period of 4 weeks.

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Rupture of tendon of quadriceps muscle of thigh occurs more often during abrupt muscle contraction in completely extended in the knee joint extremity or in case of direct hit. Subcutaneous rupture of quadriceps muscle of thigh can be complete or incomplete. A tendon usually ruptures a little above patella or in its upper pole, sometimes with cortical plate.

Typical features are local pain, recession of soft tissues above patella, disorder of extremity supportive function, disability of keeping it in extended position and of active extension of flexed in knee joint leg, instability of knee joint, decrease of movements strength and range. For maintenance of support a patient has to perform maximal rotation of extremity outside. In case of tendon rupture from upper pole of patella with cortical plate a hemarthrosis of knee joint occurs.

The treatment is surgical. A suturing of tendon is performed, in later periods – its plastic surgery. The extremity is mobilized with circular plaster bandage up to 6 weeks. That a recovery treatment is administered: physiotherapeutic procedures, therapeutic exercises, mechanical therapy.

Rupture of the calcaneal (Achilles) tendon. Injury of Achilles tendon occurs as a result of direct hit, uncoordinated overstraining of triceps muscle of calf, wounding (fig. 1.49).

Sharp local pain, inability of foot flexion, swelling and shin outlines discontinuity in the area of tendon, skin retraction in the area of injury, lack of foot movements during contraction of gastrocnemius muscle – Thompson sign (test) (fig. 1.50).

For additional examination, ultrasound and MRI can be performed. This allows to clarify the diagnosis and establish an accurate location of damage (fig. 1.51, 1.52).

Treatment. In case of incomplete ruptures a 20 ml of 1 % Novocain solution is injected in the area of injury. Then plaster bandages are applied to the middle third of thigh in equivusive position of foot. A leg is flexed then in the knee joint to 30° angle for the period of 4 weeks.

In case of complete injury of Achilles tendon a surgical treatment is performed. In out-patient practice a transcutaneous suturing or open tendon suture is used.
In case of rupture in the locus of fastening of tendon to calcaneal bone as a result of degenerative dystrophic affection, a transcutaneous fixation by thick nonabsorbable suture material is performed. In rupture along or in the locus of transfer to muscle belly a defect of tendon is recovered according to Chernavskyi or Krasnov.

According to Chernavskyi’s technique a linguiform flap 2 cm wide with base in a distal part is cut out from aponeurosis sprain of gastrocnemius muscle. A flap is inverted and sutured into the incision of distal part of tendon as a bridge. A defect of aponeurosis of gastrocnemius muscle is sutured (Fig. 1.53).

A feature of the Achilles tendon reconstruction technique according to Krasnov is reconstruction of lost tension and tonus of affected muscle (a tonic automyotenoplasty), keeping of paratenon together with surrounding scar tissues and immersion of tendon autotransplant inside. This saves surrounding tendons, vessels and nerves, as well as gliding mechanism, enabling normal conditions for regeneration.

After reconstruction of calcaneal tendon a circular plaster bandage is applied from the upper third of thigh to toes in the position of its plantar flexion and shin flexion to 100–120° for the period of 6 weeks. An exercise therapy and physiotherapy are administered. A dosed workload is indicated after 6–8 weeks, a full workload after 2.5–3 months. Working capacity is recovered after 3–4 months. A limitation of workload for the period of 8 month should be recommended to persons with rupture of tendon caused by degenerative dystrophic affection.

Injuries of fingers flexor muscles tendons can be closed (caused by elevation of heavy flat objects – glass, metal plates, etc.) and open (in different injuries of palmar surface of the hand).

Closed ruptures occur rarely enough. Injuries of deep flexor muscle of III and IV fingers and long flexor muscle of I finger may take place. As a rule a rupture of flexor muscles tendons occurs during abrupt forced extension and overextension of flexed finger or during its abrupt flexion with overcoming of significant resistance. Pain, fingers flexion function loss, which are in extended position are characteristic in the moment of trauma. In complete rupture a distal phalange takes a position of extension, its active flexion is impossible.

Open injuries of tendons of the hand fingers are quite common. In this case a flexion function is also lost. Distal extremes of the tendons are visible in wound, be-
cause proximal extremes dislocate in the proximal direction under the effect of contracted muscles (fig. 1.54).

A treatment of finger flexor muscles tendon injuries can be only surgical (fig. 1.55-1.58). The most favorable primary tendon suture is performed according to one of the techniques. In case of open injuries surgical debridement of wound is carried out, depending on level and character of injury a tenoraphy or tendon grafting is performed. After the surgery immobilization for 3–4 weeks in position of maximal relaxation of injuries tendon is carried out. After immobilization an exercise therapy, massage and physiotherapeutic procedures are administered.
Ruptures of tendons of fingers extensor muscles occur during direct blow to the dorsal finger surface or abrupt workload to longitudinal muscle axis with overstrain of the tendon. It can be on two levels: on the level of proximal interphalangeal joint (I type) and on the level of distal phalange (II type). Speaking about closed injuries, IV and V fingers are traumatized more commonly, II and III fingers are traumatized less often, and more rarely I finger.

During injury of I type in the moment of trauma a pain, swelling and typical deformity, which is flexion in proximal and extension in distal interphalangeal joints occur (fig. 1.59). Passive straightening of finger is unrestricted, but if affection stops, a previous position occurs again (double Weinstein contracture). In II type a distal phalange takes a position of flexion, its active flexion is impossible, passive flexion is remained in complete range (fig. 1.60).

Treatment. In fresh (recent) injuries of I and II type a conservative treatment is possible, which is a fixation of finger by special splints. Fixation term is 6 weeks.
In all other cases a surgical treatment is recommended, that includes primary tendon suture or one of the surgical plastics techniques with further immobilization for 4 weeks. Rehabilitation after fixation or surgery involves therapeutic exercises, massage, thermal and water procedures administration.

1.3. DISLOCATIONS

A system of skeleton, junctions and muscles represents a complicated enough formation. Here presence of levers (bones), hinge (joints) and elastic tractions (muscles) with their fine regulation enables to perform precisely enough different types of movements. From the other side, due to its anatomical features it is vulnerable for some stereotype kinds of traumatic injuries, the most common among which are dislocations. Various forms of joint surfaces, different degree of their concordance with each other is important anatomical functional feature. This determines not only rate of dislocations in certain joints, but also their different types. It is important for understanding of mechanism of dislocations occurrence and treatment.

In case of outlet of bone head for the joint cavity through ruptures capsule or complete lack of contact between joint surfaces one can talk about complete dislocation (luxation completa). Partial retention of contact between joint surfaces though in incongruous places evidence on incomplete dislocation or subluxation (luxatio incompleta, subluxacio). Subluxations occur more rarely and appear not in all joints.

Dislocation is always named due to displaced (dislocated) distal segment (for instance, dislocation of humerus, but not dislocation of the shoulder joint). The exception are dislocations of vertebrae and
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There are congenital and acquired dislocations distinguished. The latter includes traumatic dislocations (as result of direct or indirect force of traumatic agent, in sudden abrupt muscle contraction during injury by current); pathological dislocations occurs when contact between joint surfaces is lost as a result of nontraumatic forces (neoplasia, degenerative diseases of joints, laxity of capsule in plexitis, etc.) and recurrent dislocations, which are repeated many times under influence of insignificant external reasons. Traumatic dislocations appear in 80–90 % of cases of all dislocations and more commonly occur in men of 20–50 years old.

Dislocations can be closed or open, when all joint coverings are affected, including the skin. Moreover, dislocations can be complicated by fracture of para- or articular coverings, then it is considered as fracture-dislocation. Also dislocations can be complicated by injury of neurovascular structures and muscular formations (complicated dislocation).

It very important to consider time, which have passed from the moment of fracture appearance, as this as a rule determines choice of therapeutic approach and influence the treatment result. Dislocations are considered acute, when less than 3 days passed from the moment of trauma, subacute – from 3 days to 1 week, and old – more than 3 weeks.

Shoulder dislocation. Traumatic dislocations of shoulder (luxatio humeri) appear more often and amount to 60–80 % of all dislocations, presented in human. In men they appear 4–5 times more frequently than in women.

Shoulder dislocations can be congenital or acquired. The latter by-turn, can be nontraumatic (spontaneous or pathological) and traumatic (uncomplicated and complicated: open, with affection of neurovascular bundle, with rupture of tendon, fracture-dislocations, old and recurrent dislocation).

Fig. 1.61. Example of vertebral dislocation: dislocation C: A – arrow shows vertebra dislocation; B – the double arrow indicates an increase in the distance between the spinous processes

clavicle, during displacement of which we can talk about dislocation of proximally located segment, for instance, dislocation of acromial extreme of clavicle, dislocation of vertebrae C4 (fig. 1.61).
Mechanism of the trauma is more often indirect – falling on the abducted arm in position of anterior or posterior deviation, excessive rotation of shoulder in the same position.

Regarding shoulder blade there are anterior (fig. 1.62), inferior (fig. 1.63) and posterior (fig. 1.64) shoulder dislocations. Anterior are divided to subcoracoid and subclavicular dislocations. Inferior dislocation is called axillary (fig. 1.63). Anterior (75 %) and axillary (24 %) dislocations are the most common; other – 1 % of dislocations.

After obtaining of trauma patients complain of pain and nonfunction of the shoulder joint. Typical posture – patient, inclining to the affected side, holding traumatized extremity with healthy arm, abducting it and slightly leading anteriorly. The shoulder joint is deformed, smoothed in anterior-posterior direction, acromion protuberates above the skin, the retraction under it occurs, extremity seems to be a little longer (fig. 1.65). During palpation the head of the humerus is detected in locus unusual for it, that is confirmed by rotation movements, active movements are impossible, passive movements are painful, they cause a spring-elastic fixation. Movements in distal segments of extremity remain.
control of peripheral circulation and innervation is obligatory (fig. 1.66).
If shoulder dislocation is presumed, it is mandatory to fix an extremity on pre-admission stage according to one of following techniques: Cramer’s splint, Dezo’s bandage, fix extremity to the body, etc.
The diagnosis is specified after X-ray performing.

Treatment. BReduction of traumatic dislocations must be performed urgently in adequate local or general anesthesia. There are more than 50 various types of shoulder dislocation reversal, which are based on principals of levers, tractions and jogging methods. Classic techniques of shoulder dislocations reductions are Dzhanelydze’s and Kocher’s. The first one is effective in acute dislocation, the second – for old dislocations and after unsuccessful attempts of Dzhanelydze’s technique.

Dzhanelydze’s technique is the most physiological and non-traumatic. It is based on muscles relaxation in traction with all traumatized extremity weight. The patient is laid on the side so that dislocated arm hang down through table’s edge, the chair is settled under the head. (fig. 1.67). After 15–20 minutes a muscle relaxation comes, then surgeon performs traction down along the arm axis with further rotation externally and internally. Reduction is followed by characteristic click, the joint function is recovered.

Kocher’s technique is one of the most traumatic, it must be performed cautiously due to risk of humerus fracture and other complications. Depending on anesthesia a patient sits or lies. Surgeon applies the same hand on the bend of elbow and holds it, while with other hand holds radiocarpal joint, flexing extremity in elbow joint in right angle. Then surgeon actions are led in four stages:

I stage – traction along the axis of extremity and abduction of upper arm to the trunk.
II stage – continuing traction, an upper arm rotation is performed outside by abducting forearm to the same side.
III stage – remaining of achieved position and traction, an elbow joint is dislocated anteriorly and internally, approaching it to the middle line of the body.
IV stage – internal rotation of the upper arm is performed holding a forearm, moving hand on the healthy upper arm. As a rule, the dislocation is reducted in this moment.

Hippocrate’s technique. This is the most ancient method (IV century AD). It is used if other techniques performance is impossible. That’s why it is considered military surgical. Patient lies on the back, surgeon position heel of his extended leg (of the same as dislocated patient’s arm) in axillary region of

Fig. 1.65. Typical view of the shoulder joint with a dislocation – the shoulder girdle is shortened and sharply contours acromion

Fig. 1.66. In anterior dislocation of the head of the humerus a compression of the neurovascular bundle may occur
the patient (fig. 1.69). Holding a patient's hand, a surgeon performs traction along the arm axis, at the same time with abduction and pressure on the head of humerus externally and upwards.

Mukhin's technique. A patient lies on the back or sits on the chair. Traumatized shoulder joint is held behind by twisted sheet. Endings of sheet are crossed on the patient's chest; counteraction is performed. Surgeon smoothly performs traction with the patient's upper arm, gradually abducting it to the right angle and at the same time performing rotatory movements.
Mote’s technique. It is non-traumatic, indicated in all types of dislocations technique. Patient lies on the back. Assistant pulls arm upwards, setting by his foot against patient’s shoulder girdle, while surgeon reduce a head of humerus with his fingers (fig. 1.70).

After dislocation reduction an X-ray control performance is obligatory.

It must be noted, that in some cases it is impossible to make a reduction of dislocation – this is so named unreducible dislocations. They occur if tissues ingress between joint surfaces. The most often those are injuries of tendon and muscle, margins of ruptured and turned up joint capsule, bone fragments.

Unreducible dislocations are the indication for operative treatment – arthrotomy, removal of obstacles for reduction, reversal of dislocation and recovery of joint surfaces congruency.

Regardless technique of dislocation reversal, an extremity is fixed in medial physiological position. This creates conditions for ruptures capsule healing. Such position involves abduction, anterior deviation and moderate external rotation. The extremity is fixed with Dezo’s bandage, special bandage that supports arm (fig. 1.71), or with plaster splint from healthy shoulder girdle to heads of hand metacarpal bones. A term of fixation is 3 weeks; painkillers are prescribed, as well as UHF, therapeutic exercises of static type, active movements in the hand joints. After finishing of fixation term therapeutic exercises, muscle massage, physiotherapeutic procedures (Ozokerite therapy, magnet and laser therapy) exercises in swimming pool are recommended.

Treatment management in old shoulder dislocations depends on their type, prescription, age and general condition of patient. In young age it must be attempted to reverse dislocation in closed way. Reduction is performed under general anesthesia in conditions of operating room. If closed reduction is impossible, an open reduction is indicated. In aged people a reduction of old dislocations involves significant difficulties and risks because of early state muscles rigidity. That’s why manipulations must be declined in this group of patients. Active movements work out in the injured joint must be started, recommending electronic medical ionization of anesthesia, therapeutic exercises and muscles massage.

Recurrent shoulder dislocation (or chronic shoulder instability). Its rate after treatment of traumatic (acute) dislocations can reach 60 %. Injured tissues are repaired by secondary intention.
with formation of constant scars. Muscular misbalance appears, as result instability of shoulder joint and recurrent shoulder dislocation occur.

Recurrent dislocations appear more often without significant force – in abduction or rotation of the upper arm externally (during dressing, combing, arm sway, putting arms on the nape, sleeping, etc.). As time goes by dislocations repeat more often, technique of their reversal simplifies, as result patients reject medical aid and reduce dislocation by themselves or with assistance of surrounding persons. After reduction a pain disturbs patients during 1–2 days, commonly patients don’t fix extremity.

During patient’s examination an atrophy of deltoid and scapular region and restriction of the shoulder joint function are presented. Restriction of active external upper arm rotation in its abduction to 90° and flexed forearm because of fear of dislocation (Weinstein symptom) or passive rotation in the same position (Babich symptom) is presented. Attempt of passive adduction of the arm to the trunk during active resistance of patient on the affected side is easier than in health side (symptom of deltoid muscle strength decrease). Elevation of the arms upwards with their deviation backwards at the same time presents limitation of these movements on the affected side (“scissors” symptom).

Treatment of recurrent shoulder dislocations is only surgical. It is directed to dislocation relapses prevention in complete retention of upper extremity function on the existing anatomical defect as cause of recurrent dislocations. There are near 300 methods of surgical treatment in present time. However after most of them relapses rate is still high and amount 10–15 %.

All operative techniques can be divided into five main groups:

- Surgeries of joint capsule that involves excision of capsule residue with further corrugating and suturing (Bankart’s, Turner’s, Kaln Berz’s, Putti-Plyatt’s method).
- Surgeries with formation of new ligaments, that would fix head of humerus (Rosenstein’s, Okhotskyi’s, Krasnov’s, Tkachenko’s, Ozerov’s, Watson-Gones’ method).
- Surgeries on bones. The aim of surgeries is to recover bone defects and form arthrosis – additional bone supports, eminencies, which limit mobility of humerus head (Latarje’s, Eden’s, Andino’s, Weber’s method). The main disadvantage is restriction of the shoulder joint function.
- Surgeries on muscles. Changes of muscles length and reversal of muscle misbalance (Menguson-Stek’s, Andreev’s, Andreev-Boychev’s method).
- Combined surgeries, which combine methods of different groups. The most known are Weinstein’s, Sverdlov’s, Akhmedzianov’s method.

Nowadays the most rational technique of capsuloplasty is according to Bankrath. It is performed under arthroscopy guidance. If it is unsuccessful, a bone plastic of glenoid cavity according to Latarje is indicated.

**Dislocation of the forearm bones.** Traumatic dislocations of forearm (luxatio antebrachii) take the second place by the rate and compound 18–27 % of all dislocations mainly in men of young age.

The elbow joint has complicated structure. A humero-ulnar junction in the joint is a variant of hinge joint, humeroradial – of spheroidal joint, radiulnal – of typical cylindrical joint. Joint capsule is thin enough, weakly tensed; its anterior and posterior sections are the weakest. They don’t have supporting ligaments, while lateral sections are supported by two strong ligaments. Moreover, elbow joint is covered by muscles insufficiently, which promotes dislocations occurrence in it.

Simultaneous dislocation of both bones is possible in the elbow joint, as well as isolated dislocation of radial and ulnar bones.

Posterior dislocations of both forearm bones occur more frequently. In most of the patients they are associated with displacement externally and less frequently – internally. This is caused by that
the coronoid process of ulnar bone is smaller than olecranon, which makes displacement of forearm back easier, while skewness of joint extreme of humerus and presence of crest of trochlea medially promote a displacement of forearm externally.

Dislocations of both forearm bones forward, outside, inside and dislocations, when bones are diverged in the different directions (divergent), as well as isolated dislocations of radial and ulnar bones are less common.

Posterior dislocation of forearm bones amounts almost 90 % of all dislocations in the elbow joint and occurs mostly as result of indirect trauma mechanism – during falling on outstretched arm and overextended in elbow joint arm. In posterolateral dislocation an ulnar nerve can damage, in anterior – ulnar and median nerve.

During trauma a sharp pain occurs, a joint function is absent. Forearm is pronated. Patient supports it with healthy arm. The joint is swelled, deformed, a hemarthrosis is presented, the arm is flexed in the elbow joint to 70–80° degrees, active movements are not present, passive – cause an acute pain. Prominence of olecranon backwards and above – recession of soft tissues is typical. Hunter's triangle and line are abnormal. Positive symptom of spring fixation is presented (fig. 1.72).

A version of posterior dislocation is a divergent dislocation of both bones of forearm (fig. 1.73). It occurs during simultaneous influence of direct force to proximal segment of forearm bones and force directed along the axis of flexed in the elbow joint forearm from the front to back. At this time humerus goes between forearm bones.

Dislocation of forearm bones forwards occurs during falling on the back and hit by region of olecranon in flexed in the elbow joint arm. Herewith upper arm is shortened, elbow joint is deformed. Elbow joint is not detected, on its area – soft tissues recession is presented. Active movements are missing, passive prosupination movements are possible.

In case of forearms bones dislocation, complicated by radial, ulnar or median nerves injury, pain along the nerve trunk with irradiation to hand's fingers is presented.

On pre-admission stage an immobilization of traumatized segment must be performed. Efforts to dispose the dislocation without any assistance are not recommended. Diagnosis and dislocation type are specified with X-ray.

Treatment. Forearm dislocations are disposed under local or general anesthesia. For disposal of posterior dislocation an arm should be abducted and slightly extended in the elbow joint. Surgeon holds a patient’s upper arm so that thumbs would take position on the prominent olecranon. Traction of extremity axis is performed, while surgeon dislocates olecranon and head of radial bone forwardly with the thumbs with simultaneous traction of upper arm backwards.

![Fig. 1.72. X-ray of the elbow joint – dislocation of the forearm bones posteriorly and outwards](image)

![Fig. 1.73. Divergent dislocation of both forearm bones](image)

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During disposition of anterior forearm dislocation traction along the forearm axis is performed, gradually flexing it. Simultaneously surgeon tracts proximal extreme of forearm posteriorly and distally with one hand, while with other hand surgeon dislocates lower extreme of upper arm anteriorly and proximally. In accomplishment of disposition forearm is extended to oblique angle.

The extremity is fixed with posterior plaster splint from upper third of the bone to heads of metacarpal bones in position of arm flexion in the elbow joint under the angle of 90° in posterior and lateral dislocations and 60° in anterior dislocation. It is necessary to perform X-ray control. Immobilization term is approximately 2 weeks. After 3–4 days a flexion movements in the elbow joint in the splint are recommended. After that rehabilitation treatment is carried out: exercise therapy. It is necessary to remember that elbow joint is very sensitive to mechanic and thermal irritants and reacts on it with development of stiffness and ossification processes. That’s why it is not recommended to apply thermal procedures and massage of elbow joint region during rehabilitation treatment, which accelerate scarring and periarticular ossification.

Treatment of chronic dislocation of forearm is realized analogically as in acute. In recurrent dislocations an open disposition with arthroplastics is performed.

Isolated dislocation of head of radial bone is rarely observed in adults. More often it is associated with fracture of ulnar bone in its upper third.

Dislocation of head anteriorly is more common. It occurs during forced forearm pronation, which is in the position of extension. During this forearm is pronated and slightly flexed in elbow joint. Head of radial bone can be palpated in the region of external surface of bend of elbow. In passive supination of forearm a spring fixation occurs, which increase a pain. Active and passive flexion of forearm is impossible, as head of radial bone is set against an anterior surface of humerus. For diagnosis clarification an X-ray of the elbow joint is performed.

Treatment. Dislocation of the radial bone disposition is performed after appropriate local, conduction or general anesthesia. Surgeon performs traction gradually along the axis of pronated forearm and extends it. Then the surgeon performs supination, energetically pressing on the head of radial bone with thumb, simultaneously flexing forearm. In this moment a dislocation disposes. Fixation is carried out during 2 weeks in position of flexion in elbow joint to 110–115° and supination of forearm with circular plaster bandage.

In recurrence, chronic or non-reducible dislocations surgical interventions are performed – open reduction with restoration of annular ligament, endoprosthesis of radial bone head, less commonly it’s a resection.

Particularly should be mentioned such common injury as pronation dislocation (subluxation) of radial bone head in children. It occurs more frequently in girls of the age of 1–5 years. Typical trauma mechanism is holding, elevation or traction of child’s extended arm, which is complemented by rotation of upper arm and pronation of forearm (as a rule, this occurs during falling of the child, while someone holds his or her arm). That’s why it is commonly called pronation dislocation of radial bone head.

The clinical presentation is typical: child complains of pain in the elbow joint, arm is slightly flexed, it hags passively, forearm is pronated. It is difficult to perform the movements for patient, especially supination. Diagnosis is specified with X-ray.

Treatment. Reduction of the dislocation is accomplished by traction of forearm along the axis, its supination, pressing on the head of radial bone and flexing in the elbow joint. The extremity is fixed with Jude's bandage or is hanged up with cravat bandage for 3–5 days.

Dislocation of hip. Traumatic dislocations of the hip (luxacio femoris) occur as result of indirect massive trauma mainly in men of the age of 20–60 years. Its rate is from 3 % to 7 % of general amount of dislocations and mainly is explained by anatomical and physiological features of the hip.
joint: significant deepness of acetabulum, which increases cartilage trochanteric labium, complete congruency of joint surfaces and strength of ligamentous apparatus. Also the hip joint is covered by strong muscles, has sizeable movements range with small enough functional needs.

More often hip dislocation occurs as result of indirect trauma mechanism, when the force directed on femoral bone exceeds functional ability of the hip joint.

Based on dislocation of head of the hip joint relatively acetabulum there four main types of hip dislocation divided (fig. 1.74):

- anterior superior – iliac;
- posterior inferior – sciatic;
- anterior superior – suprapubic;
- anterior inferior – obturator.

Posterior superior hip dislocation is more common. It forms 80–85 % of all dislocations of hip joint. Posterior inferior dislocation takes the second place by its rate, and then – anterior inferior and anterior superior.

Patients complain of significant pain and loss of the hip joint function. Active movements are not possible. During passive movements a symptom of spring fixation occurs. Lower extremity is in forced position, which is typical for each kind of the dislocation (fig. 1.75).

In posterior superior (iliac) dislocations the thigh is moderately flexed, adducted and rotated internally. A shortness of extremity is presented. The trochanter major is detected to be higher than Roser-Nelaton’s line. In gluteal region the head of femoral bone is palpated. Shortness of leg achieves 5–6 cm.

In posterior superior (sciatic) dislocations a deformation is more significant. Adduction, flexion and internal rotation of extremity are so highly expressed, that in supine position, a traumatized extremity crosses a healthy leg above the elbow joint. Head of femoral bone is detected lower and back from trochanteric area. Trochanter major is detected a bit above Roser-Nelaton’s line. Leg is shortened to 1–2 cm.

In anterior (suprapubic) dislocations an extremity is extended, slightly abducted and rotated externally. Also leg can be in condition of slight flexion in hip and knee joint or in extended position. During palpation a head of femur is detected under inguinal ligament. Trochanter major is displaced forward and is detected laterally from Roser-Nelaton’s line.

In anterior inferior (obturator) dislocations a lower limb is abruptly flexed in the hip and knee joint, significantly abducted and rotated externally.

In some cases, as result of traumatizing force influence along the axis of femoral neck, a fracture of acetabulum occurs with displacement of head of femur in fracture zone – so called central hip dislocation.

Sometimes in hip dislocations a complications may occur, such as injury of sciatic nerve, fracture of posterior margin of acetabulum, compression of femoral artery, injury of join cartilage or head of femoral bone, muscle raptures, etc. In pre-admission period a transport immobilization of extremity is required as well as injection of painkillers. Diagnosis and type of the dislocation is specified with X-ray performance.

Treatment. Hip dislocation is an emergency trauma. That’s why it is necessary to perform reposition in conditions of hospital as soon as possible. Reposition is performed under general anesthesia.
with adequate muscle relaxation. The most common among the methods of hip dislocations reposition became methods of Dzhanelidze, Kocher and Hippocrates.

Dzhanelidze’s method. It is indicated in acute dislocations and anterior inferior dislocations of the hip. A patient is laid on the table for 15–20 minutes so that a traumatized extremity would hang down a table. Then one flexes extremity in hip and knee joint to 90° and slightly abduct it. Surgeon holds a distal part of a shin and presses on it by his knee, performing traction along the axis of the femur and performing gradual rotatory movements (fig. 1.76). Hip reduction is followed by specific click.

Kocher’s method. This method is the best for the reduction of all kinds of non-acute dislocations. Patient is in supine position. Assistant fixes pelvis of the patient with two hands. Surgeon flexes extremity of the patient to 90° in the knee and hip joints and performs slow traction along the axis of the femur during 15–20 minutes. Holding a shin with hand, surgeon presses on it from the back, and performs traction of the femur as a lever. After the traction the femur must be adducted in anterior or abducted in posterior dislocations. Then its rotation externally and abduction is performed (fig. 1.77). After dislocation reduction a control X-ray must be performed.

After reduction of the hip dislocation an extremity needs rest – bed rest up to 2 weeks. Then a walk without weight load on the extremity with the help of crutches during 6 weeks is required.

In case of dislocations complicated by injury of neurovascular bundles a revision of traumatized segment is performed according to indications. Pain killers, chondroprotectors are prescribed. Prevention of thrombosis is carried out. Lower extremities are bandaged with elastic bandages.

In unsuccessful attempt of reduction and in chronic dislocations an operative treatment is recommended.

Sometimes in fractures of the bottom of acetabulum a head of femur dislocates in the cavity of pelvis – a central dislocation of the hip occurs. More often it is plunged into a cavity of pelvis partly,
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sometimes – completely (fig. 1.78). Such dislocations occur in concurrence of acting force with long axis of the head and neck of femur, more often occurs during flexed, turned back and abducted femur.

During central dislocation of the hip an extremity is slightly flexed in the hip joint, adducted and moderately rotated externally. A shortening of extremity, rigid mobility in the joint and impossibility of the femur abduction are presented.

Treatment. In acute cases a central dislocation is reducted with double skeletal traction. Wherein, the single-stage traction is performed along the axis of the femur and axis of the femur neck with wires and nails. After releasing of the femur head from the cavity of small pelvis, traction along the neck of femur is reduced. Meanwhile traction along the axis of femur is controversially increased. System of traction is remoted in 2 months with gradual decrease of traction. Load on the extremity is allowed not earlier than after 3–4 weeks.

In chronic dislocations and ineffectiveness of conservative treatment an operative treatment is recommended.

Fig. 1.76. Stages of reduction of the hip dislocation according to Dzhanelidze (1–2)

Fig. 1.77. Stages of the hip dislocation reduction according to Kocher and Hippocrates (1–2)

Fig. 1.78. Central hip dislocation with acetabular fracture
TASKS AND TESTS

TASK #1

Patient K., 27 years old, when leaving the fixed-route taxi, hit his right thigh on the bandwagon. Patient complains of pain in the middle third of the right thigh, which increases with movement.

He walks by himself. When examined at the site of the injury, a bruise is identified; soft tissues are moderately swollen, pain during palpation occurs. Movements in the hip and knee joints are in full range, painless.

Make a preliminary diagnosis.

A. Rupture of the quadriceps femoris muscle.
B. Contusion of soft tissues of the thigh.
C. Fracture of the femur.
D. Stretching of the thigh muscles.
E. Damage to the neurovascular bundle.

TASK #2

The patient M., 37 years old, felt a sharp pain in the right shoulder joint, weakening the strength of the right arm, when he was lifting the load.

During the examination of the external surface of the upper third of the right upper arm, there is a recession of the soft tissues, a globular swelling of the anterior surface of the distal part of the humerus, a decrease in strength during flexing the forearm. Make a preliminary diagnosis.

A. Rupture of the acromioclavicular joint.
B. Dislocation of humerus.
C. Traumatic injury of the brachial plexus.
D. Rupture of the biceps tendon of the shoulder.
E. Rupture of the triceps arm muscle.

TASK #3

Patient P., 23 years old, as a result of a direct hit on the dorsum surface of the right hand, there was a rupture of the tendon of the extensor of the third finger at the level of the terminal phalanx. Which treatment method is appropriate to apply?

A. Conservative treatment – fixation of the finger in the middle physiological position.
B. Conservative treatment – fixation of the finger in the position of extension.
C. Conservative treatment – fixation of the finger in the position of overextension of nail phalanx and flexion of the middle phalanx.
D. Surgical treatment – the primary suture of the tendon.
E. Surgical treatment – plastics of the tendon.

TASK #4

Patient A., 32 years old, during sports (jumping) felt a pain in the distal part of the thigh, after which the supporting function of the limb was impaired, and the recession of the soft tissues appeared above the patella.

He walks by himself, with the maximum rotation of the limb outward, it is impossible to keep it in an extended position. Active extension of the leg flexed in the knee joint is absent, passive movements are in full range.

Make a preliminary diagnosis.

A. Stretching of the thigh muscles.
B. Separation of the quadriceps femoris muscle.
C. Fracture of the upper pole of the patella.
D. Rupture of the fibular collateral ligament.
E. Fracture of the lower third of the femur.
TASK #5

Patient P., 47 years old, was injured as a result of falling on the left arm. Patient complains of pain in the left shoulder joint, lack of its function.

During the examination patient is bent to the left, supports the injured arm with a healthy arm, which seems somewhat longer. The shoulder joint is deformed, the contours are smoothed out, acromion is clearly contoured, the recession is revealed under it. Active movements in the shoulder joint are impossible, passive movements are sharply painful, they cause a springy fixation. Movements in the elbow and wrist joints are remained. Make a preliminary diagnosis.

A. Dislocation of the acromial end of the clavicle.
B. Rupture of the biceps tendon of the shoulder.
C. Fracture of the surgical neck of the humerus.
D. Shoulder dislocation.
E. Fracture of the articular surface of the scapula.

 TASK #6

The patient B., 38 years old, got an anteroposterior dislocation of the humerus. After anesthesia, the reduction of dislocation was performed by the Mot's method. Which fixation is appropriate for the patient?

A. Bandage of Dezo or plaster splint from a healthy shoulder girdle to the heads of the metacarpal bones of the hand.
B. Skeletal traction over the humerus.
C. Scarf.
D. Thoraco-brachial plaster dressing.
E. Plaster splint from the injured joint to the wrist joint.

 TASK #7

Patient T., 43 years old, had a dislocation of the right humerus when he was sleeping. It is known that 5 years ago the patient had a traumatic dislocation of the right shoulder, after which, there are relapses of dislocation, periodically, about 5–7 times a year, the patient reduces them independently.

During examination after the dislocation is reduced, the atrophy of the deltoid and scapular regions is revealed, and the function of the right humeral joint is limited. The limitation of the active external rotation of the shoulder during its abduction and the flexed forearm is marked. Which therapeutic tactics should be applied?

A. Conservative – fixation with a Dezo’s bandage or plaster splint.
B. Conservative – skeletal traction over the humerus for 5 weeks.
C. Conservative – fixation of thoraco-brachial plaster bandage for 6 weeks.
D. Operative – arthrodesis of the shoulder joint.
E. Operative – plastics (strengthening) of the capsule of the shoulder joint.

 TASK #8

Patient L., 39 years old, when falling on a straightened and overextended in the right elbow joint arm, felt a sharp pain in the joint, loss of its function.

During examination, the patient supports the right arm with a healthy one, the arm is flexed at the elbow joint, the right forearm is shortened, pronated, the triangle and the Hunther’s line are changed. The elbow joint is swollen, its contours are altered, active movements are absent, passive movements show a symptom of a springing fixation, intensify the pain. Make a preliminary diagnosis.

A. Fracture of the condyle of the humerus.
B. Dislocation of the bones of the forearm.
C. Fracture of the elbow process.
D. Contusion of the elbow joint.
E. Dislocation of the head of the radius.

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TASK #9

The patient S., 53 years old, was injured as a result of an accident (driver of a car). Patient complains of pain in the right hip joint, the impossibility of movements in it, the forced position of the right hip.

During examination, the right leg is shortened to 5 cm, the thigh is slightly curved, adducted and rotated inward. During palpation in the gluteal region the head of the femur is determined, a major trochanter is determined above the Roser-Nelaton line. Active movements in the right hip joint are absent, passive movements are sharply painful, a symptom of a springy fixation occurs. **Make a preliminary diagnosis.**

A. Anteroinferior dislocation of the femur.
B. Anterosuperior dislocation of femur.
C. Posteroinferior dislocation of femur.
D. Posterosuperior dislocation of femur.
E. The central dislocation of the femur.

TASK #10

The patient M., 34 years old, was hit by a car when crossing the street. Patient complains of severe pain in the left hip joint, impossibility of movements in the left leg. During examination the patient lies on the back, the left leg is flexed in the hip and knee joints, sharply abducted and turned outward. The left leg seems longer than the right one. Active movements are impossible, passive one are elastic, painful. **Make a preliminary diagnosis.**

A. Transtrochanteric fracture of the femur.
B. Fracture of the femoral neck.
C. Anterior dislocation of the hip.
D. Fracture of the bottom of the acetabulum.
E. Fracture of a large trochanter.

TESTS

11. Actions of the second stage in the reduction of the shoulder dislocation according to Kocher is:

A. Flexion of the forearm at right angle, pulling the shoulder down, abducting to the chest.
B. Maximum elbow abduction to the front surface of the chest.
C. Without reducing stretching and abduction the shoulder, the forearm is withdrawn to the level of the frontal surface.
D. Lifting the arm anteriorly and upwards.
E. Fast internal rotation of the upper arm with the transfer of the hand to a healthy shoulder girdle.

12. Most often there is a dislocation of:

A. Lower jaw
B. Clavicle.
C. Shoulder.
D. Hip.
E. The ankle joint.

13. Most common is congenital dislocation of:

A. Shoulder.
B. Forearm.
C. The radiocarpal joint.
D. Hip.
E. The main phalanx of the first finger.

14. The cause of pathological dislocation can be:

A. Osteoarticular tuberculosis.
B. Underdevelopment of articular surfaces.
C. Damage to the ligaments of the joint.
D. Damage by electric current.
E. Traumatic shock.
15. Symptom of dislocation is:
A. Change of the absolute (true) length of the limb.
B. Restriction of the movements, elasticity.
C. Pathological mobility in the damaged joint.
D. Bone crepitation.
E. Subcutaneous emphysema.

16. Indicate the pathognomic symptom of differential diagnosis between dislocation and fracture:
A. Painfulness.
B. Crepitation.
C. Deformation.
D. Changing of the length of the limb.
E. Forced limb position.

17. Indicate the symptom, which is present in traumatic dislocation of the shoulder:
A. Pain in the shoulder joint.
B. Sharp restriction of movements in the joint.
C. Deformation and swelling in the joint.
D. Crepitation during palpation of the head of the humerus.
E. Elasticity in the joint and limitations during movements attempt.

18. Which dislocation among dislocations of the thigh is accompanied by a fracture of the bottom of the acetabulum:
A. Iliac.
B. Sciatic.
C. Central.
D. Pubic.
E. Obturator.

19. Which dislocations are related to acute?
A. The first days after the injury.
B. Up to 3 days.
C. Up to 1 week.
D. Up to 3 weeks.
E. Up to 2 months.

20. What is considered the main cause of unreducible dislocation?
A. Osteomyelitis of bones.
B. Interposition of the capsule, ligaments.
C. Interposition of blood vessels.
D. Deforming arthrosis.
E. Interposition of sesamoid ossicles.
Around 40 years ago a new definition occurred, meaning simultaneous injury of several anatomical regions, – multitrauma. During this time it steadily entered the scientific and practical use of domestic and foreign medicine. For medical staff this word is a signal of danger, stimulus for the beginning of emergent diagnostic and treatment actions.

2.1. MULTITRAUMA

Multitrauma is severe or critical condition of injured patient, associated with vital functions disorders in form of traumatic shock, traumatic coma, acute respiratory and (or) acute heart failure or terminal condition and demands reanimation and surgical actions of intensive care.

Multiple injuries are considered to be injuries of two or more inner organs in a single cavity (rupture of liver and spleen), traumas within the limits of one or more anatomical functional formations of musculoskeletal system (fracture of femur and shin), injuries of great vessels and nerves in different anatomical segments of extremity or extremities. All traumas as part of of multiple injuries may be mono- or polifocal.

Monofocal injury is a traumatic injury in area of one anatomical functional formation (fracture of femur, shin).

Polifocal injury is an injury of one anatomical functional formation in several places (fracture of shin on two levels, 2 and more ruptures of small intestines).

Associated are injuries of inner organs in different cavities (trauma of lungs and liver, brain contusion and urinary bladder rupture), simultaneous trauma of musculoskeletal system, great vessels and nerves. The most numerous group of associated injuries are traumas of inner organs and musculoskeletal system (rupture of liver and fracture of bones, fracture of ribs and fracture of lumbar vertebrae).

Combine injury is a single moment injury caused by two or more aetiologically different factors (burn and shin fracture, frostbite and foot injury).

However multitrama is not just sum of injuries in the patient. It presents complicated and multifarious pathogenic process. In its acute period, disorders of vital functions occur, that threaten life of patient. It is not only the signs of fracture or injury of inner organ.
CLINICAL PRESENTATION

The traumatic disease is a clinical presentation of multitrauma. This represents a complex of pathologic reactions of the organism as a response directly to an injury and (or) to farther development of traumatic process. It is clinical pathological category, but not a separate nosological unit (disease).

4 periods are divided in the course of traumatic disease.

I period (acute)

This is a period of an acute disorder of vital functions (shock phase). It is characterized by shock occurrence, stage of which depends on the intensity of traumatic agent, general amount of injury, and significant rate of vital organism systems disorder. It begins directly after the trauma and lasts up to 72 hours dependently on severity of trauma and effectiveness of treatment procedures.

The most often the disorder of vital functions is presented as traumatic shock or terminal condition in 65 % of cases, as coma in severe brain injury in 17 % of cases, acute respiratory failure in severe injuries of thorax occurs in 13 % and acute heart failure as a result of heart injuries occurs in 5 % of cases.

Clinical presentation of acute period of traumatic disease consists of symptom complex, which includes a traumatic shock, blood loss, acute respiratory failure, signs of inner organs injuries (primarily of the brain) and musculoskeletal system.

Traumatic shock

Traumatic shock is pathophysiological condition, which occurs as a response to mechanical injury and is characterized by disorder of vital organism functions. Its distinguishing feature is development of hypotonic syndrome and respiratory failure. In absence of arterial hypotension a diagnosis of traumatic shock is not stated.

In multitrauma the traumatic shock occurs in 47–86 % of injured patients. Its clinical and pathogenetic basis is formed by syndrome of acute circulation disorder, which occurs after influence of vitally dangerous trauma consequences on the injured patient's organism acute blood loss, injury of vital organs, neuro-painful influences. More often traumatic shock occurs in injuries of pelvis, thorax, lower extremities bones, inner organs, in open injuries with massive crushing of soft tissues, extremities avulsions.

Two phases are distinguished in the course of traumatic shock: erectile and torpid.

Erectile phase is short, lasts from several minutes to several hours. Injured patient is conscious, anxious, movement and vocal excitation is presented. Self condition criticism is disordered. Arterial pressure is within the normal range, pulse is satisfactory; tachycardia is present. An increased pain sensitivity and skeletal muscles tonus are present.

Erectile phase is short, lasts from several minutes to several hours. Injured patient is conscious, anxious, movement and vocal excitation is presented. Self condition criticism is disordered. Arterial pressure is within the normal range, pulse is satisfactory; tachycardia is present. An increased pain sensitivity and skeletal muscles tonus are present.

I stage shock. A consciousness remains; a slight reactions delay and retarding are present. Reactions to pain are decreased, skin is pale, acrocyanosis is present. Tachycardia up to 90–100 bpm, BP – 90–100 mmHg. Muscle tonus is decreased, diuresis is not changed.

II stage shock. This is characterized by increasing of symptoms of previous condition, consciousness repression, decreasing of pain sensitivity and muscle tonus, significant haemodynamics disorder. Tachycardia up to 110–120 bpm, BP is up to 70–90 mmHg.
III stage shock. Mental confusion, reaction to external stimuli is significantly decreased. Skin coverings are pale with cyanotic tinge. Pulse is 130 bpm and higher. Systolic pressure is 70 mmHg and lower. Breezing is superficial, frequent. Hyporeflexia, muscle hypotonia are presented. Diuresis is decreased, anuria may be presented.

III stage traumatic shock, which is proceeding, may transfer to terminal condition, which presents extreme stage of vital functions depression, clinical death comes.

**Terminal condition is developed in 3 stages:**

- Preagonal condition – loss of pulse on radial arteries while its presence on carotic and femoral arteries, BP cannot be detected by regular methods.
- Agonal condition has previous signs, but is associated with breathing disorders (arrhythmic Cheyne-Stokes breathing, significant cyanosis), loss of consciousness.
- Clinical death begins from the moment of last breath and cardiac arrest. Clinical features of life are totally absent. However, metabolic processes in brain tissue continue for around 5–7 minutes. Therefore if reanimation actions are started at first 3–5 minutes after apparent death, full rehabilitation of vital organism functions can be achieved.

**Coma**

This definition is considered to be acutely developed severe pathologic state, which is characterized by progressed depression of central nervous system functions with loss of consciousness, disorder of reaction to external stimuli, increasing failure of respiration, circulation and other vital organism functions.

Coma occurs as a result of initial injury of brain structures in severe brain trauma, in consequence of disorder of oxygen transportation in massive blood loss and in severe injuries of thorax.

Clinically coma is presented with absence of consciousness, sometimes a motor excitement occurs. Depending on the pathologic processes coma is divided into following types.

- **Moderate coma (coma I).** A patient reacts to pain stimuli with flexing and extensive movements, without opening the eyes. Defensive reactions are not coordinated. Reactions of pupil to the light remain. Abdominal reflex is decreased; tendon reflexes are normal, decreased or increased. Pathologic reflexes of brain are missing or excited on one side.

- **Deep coma (coma II).** Reactions to the noise and mechanical external irritants are missing. Reflexes are depressed, part of them is missing, muscular hypotonia is possible. Spontaneous breathing and cardiovascular activity remain, but can be disordered according to central type – tachy- or bradypnoe, heart rate disorders, BP increasing.

- **Terminal coma (coma III).** Bilateral mydriasis is presented, reaction of pupils to the light is missing. Areflexia is presented. Diffuse muscle atonia, deep disorder or vital functions: breathing – central or peripheral type (Cheyne-Stokes, terminal or apnea). Arterial hypotonia.

As result of increasing of nervous symptomatic efferentation and abrupt release of significant number of catecholamines (adrenalin and noradrenalin) in bloodstream, occurred as result of trauma, a general spasm of small peripheral vessels (extremities, pelvis, abdominal cavity). Spasm of capatial veins, which decreases capacity of venous reservoir, mobilizes up to 1l of blood for the circulation. This is primary reaction, which compensates blood loss.

Second by the time compensatory reaction is spasm of arterioles and precapillary sphincters. As a result of this a general peripheral resistance increases, that enables to keep minimal sufficient blood pressure. Biological sense of this processes is in mobilization of the blood from depot, mobilization of fluid to bloodstream, redistribution of blood for maintenance of brain and heart blood perfusion, in arrest or decrease of circulation. This processes was named as “circulation centralization”.

Traumatology & Orthopedics
Due to them organism is able to compensate blood loss up to 20 % of volume of blood circulation (BCV) by itself.

In progressing of hemorrhage and traumatic shock BP and blood circulation volume, a circulatory and tissue hypoxia develops. For compensation of blood circulation volume deficit, circular hypoxia, maintenance of necessary circulation a heart rate increases – tachycardia develops, which level is in direct proportion to shock severity.

Noted defensive adaptive reactions take place in the period of first hours after the trauma. Pathogenically they are the stage of compensation, clinically – traumatic shock of I and II stage.

In multitrauma the shock is always associated with blood loss. This connection in direct ratio deepens a severity of patient condition: more hemorrhage level means more severe shock.

Among the reasons of massive hemorrhages on the first place by its rate are bones injuries, on the second – injuries of inner organs, on the third – injuries of great vessels. So, in fracture of shin bones a blood loss can achieve 1.5–2 l, in femur fracture – 2.5 l, in fracture of bones of pelvis – 3.5 l, in associated injuries – up to 4 l. While loss of 30 % of circulating blood volume with association of multitrauma causes the death of injured person.

If pathogenic factors of shock continue to effect, the defensive reactions of the organism gain contrary features and become pathologic. It deepens pathogenesis of traumatic shock. As a result of long term general spasm of small vessels, microcirculation hypoxia develops, that causes generalized hypoxic injury of cells – main factor of III stage traumatic shock.

**Fat embolism**

It is one of severe complications of mechanic trauma, in 15–58 % cases causes death. More often it occurs in trauma of pelvis, femur, shin bones, massive injuries of fat tissue, less commonly – in surgeries (in the first place on musculoskeletal system) and somatic diseases.

Main condition of fat embolism development is formation of fat emboli. Their sources are drops of fat of bone marrow, lipids, circulating in blood, and redundant entrance of triglycerides, lipoproteins and fatty acids from fat depots of the blood in conditions of fast increasing energetic demands of the organism in trauma, glycolysis exhaustion and gluconeogenesis.

Subclinical and clinical forms of fat embolism are divided. Subclinical form occurs quite frequently, but mild consciousness disorders, slight tachycardia, hyperthermia, caught and other symptoms are considered as manifestations of brain trauma, alcoholic intoxication, etc. In conditions of adequate and timely medical aid in most of the patients fat emboli dissociate.

Clinical form is divided into fulminant, acute and subacute.

Fulminant form of fat embolism causes death in several hours.

Acute form develops in fast massive entry of fat drops. As result significant hemodynamic disorders occur in pulmonary and systemic circulation. Hypotonia, tachycardia, tachipnoe, impairment of consciousness, anemia, that occur in first minutes after the trauma are clinically typical – i.e. clinical features of traumatic shock. The only one of clinical features, that gives reason to suggest fat embolism presence, is progressive decrease of oxygen saturation of arterial blood, which is refractive to oxygen therapy. Progressive cardiopulmonary failure in most of the cases causes death in 24 hours.

Subacute form is presented by a “lucid space” existence, duration of which may be 1–3 days, then injured person’s condition impairs progressively. The most early and expressed feature of fat embolism is respiratory failure (tachipnoe, feeling of pressure and pain behind the sternum, acrocyanosis, inspiratory dyspnea, caught, saturation decrease). CNS function impairment is the second main feature of fat embolism. Anxiety, emotional lability are presented, in addition with impairment of consciousness, sometimes even to the condition of coma. Brain and pulmonary manifestations of fat embolism may be presented together or separately.
Pathognomonic symptoms are petechial skin rash on palate and upper half of lateral surfaces of thorax, persistent fever up to 40 °C.

**Acute respiratory failure**

Associated with shock and hemorrhage this condition leads to critical changes in brain, heart, liver, kidneys.

It develops as result of respiratory center depression or in external respiration disorder. Reason of acute respiratory failure during brain trauma is contusion of brainstem, where the respiratory center is situated, or by pressing of brain with its dislocation and decreasing of stem part and secondary traumatization.

Disorders of external respiration occur during trauma of thorax, injury of vertebra and spinal cord, craniocerebral injury, etc. Injury of pulmonary artery itself in presence of bruises, atelectasis, hemorrhages in alveoli, impaired gas exchange contributes the development of inflammation focuses, as a result of which significant areas of pulmonary tissue are excluded from gas exchange.

Due to clinical course acute respiratory failure is divided into two stages: compensation and decompensation.

Disorders of oxygen transport in cell lead to energy production in cells by anaerobic glycolysis, as result of that suboxided metabolites are stored in the organism, acidosis develops. Tissue hypoxia leads to destruction of cell membranes, as result high-energy Sodium-Potassim pump stops its work. Sodium enters the cell, water follows. Cell swelling together with membrane destruction cause cell death, as a result of this lysosome enzymes release and enter bloodstream, under the influence of them a formation of vasoactive peptides activates (histamine, bradykinin). They causes stable paralysis of precapillary sphincters, as result peripheral resistance decreases significantly and arterial hypotonia becomes nonreversible.

Microcirculatory disorders impair by DIC syndrome. It becomes reason of microtrombus formation in lungs, liver, kidneys, heart, which associates with function disorder of these organs, or reason of formation of severe fibrinolysis hemorrhages. Polyorganic dysfunction of vital organs develops – simultaneous disorder of inner organs function, not accomplished critical values.

Mentioned pathological processes are featured for long term shock, however in time started and correctly carried treatments actions often may be effective in III stage of traumatic shock.

Last stage of pathological processes in III stage of traumatic shock is progressive disorder of vital organs and systems function – multiple organ failure develops. In vast majority of cases its result is terminal condition and death.

Every mechanical injury of organs and tissues contributes to development of pathological processes in injured patient organism, increasing functional disorganization. Pathological factors in associated trauma are not only combined with each other, but make enhancing effect, which leads to more severe course of each injury. This phenomenon is called syndrome of interference burden.

Its development includes following pathogenetic factors:
- multiple sources of pathological (pain) impulsion;
- multiple sources of hemorrhage;
- disorder of coordination function of central nervous system;
- multiple focuses of primary, and then secondary tissues necrosis, leading to intoxication development.

I period ends with final diagnostics of injury, elimination of the reasons of vital functions disorder, blood loss compensation and relative stabilization of indicators of respiratory and circulation systems. At the I period of traumatic disease up to 10 % of injured patients die.
II period (unstable adaptation)

It lasts up to 5 days. In this period formal indicators of vital functions approach normal ones. The conditions for prevention of severe, life threatening complications are formed primary by surgical way: surgeries of long bones, pelvic bones, great vessels.
In this period up to 5% of injured patients die.

III period (period of the highest possibility of complications development)

It lasts from 5 to 10 days. In this period optimal conditions for complications development occur. As result of significant blood loss, endotoxicosis, DIC syndrome, systemic inflammation reaction in inner organs multiple focuses of microthrombosis form, which are target for endo- and exogenous microorganisms. Especially auspicious conditions for severe complications development arise in lungs. This is presented clinically by fat or thrombus embolism of small branches of pulmonary artery, acute respiratory distress syndrome, focal pneumonia with formation of “wet (shock)” lungs. Lethality at the background of such complications may achieve 50–90%.

Systemic processes of microthrombs formation in inner organs and tissues of musculoskeletal system lead to development of local, visceral and general infectious complications.
The most important factors of this complications occurrence is endogenic microflora, condition of area of injury (wound, fracture area, etc.) and microbe invasion; invasion by nosocomial (hospital) microflora is especially dangerous.

Thus, starting from 5th day after the trauma, a maximal amount of visceral infectious complications develops, in main – pneumonias. From 6–10th day – maximal amount of local and generalized infectious complications develops: purulent tracheobronchitis, peritonitis, different forms of local purulent infection (abscesses, phlegmons, etc.), sepsis.
At the third period of traumatic disease up to 15% of injured patient dies.

IV period (complete stabilization of vital functions)

It starts from 10th day and may continue up to several months.
At this period planned surgeries are performed to patients, primarily on musculoskeletal system, with aim to recover structure and functions of injured tissues, organs and systems, medical rehabilitation is carried out
Average lethality in injured patients with severe associated injuries is up to 30%, average term of treatment may last for several months.

ESTIMATION OF THE TRAUMA SEVERITY

It is one of the topical issues of medicine. Thus, at the beginning of XIX century D.J. Larrey first suggested to move seriously wounded men out the battle field, regardless military rank. N.I. Pirogov divided patients to hopeless, badly wounded of different categories and mildly wounded, created algorithm of their assortment.
In estimation of severity of trauma a necessary attention is paid to two main parameters: severity of injury and severity of patient’s condition, as well as to prognosis of course of traumatic process.

Severity of injury is morphological component of trauma, i.e. result of interaction of morphological structures of the organism with traumatic agent. Severity of injury is defined by complex of morphological disorders, occurred in result of this interaction. It depends on injuries amount, its character, localization and significance of injured structures in life support of the organism, as well as from influence of gained injuries to final trauma results. Severity of injury is stable morphological parameter of trauma.

Methods of injury severity estimation are oriented to summation of morphological disorders, occurred in trauma. The example may be AIS scale (Abbreviated Index Severity – shortened scale of injuries), created in 1970 in the USA. According to the scale severity of trauma is estimated in points from 1 (mild injuries) to 5 (injuries, critical for life) in 6 body regions (head, spine, chest, abdomen, pelvis, extremities). Estimation is given due to highest point.

However this scale is insufficiently accurate in estimation of trauma severity in multiple and associated injuries. That’s why in USA a new system of estimation was suggested – Injury Severity Score (ISS). For estimation of severity of injuries due to ISS scale a sum of quadrats of tree highest points in 6 body regions is assessed. Gained value (from 1 to 75 points) represents the severity of injury. Despite disadvantages (subjective estimation and difficulties of usage in injuries of more than 3 anatomical regions), ISS scale gained the highest spreading and is anatomical standard for estimation of injury estimation.

Other suggested scales of severity of injuries (CITO, NISS, OIS, TAS, PTS-Hannover, AP, V.A. Sokolov’s, MFS (military field surgery), etc.) have not found such wide implementation in practice.

Severity of condition is a functional component of trauma. This characteristic of trauma is defined by condition of organ-function systems of injured patient’s organism in specific time period, extent of realization and effectiveness of biological reaction to trauma. Severity of consciousness of injured patient is a dynamic parameter of trauma, which changes constantly in treatment process and requires constant objective quantitative expression.

Far from always severity of patient’s condition correlates with severity of anatomical injuries. In historical aspect Algover’s shock index (relation of pulse rate to systolic BP level) is interesting, but it is unilateral, as two parameters of hemodynamics, which are separately taken without considering other indicators, are less informative relating to severity of injured patient’s condition. For its objectification scale and indexes are used, on the basis of which mathematical estimation of clinical and laboratory indicators underlies. Trauma Score (TS) can be an example. It is a trauma scale, oriented on sorting of wounded patients in military field conditions. After remodeling and simplification of the TS, authors suggested – Revised Trauma Score (RTS). Its prognostic accuracy is 85 %.

CRAMS scale (Circulation, Respiration, Abdomen, Motor and Speech) enables with almost 100 % probability give accurate prognosis for injured patients with high (favorable prognosis) and low (lethal outcome) scores number. However for intermediate values the accuracy decreases significantly.

GCS (Glasgow Coma Scale) is the most commonly used for determination of the severity of consciousness impairment. A level of consciousness impairment is determined by estimation of the three functions in points: eyes opening, language and movements. The fewer points are scored when examining a patient, the deeper is level of impaired consciousness. Due to its simplicity GCS has received wide spreading. However, it characterizes only the degree of impairment of consciousness, but not the severity of the patient’s condition. In addition, it is not applied to patients with associated trauma, in a condition of alcoholic intoxication, in injured patients with aphasia.

One the best estimation system of condition severity of patient is APACHE (Acute Physiology and Chronic Health Evaluation) and revised APACHE II, which includes quantitative estimation of pathophysiological changes, caused by trauma, chronic disease and patient’s age. In APACHE II scale 12
physiological indicators (section A), age (section B) and presence of comorbid pathology (section C) are estimated in points. Points sum lower than 11 corresponds to intermediate severity condition, higher than 20 – to critical condition. However this system is inapplicable on pre-admission stage, as it doesn’t take into account severity of anatomical injuries.

SAPS score (Simplified Acute Physiology Score) represents simplified version of APACHE. It enables to estimate 14 physiological indicators, patient’s age and neurological state according to Glasgow score.

Russian scientists suggested MFS-I (military field surgery – injury) score for objective estimation of patient’s condition severity. In its application the 12 most significant and easily detected signs are estimated. One of them characterizes color of skin coverings, two – condition of respiratory system, four – central nervous system, three –circulatory system, one – condition of gastrointestinal tract and one – approximate amount of blood loss. Each indicator is estimated from 1 to 9 points, index of severity is assessed by summation of points of all 12 signs.

As standard approach for estimation of treatment prognosis of patients with traumas a TRISS-method is used. It determines probability of patients’ survival dependently on values of Injury Severity Score (ISS), Revised Trauma Score (RTS) and patient’s age. Method for assessment of the consequences for patients with mechanical trauma (V.K. Kalnberz’s scale) deserves an attention. It accounts three visual signs in points (injuries, detected during inspection, consciousness condition and approximate age). In points summation a prognostic index is received, which can be favorable, doubtful or unfavorable.

TREATMENT

Treatment of multiple trauma is quite difficult medical issue. Adequate medical aid to patients with multiple trauma will be maximal effective in compliance of main principle: “Fast, gentle, simultaneous”. Process of patients’ treatment may be divided into 5 stages:

I stage – pre-hospital

It starts from the moment of trauma, corresponds the beginning of I period of traumatic disease, when compensatory and pathological mechanisms are launched. Aid is supplied as emergency or in order of self- or mutual aid. Regardless of the person who supplies medical aid, one of its main elements is transport immobilization.

First data about using of immobilization in different injuries are related to distant ages. Even 3–4 thousand years ago people performed immobilization by bandages for treatment of bone fractures. In the middle of XVI century French surgeon Ambroise Pare used different splints for aid supply to wounded patients. But first time the significance of transport immobilization and required functional features of immobilization bandages were presented by founder of military-field surgery N.I. Pirogov. For transport immobilization he used starched bandages, for treatment immobilization – plaster.

Application of modern splints for transport immobilization is connected to Cramer, who suggested metal splint in 1887. It became popular in armies of all European countries very quickly (Cramer splint). In 1875 English surgeon Thomas suggested splint for transport immobilization in hip fractures, based on traction principle. Main disadvantage of Thomas splint – lead of traumatized extremity through upper hoop of splint – was solved in its versions suggested by J. Black and H. Lardenois by creating a removable hoop. In Soviet Union this splint was improved and modified by M.P. Vinogradov (fig. 2.1).
In 1923 Russian surgeon Dieterichs suggested unique splint for immobilization of fractures of lower extremities. It occurred to be very successful for fixation of hip, shin and adjacent joints fractures (fig. 2.2). In 1934 Dieterichs' splint was improved and adopted for usage in Red Army.

During entire history of transport immobilization a priority was given to wooden splints. However majority of them are interesting only in historical aspect, as they are not flexible enough, fix on the body not good enough and lose their characteristics during transportation. These may include bast splint, Sazon-Yaroshevich’s, Barentsevich’s and Kuslik’s, Faltin’s splints. In its time, the Filbry’s net splint was widely used, but it did not have sufficient rigidity, it did not provide reliable immobilization, and on the X-ray it gave a simple grid, making it difficult to recognize the fracture. In 1942 I.M. Gindin suggested a fairly successful splint, embodying in it the idea of “curtain splint”.

Fig. 2.1. Splits for transport immobilization of:
A – Thomas; B – Black; C – Lardenois;
D – Lardenois – Vinogradova;
E – staircase (Cramer) splint with the possibility of modeling

Fig. 2.2. Dieterichs’ splint:
1 – long board-splint; 2 – short board-splint; 2.1 – twist; 3 – wooden sole.
Nowadays the main method of transport immobilization is also splints of different types. Due to the function principle they are divided into fixators and tractions. Means of transport immobilization can be standard, non-standard, improvised (at hand) and using soft-cloth bandages (Dezo’s, Velpo’s, Delbe’s hook, etc.).

**Standard transport splints** – are means for immobilization, with which medical institutions, ambulance cars, etc. are equipped. These include a wire ladder Cramer’s splint, Dietrich’s distraction type splint, plastic splints, medical pneumatic splints (inflatable), vacuum stretchers, anti-shock suit "Kashtan" (fig. 2.3). The latter, due to pneumatic compression of the lower extremities and the lower half of the trunk, provides a temporary stop of intra-abdominal bleeding, bleeding in the area of pelvic bones hip, shin bones fracture, and redistribution of 1.5–2 l of blood from the depot of the lower half of the trunk and extremities into the central volume of blood.

**Non-standard means of transport immobilization** are splints and devices used in certain medical institutions or departments, but are not produced by the medical industry and are not included in the set of standard splints (Elansky’s, Petrukhov’s, Bogdanov’s, Nechaev’s splint, etc.) (fig. 2.4). In the West, the most popular splints are Thomas’ in the modification of Heyr for simultaneous immobilization and traction and the Sager’s splint with a traction device.

Improvised splints are made of various at hand materials on the principle of fixation splints (wooden slats, bars, a bunch of branches, thick cardboard, etc.). In the absence of improvised means, one can bandage upper limb to the trunk, lower – to a healthy limb.

Regardless the material from which the splint is made and the conditions of its application, the area of limb coverage must be sufficient for adequate immobilization and be at least two thirds of the circumference and two adjacent joints along the length.
Algorithm of aid supply at the pre-hospital stage is the following:

- detection of the vital signs presence in the patient (consciousness, pulsation on the great and carotid arteries, breathing);
- restoration of airways patency, oxygen therapy;
- temporary arrest of bleeding, aseptic dressing for wounds;
- transport immobilization of injured extremities, in the absence of special – by improvised means;
- if necessary, intubation, artificial lungs ventilation carrying out;
- anesthesia;
- introduction of anti-shock drugs;
- local anesthesia of possible fractures;
- lie the victim on special stretcher splints or on a stretcher with a rigid base;
- to deliver the patient as quickly as possible to a medical institution.

Most of these activities can be performed while transporting the patient to an ambulance.

II stage – hospital reanimation

It begins from the moment of patient admission in a hospital and lasts up to 72 hours, i.e. during the I period of traumatic illness. At this stage, the life of the patient is saved in the anti-shock operation room, which is an active instrumental diagnostics of injuries by method of their exclusions, restoration of vital functions, removal of the patient from shock by resuscitation, urgent and emergency surgical interventions performance. Thus, the principles of treatment of traumatic shock are the following: the urgent kind of the provision of medical care, a differentiated approach, the urgency of surgical treatment. Exactly urgent surgical treatment has a pathogenetic sense and eliminates the cause of shock by bleeding arrest, stable fixation of long bones, elimination of strained or open pneumothorax, etc.

Urgent surgical interventions are operations, failure of which leads to the death of the patient. Therefore, their delay is unacceptable. They are performed immediately after the patient’s admission to the medical institution, while resuscitation and diagnostics of injuries are performed during surgery. Urgent surgeries in complex treatment of combined injuries are considered as the main anti-shock activity.

Immediate interventions are operations which failure threatens the life of the patients, but their delay within 2–6 hours is justified by the elimination of life-threatening conditions, preoperative preparation and instrumental diagnostics.

When the patient is admitted to the admission office, the clothes are removed from him, blood pressure is measured, and sanitary decontamination is performed. In this case, it is unacceptable to repeatedly shift the patient from one stretcher to another. If the general condition of the patient allows, the doctor or the team of the department of the multitrauma examines it. The matter of the place, timing and order of examination, diagnostic and therapeutic manipulation is decided.

In case of traumatic shock of II-III degree, the victim is immediately taken to the intensive care unit or to the operating room. Immediately begin to carry out anti-shock and resuscitation measures, while conducting an examination, diagnostic and therapeutic manipulation. Immediately should be performed catheterization of the central vein, bladder, if necessary – intubation of the trachea.

Anti-shock measures can be conditionally combined in several directions.

Recovery of VCB during blood loss up to 1 l is performed due to crystalloid and colloidal blood substitute solutions with a total volume of up to 2–2.5 l per day. With blood loss up to 2 l – because of blood and blood substitutes in a ratio of 1: 2 with a total volume of up to 3.5–4 l per day. With a massive blood loss of more than 2 l – mainly due to blood in a ratio of 2: 1, the total volume of fluid
can exceed 4 l. With blood loss of more than 3 liters it is mainly due to large doses of blood (3 l and
more), while blood transfusion is rapidly performed in two large veins or in the femoral artery. During
intracavitary hemorrhage, the blood of the cavities should be reinfused (with the absence of damage
to the hollow organs). The rule should be compensation of lost blood within 2 days after injury. The
effectiveness criteria are stabilization of blood pressure, reduction of tachycardia, restoration of red
blood indicators.

**Stimulation of the tonus of peripheral vessels** is a necessary for the functioning of the heart,
lungs, liver, kidneys. It is effective in restored blood loss and is performed by the administration of
dopamine, norepinephrine at a speed of 40–50 drops per minute.

**Stabilization of hemodynamics** with glucocorticoids, which improve the contractile function of
the myocardium, relieve the spasm of peripheral vessels, stabilize the cell membranes and reduce the
permeability of the vascular wall.

**Improvement of rheological properties of blood** with the help of rheologically active blood
substitutes, crystalloid solutions, disaggregants.

**Correction of the blood coagulation system** is determined by the degree of severity of the DIC
syndrome. During hypercoagulation a heparin at a dose of 2500–5000 units 4–6 times a day, trental,
low molecular weight heparins are used. In hypocoagulation without activation of fibrinolysis heparin
(no more than 5000 units), prednisolone, albumin, plasma, fresh blood are prescribed. In hypocoagu-
lation with the activation of fibrinolysis, prednisolone, counterene, albumin, plasma, blood, fibrino-
gen, dicicnine are used.

**Correction of metabolism** consists in the correction of acidosis, arising, on the one hand, due to
hypoxia of tissues, on the other – because of the transfusion of large amounts of blood. Buffer solu-
tions of sodium bicarbonate, trisamine are used. At large volumes of blood transfusion for every 500
ml of blood, 15 ml of a 10 % solution of calcium chloride must be administered.

**Neutralization of enzymatic aggression** is performed by the introduction of enzyme inhibitors
(countercritical, tracel).

**Recovery and support of kidney function.** Prolonged hypotension and large volumes of blood
transfusions suppress kidney function and lead to prerenal kidney failure, the initial manifestation
of which is the level of diuresis below 50 ml/h. Stimulation begins with the introduction of saluret-
ics (lasix). If response to its use is adequate, the hemodynamics and renal blood flow stimulation is
performed by the administration of rheologically active blood substitutes, disaggregants, osmotic and
oncotic diuretics.

**Prevention of fat embolism**

Prevention activities include, besides anti-shock, the normalization of arterial oxygen saturation
indices, the use of fat demulsifiers (essential), early nutritional support (use of balanced amino acid
solutions). The main measure of prevention is early minimally invasive synthesis of large bones (pelvis,
hip, shin).

Simultaneously with carrying out anti-shock and resuscitation measures, diagnostic and therapeu-
tic manipulations, urgent surgical interventions are performed.

If the patient is conscious, then, taking into account complaints, an X-ray and, if possible, instru-
mental examination (US, CT, etc.) of these segments and systems is performed. But in the overwhelm-
ing majority of cases, the condition of the victims does not allow performing additional methods of
examination, so preference is given to simple and reliable manipulations: pleural cavity puncture,
laparocenesis, catheterization of the bladder. Such manipulations take several minutes and are suf-
iciently reliable in the aspect of diagnostics. In case of receiving air or blood in the pleural cavity or
blood in the abdominal cavity, drainage of the pleural cavities according to Bulau or urgent laparot-

2. Traumatic disease. Multitrauma. Modern principles of medical aid supply during fractures
omy is immediately performed in order to establish the source of bleeding and stopping it. In parallel with these surgical interventions, osteosynthesis of long bones of the extremities (femoral, tibial, humeral) and pelvis should be performed. Preference is given to low-traumatic, minimally invasive and short-time methods, primarily – osteosynthesis by external fixation devices on a rod base. Damage of clinically less significant segments (forearm, hand, foot) is fixed with plaster bandages.

It should be remembered that the purpose of urgent surgical intervention is the rapid arrest of bleeding and restoration of the function of the injured organ. The performance of various types of plastics, long in time and the volume of organ-saving operations is unacceptable. When fixing large bones, the main goal is the early stable fixation of fragments. The implementation of anatomical reposition of fragments is inappropriate, this is the task of the next stage of rendering assistance. It is sufficient to eliminate gross displacements along the width and length of the segment.

**Craniocerebral trauma**

If there is a suspicion or presence of a craniocerebral trauma, X-ray examination of the skull bones, CT scan of the brain, is mandatory. If tomography performance is not possible, then in the presence of clinical data on severe craniocerebral trauma and the presence of intracranial hemorrhage, a diagnostic craniotomy is performed, the purpose of which is to audit the epi- and subdural spaces, remove the hematomas and stop the bleeding.

**Damage to the organs of the chest and abdomen**

Such damages are an indication for urgent surgical interventions. If hemo- or pneumothorax is detected with a lung rupture, drainage of the pleural cavities by Bulau is urgently performed. If after the removal of hemothorax, blood continues to excrete through the drain, this indicates continued bleeding. Also informative is the test of Ruvila – Gregoire – if the blood extracted from the pleural cavity is curtailed, this indicates continuing bleeding. At a bleeding rate of more than 200 ml per hour for two hours, as well as a single excrete of more than 800 ml of blood, thoracotomy is indicated.

Fractures of the ribs, especially from both sides, must be mandatory anesthetized: local anesthetic injection, vagosympathetic blockade (on the one side), subpleural space catheterization for periodic administration of anesthetics, ethanol-novocain blockade.

Contusion and rupture of the lungs in most cases is accompanied by a heart attack. The diagnosis is established on the basis of ECG data, laboratory and biochemical tests, ultrasound, the nature of chest damage.

Acute bleeding in the abdominal cavity is an indication for urgent surgical intervention. With simultaneous damage to the organs of the pleural and abdominal cavities, the function of the lungs is first restored, then operations on the internal organs are performed.

**The musculoskeletal system injuries**

Conservative treatment of fractures in conditions of multiple and combined injuries not only leads to an increase in unsatisfactory consequences and functional results, but also significantly complicates the implementation of resuscitative and anti-shock measures and the course of traumatic illness. At the same time, excessive surgical activity affects mortality rates, and unreasonable conservative strategy worsen the results of social and labor rehabilitation. It must be remembered that interventions on the musculoskeletal system should not be the cause of lethal outcome.

The purpose and objectives of osteosynthesis at the resuscitation and profile stage are to restore in the shortest possible time the anatomy and function of the damaged segments, prevent infectious and hypostatic complications.
The main requirements for osteosynthesis of bones in multitrauma are:

- low-injury and minimally invasive synthesis;
- possibility of its performance to the patients in severe condition;
- mobility of patients after osteosynthesis;
- speed and simplicity of implementation;
- satisfactory early and long-term results, the absence of reparative disorders;
- improvement the quality of life of the patients.

The multiple and combined nature of trauma excludes a template approach to the choice of the method of osteosynthesis. It is also unacceptable to use hybrid methods, i.e. combinations of osteosynthesis and conservative treatment, since in such cases the advantages of osteosynthesis are reduced to none.

At the resuscitation stage, the choice of the method of osteosynthesis depends on the general condition of the victim, the age and concomitant diseases, the type, amount, localization and nature of the fractures. The most important are fractures of the pelvic bones and femur, and their immobilization by conservative methods (plaster bandage or skeletal traction) in patients with severe multitrauma is unacceptable.

The modern approach to the treatment of severe traumatic injuries became the use of programmed multi-stage surgical treatment strategy – “damage control surgery”. It aims to prevent the unfavorable development of traumatic disease by reducing the amount of the first surgery and shifting the final restoration of damaged organs and structures to stabilize the vital functions of the body. This means performing surgical intervention in the minimum necessary amount, for example, stopping the bleeding of the parenchymal organ and its tamponade.

The damage control system in orthopedics (damage control orthopedics) is used for fractures of the femur, pelvic bones with damage to the anterior and posterior half-rings, multiple fractures of long bones of extremities, hip and thigh detachments. It includes osteosynthesis of the femoral, tibial and humerus by external fixation devices. Other, as well as specified injuries in the victims in the extremely severe and terminal state – immobilization with plaster cast (or skeletal traction – stage I (within 12 hours from the moment of trauma, after urgent surgical interventions on the brain, thoracic or abdominal cavity organs). Wounds and open fractures of bones are washed with solutions of antiseptics. Foreign bodies must be removed, the edges of wounds are infiltrated with solutions of antibiotics, covered with bandages with antiseptics. Simultaneous operations by two or three different teams are not allowed. Simultaneously, only the same type of surgical intervention can be performed, various types of operations are performed sequentially.

In seriously injured patients, operations on the internal organs of the abdomen, small pelvis, thorax, brain have a priority. It can also be divided into several phases.

Treatment of unilateral fractures begins with osteosynthesis of the bones of the lower limb, possibly by two teams. Symmetrical fractures are treated with osteosynthesis of the segment, which is simpler in technical performance. Osteosynthesis of adjacent fractures begins with a distal segment, of asymmetric – with more clinically significant damage. In cross fractures osteosynthesis begins from the bones of the lower limb. In all cases, the first osteosynthesis may be performed for more clinically significant segment.

III stage – intensive therapy

It is linked to II and III periods of traumatic disease. During the III stage at the background of stabilization of vital functions and intensive therapy, delayed surgical interventions are performed. It is aimed to prevent serious complications.
Delayed surgical interventions are those, the failure of which is likely to lead to the development of multi-organ failure and infectious complications. They are performed before the development of complications and are the best way to prevent complication.

These include relaparotomy after using the “damage control surgery” strategy (stage II), secondary surgical treatment of wounds (if necessary), a tracheotomy for the patients undergoing mechanical ventilation of the lungs.

The meaning of this stage of treatment is intensive therapy aimed at restoration and stabilization of vital functions.

IV stage – specialized treatment

It is linked to IV period of traumatic disease.

During the IV stage, the structure and functions of damaged organs and tissues are restored with conservative and surgical measures.

At this stage, the problems of the previous stages of treatment are finally solved, and planned surgical interventions are conducted.

Planned operations are operations performed according to a previously developed plan for improving the functional results of treatment and creating the most favorable conditions for the consolidation of fractures, the functioning of joints, the healing of wounds and the restoration of the functions of internal organs.

Osteosynthesis of the fractures to which the “damage control orthopedics” strategy (III stage) was applied, as well as fractures that are fixed with plaster bandages with unsatisfactory position of fragments, reconstructive or plastic operations on internal organs, etc. are performed.

2.2. MODERN PRINCIPLES OF AID IN FRACTURES

Fracture is considered to be damage in the continuity of the bone, resulted by the action of physical (mechanical) factors or pathological processes, accompanied by damage to surrounding tissues. Mechanogenesis of the fracture can be direct or indirect.

In case of direct fracture mechanism, the damage zone and the point of force application are the same. Accordingly, with an indirect mechanism, the injury site and the point of application of the traumatic force are not the same. For example, during fall on the abducted arm a hand would be point of force application. It can lead to fracture of the surgical neck of the humerus.

CLASSIFICATION OF THE FRACTURES

Due to the surface of fracture of bone fragments respectively to the long axis of the diaphysis the following types of the fractures are distinguished: transverse, oblique, oblique-transverse, helical, comminuted, perforated and marginal (fig. 2.5).

Displacements of bone fragments can be along the length, along the width, at an angle, rotational, impacted, which is the result of traumatic force and spastic contraction of muscles (fig. 2.6).

Classification of fractures, proposed by Swiss scientists, is the only unified, interdisciplinary, clinical classification of AO/ASIF. It was adopted practically worldwide. The classification was released and popularized by M. Müller and co-authors in 1987–1991.
According to this classification, all bones of the skeleton get a numeric designation. In the long tubular bones, three segments are distinguished: proximal (1), diaphyseal (2), distal (3). Ankle fractures are included in a separate segment (44) (fig. 2.7).

The fractures of each segment of the bone are divided into three types: diaphyseal fractures – simple (A), comminuted (B), complex (C). While fractures of the proximal and distal segments are divided into periarticular (A), intra-articular partial (B) and intra-articular complete (C). Due to its complexity, each type is divided into three subgroups: A1, A2, A3; B1, B2, B3; C1, C2, C3. This classification is basically a coded diagnosis. This allows choosing a method of treatment or a method of osteosynthesis (fig. 2.8–2.20).

**CLINICAL SIGNS OF FRACTURES**

The most common clinical signs of limb fractures are pain, impaired function, limb shortening and its deformation, pathological mobility and crepitus of bone fragments, a positive symptom of the axial load. For intra-articular fractures, pain, hemarthrosis, joint deformity, bone fragments crepitus, symmetry breaking of external landmarks, positive symptom of axial load are typical.

The diagnosis is verified by X-ray.
Fig. 2.7. Numbering of bones in the AO/ASIF classification

Fig. 2.8. Injuries of the proximal segment of the humerus

A1 – periarticular unified fracture of tubercle
A2 – periarticular unified metaphyseal impacted fracture
A3 – periarticular unified fracture with displacement
B1 – periarticular bifocal fracture with impacted metaphysis
B2 – periarticular bifocal fracture without impacted metaphysis
B3 – periarticular bifocal fracture with shoulder dislocation
C1 – intra-articular fracture with minor displacement
C2 – intra-articular impacted fracture with significant displacement
C3 – intra-articular fracture with shoulder dislocation
Fig. 2.9. Injuries of the diaphyseal segment of the humerus

A1 – helicoid fracture
A2 – oblique fracture
A3 – transverse fracture

B1 – sphenoid fracture, helical wedge
B2 – sphenoid fracture, flexing wedge
B3 – sphenoid fracture, fragmentary wedge

C1 – compound spiral fracture
C2 – compound segmentary fracture
C3 – compound irregular fracture

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Fig. 2.10. Injuries of the distal humerus segment

A1 – periarticular fracture, apophysis avulsion
A2 – periarticular metaphyseal simple fracture
A3 – periarticular metaphyseal comminuted fracture

B1 – incomplete intra-articular sagittal lateral condyle fracture,
B2 – incomplete intra-articular sagittal medial condyle fracture
B3 – incomplete intra-articular frontal fracture,

C1 – complete intra-articular articulate simple metaphyseal fracture,
C2 complete full intra-articular articulate simple metaphyseal comminuted fracture
C3 – complete intra-articular articulate comminuted fracture
A1 – periarticular fracture of the ulna, intact radial bone
A2 – periarticular fracture of the radius, intact ulnar bone
A3 – periarticular fracture of both bones

B1 – intra-articular fracture of the ulna, intact radial bone
B2 – intra-articular fracture of the radius, intact ulnar bone
B3 – intra-articular fracture of one bone, periarticular fracture of another one

C1 – intra-articular joint articulate fracture of both bones
C2 – intra-articular fracture of both bones: the first is simple, the second is a comminuted
C3 – intra-articular articulate comminuted fracture of both bones

Fig. 2.11. Injuries of the proximal segment of the radial and ulnar bones
Fig. 2.12. Injuries of the diaphyseal segment of the radial and ulnar bones

A1 — simple fracture of the ulnar bone, intact radial bone
A2 — simple fracture of radius, intact ulnar bone
A3 — simple fracture of both bones

B1 — sphenoid fracture of the ulnar bone, intact radial bone
B2 — sphenoid fracture of the radial bone, intact ulnar bone
B3 — sphenoid fracture of one bone, simple and sphenoid fracture of the other bone

C1 — compound fracture of ulnar bone
C2 — compound fracture of radial bone
C3 — compound fracture of both bones

Fig. 2.12. Injuries of the diaphyseal segment of the radial and ulnar bones
Fig. 2.13. Injuries of the distal segment of the radial and ulnar bones

A1 – periarticular fracture of the ulnar bone, intact radial bone
A2 – periarticular simple impacted fracture of radial bone
A3 – periarticular comminuted fracture of radius

B1 – incomplete sagittal intra-articular fracture of the radius
B2 – incomplete intra-articular frontal fracture of the radius
B3 – incomplete intra-articular frontal fracture of the ulna

C1 – complete intra-articular simple articular, simple metaphyseal fracture of the radius
C2 – complete intra-articular simple articular, comminuted metaphyseal fracture of the radius
C3 – complete intra-articular comminuted articulate fracture of radius
Fig. 2.14. Injuries of the proximal segment of the femur
Fig. 2.15. Injuries of the diaphyseal segment of the femur

A1 – simple spiral fracture
A2 – simple oblique fracture
A3 — simple transversal fracture

B1 – sphenoid fracture, spiral wedge
B2 – sphenoid fracture, flexing wedge
B3 – sphenoid fracture, fragmentary wedge

C1 – compound spiral fracture
C2 – compound segmentary fracture
C3 – compound irregular fracture

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Fig. 2.16. Injuries of the distal femur segment

A1 – periarticular simple fracture
A2 – periarticular fracture, metaphyseal wedge
A3 – periarticular metaphyseal compound fracture

B1 – incomplete intra-articular sagittal fracture of the lateral condyle
B2 – incomplete intra-articular sagittal fracture of the medial condyle
B3 – incomplete intra-articular frontal fracture

C1 – complete simple articular, simple metaphyseal intra-articular fracture
C2 – complete simple articular, comminuted metaphyseal intra-articular fracture
C3 – complete comminuted articular intra-articular fracture
Fig. 2.17. Injuries of the proximal segment of the tibia and fibula
Fig. 2.18. Injuries of the diaphyseal segment of the tibia
A1 – periarticular simple fracture
A2 – periarticular sphenoid fracture
A3 – periarticular compound fracture

B1 – incomplete intra-articular fracture, genuine cleavage
B2 – incomplete intra-articular fracture, cleavage and indentation
B3 – incomplete intra-articular comminuted fracture with indentation

C1 – complete intra-articular simple articular, simple metaphyseal fracture
C2 – complete intra-articular simple articular, comminuted metaphyseal fracture
C3 – complete intra-articular articular comminuted fracture

Fig. 2.19. Injuries of the distal segment of the tibia and fibula

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Fig. 2.20. Injuries of the ankles

A1 – undersyndesmosis isolated injury
A2 – undersyndesmosis injury with a fracture of the medial malleolus
A3 – undersyndesmosis injury with fracture of posteromedial margin

B1 – transsyndesmosis isolated fibula fracture
B2 – transsyndesmosis fracture of the fibula, with damage to the tibia and deltoid ligament
B3 – transsyndesmosis fracture of the fibula, with damage to the tibia and deltoid ligament and fracture of the posterior part

C1 – suprasyndesmosis injury, simple diaphyseal fracture of the fibula
C2 – suprasyndesmosis injury, simple diaphyseal fracture of the fibula
C3 – suprasyndesmosis injury, proximal injury to the fibula
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 unsuccessful 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. For the first time in Ukraine the method of permanent skeletal traction in 1910 was introduced by K.F. Wegner.

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 "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. Sneider 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. 2.21).

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. 2.22). Author’s technical solutions to improve such metal structures did not significantly affect the stability of osteosynthesis and the potential re-
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Comparative capabilities of bone tissue. Today, all these fixatives have a historical meaning and as a modern method of intramedullary osteosynthesis are practically not used.

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 for the first time in December 1944 at the Strasbourg Center for Traumatology and Orthopedics.

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. Küncher 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. 2.23).

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;

![Fig. 2.22. Rods for intramedullary fixation (scheme). A – femoral, B – humeral, B – tibial](image)

![Fig. 2.23. Intramedullary blocking osteosynthesis](image)
● 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 (fig. 2.9). 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.Lamotte, 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 (fig. 2.24) have made a great contribution to the development and creation of compression-distraction devices in our country.

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.

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 (fig. 2.11).

**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.

**Fig. 2.24. External fixation devices:**

A – Gudushauri; B – Ilizarov; C – the apparatus of AO
When choosing the method of osteosynthesis, it is important to assess the degree of skin damage in order to prevent infectious complications. The modern scale of severity of skin lesions was proposed by the authors AO/ASIF.

**In closed fractures – IC (I – integument (skin), closed):**
- IC1 – no skin damage;
- IC2 – no rupture of the skin, but contusion is present;
- IC3 – limited detachment;
- IC4 – spread closed exfoliation;
- IC5 – necrosis due to concussion.

**In open fractures – IO (I – integument (skin), O – open):**
- IO1 – internal rupture of the skin;
- IO2 – the skin is ruptured from the outside, the wound is less than 5 cm, and there is a bruise of the edges of the wound;
- IO3 – a wound more than 5 cm, the edges of the wound are devitalized;
- IO4 – significant full-thickness bruise, widespread open exfoliation, skin defect.

Open fractures are characterized by the presence of a wound, through which bone fragments are connected with the external environment, and it is the entrance gate for the penetration of microorganisms. A special type of fractures is gunshot fracture, which are always primarily infected.

Traumatic avulsion of the limb can be complete or incomplete. With complete avulsion, the limb or distal part of it has no connection with the proximal one. With incomplete avulsion, the distal part of the limb because of the skin, nerve, skin-muscle fragment remains connected with the proximal part, but the main vessels are completely damaged. Crushing and smashing of the limb can also be complete and incomplete.

The most common classification in the world is the one proposed in 1984 by R. B. Gustilo:
- I type – a clean wound up to 1 cm long;
- II type – a wound from 1 to 5 cm, but without significant damage to soft tissues;
- III type – a wound more than 5 cm with common soft tissue damage:
  - A – bone fragments in the fracture zone are closed by the periosteum and soft tissues;
  - B – bone fragments exposed due to complete damage to soft tissues;
  - C – fracture is accompanied by impaired blood circulation, the need for revascularization of the limb.

At the pre-admission stage, the amount of medical assistance consists in emergency transport immobilization, wound toilet; application of an aseptic dressing, stopping of external bleeding, anesthetic therapy, if necessary – anti-shock actions.

At the hospital stage in the centers of first level trauma with open fractures, it is necessary to perform primary surgical treatment of the wound. The aim of this operative intervention is to create favorable conditions for wound healing and thereby minimize the infectious complications. If the wounds are visually contaminated, antibacterial therapy should be started. Osteosynthesis with external fixation devices is indicated at the hospital stage in centers of second level trauma with open fractures of all types after primary surgical treatment, if necessary, even as a way of
medical-transport evacuation of such patients to the centers of trauma of the first level. For fractures of I and II types, intramedullary osteosynthesis with blocking rods is possible. At the specialized clinical stage in the centers of the first level trauma after wound healing, the transition in the treatment tactics to internal osteosynthesis is possible, and when the injured immediately to the center of the first level trauma patients with fractures I, II, IIIA, IIIB types, it is possible to perform osteosynthesis with blocking rods.

When providing medical care to patients with open fractures of type IIIC in the centers of trauma of the first and second levels, it is necessary to call vascular surgery specialists, and before their arrival to carry out a complex of anti-shock actions.

**Disorder of reparative osteogenesis of bone tissue** are delayed consolidation, fracture nonunion, false joint, neoarthrosis.

- **delayed consolidation** — the fracture did not heal during 1.5 of period, which is necessary for osteoreparation of this localization;
- **fracture nonunion** — the fracture did not heal during more than 2 terms, which are necessary for osteoreparation of this localization;
- **false joint** is characterized by X-ray signs: the remain of the inter-fragmental gap, the sclero-
tized ends of the bone fragments. Clinically characterized by painless pathological mobility;
- **neoarthrosis** — there are signs of formation of the synovial joint.

The most common causes of bone tissue dysregeneration are inadequate medical tactics, decrease of potential reparative abilities of the body and interruption of the patient's orthopedic regimen.

**GUNSHOT FRACTURES OF LONG BONES**

Analysis of the sanitary losses of the surgical profile in wars and armed conflicts testifies to the prevalence of gunshot wounds of extremities among other localizations: 54–70 %, and with fractures of long bones 35–40 %. Traumatic shock develops in 8–10 % of the patients. One-third of them the bone injuries of extremities are accompanied by severe injuries to other anatomical formations of the limbs.

In recent decades, there has been rapid progress in the development of new, more advanced types of small weapons and explosive munitions. The adoption of these weapons of mass injury by the majority of the armies resulted in a significant increase in the severity of the firearm injury, increased the rate of multiple and combined injuries, and increased the amount of destructions.

In the context of military operations, injuries and non-combat damages are possible. They are not related to the actions of the enemy or the immediate performance of the combat mission, but are caused by inept and careless handling of weapons and equipment. On the basis of historical analysis it was possible to establish that among the health losses of the surgical section, the specific amount of non-combat trauma was: during the years of the Second World War – 3 %; during the fighting in Afghanistan – 37.2 %; in actions in the Chechen Republic – 18.1 %.

Among the gunshot fractures, fractures of the shin bones (42.1 %) prevail, femoral and humerus fractures are less frequent (23.8 % and 22.3 %, respectively); fractures of the forearm bones are 11.8 %. In all the segments diaphyseal fractures dominate, and intra-articular fractures are detected in 17.1 % of the patients. Among the 76.4 % of gunshot fractures received with modern weapons, 35.1 % are comminuted, and 41.3 % are fragmented. Primary bone defects were recorded in 7.1 % of the patients, of which 79.3 % had
defects in long bones of 3 cm or more.

In the structure of military surgical trauma of the extremities, the slight wounded traumas are about 70 %. The high rate in returning to the structure of this category of the wounded patients is the reason for its great attention as a reserve for replenishing the personnel of the Armed Forces of Ukraine.

Classification. Injuries of the extremities are divided into soft tissues injuries, bone fractures and joint damages.

Classification of extremities injuries
1. Damage to soft tissues of the extremities are classified by:
   - localization (upper extremity, lower extremity);
   - type of injury (bruises, crushing, wounds, destruction);
   - the damage to anatomical structures (skin and subcutaneous tissue, fascial-muscular structures
2. **Fractures of long bones of extremities are classified by:**
   - localization (shoulder, forearm, hip, shin);
   - a third of the segment (upper, middle, lower);
   - the mechanism of injury (direct, indirect);
   - the nature of the fracture (full – bent, transverse, oblique, comminuted, fragmented, helical, with a defect in the bone, incomplete – marginal, perforated, intraarticular);
   - the type of fracture (closed, open: non- gunshot, gunshot).

3. **Damage to the joints is classified by:**
   - the localization of the joint (humerus, ulna, wrist, hip, knee, ankle);
   - type of damage (closed – non-penetrating, open – penetrating);
   - the nature of damage to joint surfaces (without damage, limited damage, large damage – surface defect);
   - the condition of the ratios of articular surfaces (dislocation, subluxation).

Among all limb injuries, depending on the number and location of lesions, isolated, multiple and combined injuries are divided (see also P. 2. Multitrauma).

Isolated injuries are called limbs traumas with a single injury. It should be noted that when injuries of limbs in one morphological substrate damage can be simultaneously involved in soft tissues, bones, large vessels and nerves.

Multiple injuries are called limbs traumas, in which there are several injuries within one anatomical region (according to the generally accepted classification of the human body, the two upper and two lower limbs form one of the seven sites defined as "limbs").

Combined are injuries, in which the lesions are localized in various anatomical areas of the body (abdomen – limbs, thorax – limbs, etc.). In case of combined injuries, the damaged areas are listed in the diagnosis according to the principle from more to less severe.

**Etiology and pathogenesis.** The severity of injuries has increased significantly due to the impact of modern types of small arms. A gunshot wound, and in particular a gunshot fracture of bones, is a mechanical injury inflicted by an injurious small in size and mass projectile that has significant kinetic energy. The kinetic energy of a wounding projectile depends on its mass and, to a much greater extent, on the speed and path of movement in tissues.

In the tissues surrounding the wound channel, three zones are distinguished (fig. 2.25). The first zone is a primary wound channel, formed as a result of direct destruction of tissues by a wounding projectile. It is filled with scraps of damaged tissues, blood clots and wound exudate.

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Fig. 2.25. Wound canal zones:
1 – wound canal; 2 – zone of primary traumatic necrosis; 3 – zone of molecular shock; 4 – wound detritus; 5 – secondary wounding shells
The second zone is a zone of concussion or primary traumatic necrosis of tissues around the wound canal.

The third zone is a zone of molecular concussion or tissue concussion, characterized by damage to cells and tissue structures. The last two zones are formed as a result of the lateral action of the wounding projectile during the formation of a temporary pulsating cavity.

Thus, the closer the tissues are to the wound channel, the more massive their damage and the more significant the morphological and functional changes that arise in them.

Wounds in gunshot fractures always have a very complex structure. As a result of the injury, the dense structure of the bone diaphysis is destroyed with the formation of a number of bone fragments that have received a pulse from the injuring shell and have acquired a certain speed, which turns them into secondary wounding projectiles that cause additional trauma to the soft tissues with the formation of secondary wound channels.

The depth of soft tissue damage depends on the strength of the mechanical action, its direction, the nature of the wounding projectile and the location of the wound.

Particularly significant disorders occur in the muscles. Defects in them increase due to the reduction of individual muscle beams, resulting in the creation of cavities and nooks. In the zone of soft tissues destruction, blood vessels are damaged, and the area of the wound canal is imbibed by the blood outflow. The presence in the wound of crushed and ruptured muscle and fascia areas, free bone fragments and blood clots, as well as microcirculation disorder and edema in the area of damage in combination with microbial contamination create favorable conditions for the development of wound infection.

Concomitant vascular and nerve damage make a great influence on the course and outcome of gunshot fractures. Damage to the main blood vessels occurs in approximately 10% of cases, and nerve damage – in 15–20% of all gunshot limb fractures.

Gunshot fractures are often complicated by external or internal hemorrhage, shock, fat embolism. External bleeding and acute limb ischemia are the life-threatening consequences of trauma in case of gunshot fractures of long bones. Prolonged external bleeding from large vessels is accompanied by the rapid loss of large amounts of blood and without medical treatment leads to loss of blood and death within 10–20 minutes. Acute ischemia of the limb is a life-threatening consequence of trauma with an uncompensated and irreversible character. At the same time, the dynamics of pathological processes develops more slowly, but without medical assistance inevitably leads to death: decompensated ischemia in 6–8 hours becomes irreversible, which leads to endotoxicosis, and later to acute renal failure and death on 3–4 days.

Diagnostics

Gunshot fractures of long limb bones are accompanied by symptoms, that are typical for closed bones fractures (pain, swelling, hemorrhage, deformity, segment shortening, pathological mobility, crepitation of bone fragments, limb function abnormalities), but with external bleeding and wound. When examining the wound, it is possible to determine the damage to large vessels and nerves, the presence of bone fragments (splinters) in the wound, to assess the degree of destruction of soft tissues and bone. For more detailed diagnosis, an X-ray of the limb segment is required, which is performed in two projections. At the modern level, a more detailed assessment of the degree of disruption and destruction of tissues in the area of the wound canal is provided by CT and MRT investigations.

Correct and timely diagnostics of gunshot fractures determines the rational sorting of the
wounded. The following absolute signs are determined among the diagnostic criteria of a gunshot fracture: the presence of bone fragments in the wound; pathological mobility throughout the segment; bone crepitation; shortening or deformity of the limb.

Relative signs of gunshot fractures are a feeling of pain, swelling, hemorrhage in the area of damage, a disorder of the function of the limb and a characteristic localization of the inlet and outlet openings in perforating wounds.

The diagnosis of a gunshot fracture must reflect the kind of wounding projectile (bullet, comminuted, mine-explosive, etc.), the nature of the wound (perforating, blunt, gutter), the type of fracture (complete, incomplete), the character of the fracture line (transverse, oblique, etc.), localization, concomitant damage to soft tissues, major vessels, nerves, joints, as well as the localization of injuries in multiple, associated or combined trauma, general and local complications.

Absolute signs of gunshot wounds of the joint are a gaping wound in the corresponding area with the outflow of synovial fluid and deformation of the joint outlines. In the diagnosis of gunshot joint injuries the following must be also taken into account:

- localization of the wound inlet and outlet;
- the direction of the wound canal;
- limb position: retraction, flexion, external rotation of the thigh with hip joint trauma; flexion during knee joint injury; plantar flexion of the foot in case of an ankle injury; extension when injured elbow joint;
- restriction of joint function, soreness in passive and active movements, palpation and axial load on the limb;
- the presence of fluid in the joint cavity (hemarthrosis, synovitis).

The final diagnosis of the type of gunshot fracture can be established after performing an X-ray examination (fig. 2.26).

Diagnosis is more difficult for blind comminuted-explosive wounds with small fragments, intra-

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Fig. 2.26. X-rays of patients with long-bones gunshot fractures: A – lower third of the femur; B – distal epimetaphysis of the femur and the patella; C, D – diaphysis of the tibia
articular gunshot fractures with high-speed bullets, with fragmentation-explosive wounds. In doubtful cases, injuries should be considered as those accompanied by gunshot fractures, and all medical measures should be carried out accordingly.

One of the severe complications of bone fractures is local hypertensive ischemic syndrome (compartment syndrome). This is a condition in which a high pressure in the bone-fascial spaces reduces the perfusion of capillary blood under the level necessary for the viability of the tissues. Local hypertensive ischemic syndrome is characterized by the appearance of sudden severe pain in the area of the affected case, which does not correspond to the severity of the injury and in most cases is not decreased after immobilization. The intense swelling of the limb segment is one of the important objective clinical signs. Edema progresses on the 2–3 day after the injury for the majority of patients.

Principles of medical care at the stages of medical evacuation

The first medical aid is admitted on the location of the disaster or on the battlefield in the form of self-help and mutual assistance. The first medical aid in the field can be provided by a medical officer or a sanitary instructor. It includes: temporary arrest of external bleeding with a pressure bandage or hemostatic tourniquet, anesthesia, the application of an aseptic dressing, the immobilization of the limb with improvised means, the taking of antibiotics *per os*.

Rules for the application of an arresting bleeding tourniquet:
1. Apply the tourniquet for the injured limb above the wound, but as close as possible to it, and stretch the tourniquet with maximum force (fig. 2.27 A).
2. Press the first round of the hemostatic harness and make sure there is no pulse on the artery (fig. 2.27 B).
3. Apply the following tours of the arresting bleeding tourniquet with less effort (fig. 2.27 C).
4. Attach a note on the time of application of the tourniquet (hours and minutes) under the rubber band of the loop (fig. 2.27 D).
5. Apply the tourniquet no more than 1.5 hours in summer and 1 hour in winter.
6. Using splints or improvised material, ensure the immobilization of the damaged segment of the limb.
7. It is necessary to administer painkillers intramuscularly.
8. Periodically check the need for further keeping of the tourniquet and in case of bleeding arrest, apply a compressing bandage.
9. In the cold season, in order to prevent frostbite after the application of the tourniquet, the cover the limb to keep warm, in summer it should be protected from direct sun rays.
10. After the expiry of the time limit for the application of the tourniquet, a compressing bandage is applied (fig. 2.27 D).

Fig. 2.27. Technique of tourniquet application
plication of the tourniquet and the impossibility of providing appropriate care, the tourniquet should be removed for 10–15 minutes, with a preliminary finger compression of the corresponding main artery, which is the source of bleeding, to the bony protrusion.

If the tourniquet is applied correctly, the arterial bleeding will immediately stop, the pulse on the peripheral arteries will disappear, the limb will become pale and its sensitivity will decrease. Applying the tourniquet is a responsible procedure. Prolonged stay of the tourniquet, as well as excessive tightening, can lead to disruption of limb movement, which is caused by a secondary trauma of nerve trunks from compression. The tourniquet is applied without excessive tightening and with such force of compression that allows arresting bleeding. At the same time, a weak tightening of the tourniquet is not accompanied by sufficient plug of the circulation in the main artery. In this case, only the vein is squeezed, along which the blood flows from the limb, resulting in an increase in venous bleeding.

An even more threatening complication of applying tourniquet to the limb is the death of limb tissues. Such a complication develops in violation of the rules of tourniquet application, primarily because of uncontrolled leaving it for a long time.

**Indications and means of transport immobilization**

Transport immobilization is an important mean of preventing traumatic shock, early infectious complications and repeated bleeding. The transport immobilization of damaged limbs is carried out by the service splints.

Indications for transport immobilization are fractures of bones, joints, injuries of great vessels and nerve trunks, extensive soft tissue injuries, burns and frostbites.

*Transport immobilization is performed in compliance with the following rules:*

1. It is necessary to minimize the time from the moment of injury to the application of transport splint. If possible, it is necessary to perform immobilization directly at the site of the injury.
2. Application of transport splints should be preceded by the introduction of painkillers.
3. Before applying transport splints, wounds should be protected with aseptic bandages.
4. The transport splints must be put over the shoes and clothes.
5. In case of arterial hemorrhage from the wound, the blood arresting tourniquet should be applied directly proximal to the wound. After this the transport splints should be fixed so that, firstly, the tourniquet was clearly visible and, secondly, if necessary, it could be removed without disturbing the immobilization of the limb.
6. The splint before application should be adjusted to the size and shape of the injured limb and be modeled so that the limb would be fixed in the middle physiological position, which ensures maximum relaxation of the muscles.
7. Ladder and plywood splints are lined with a cotton-gauze padding beforehand, and when using the help on the battlefield or on the scene of the accident, the improvised material is used. This will help prevent compressure of soft tissues and the formation of pressure sores, and in the cold season – contact frostbites. Between the splint and the bony protuberances (ankles, condyles, iliac crests), cotton-gauze pads are put.
8. When carrying out transport immobilization, it is necessary to immobilize at least 2 adjacent joints, and for fractures of the femur and humerus – 3 joints.
9. Transport splints are fixed to the injured limb with even tours of the gauze bandage. Bandaging should not be tight, so as not to violate the blood circulation in the limb. To fix the Dieterich's splint kerchiefs, trouser leather belts and belts are used.
10. In the cold season, the immobilized limb needs to be insulated.
For immobilization of the upper limb, ladder and plywood splints, scarves are used (fig. 2.28). In case of damage to the shoulder joint, humerus and elbow joint, a long ladder splint is applied. It is applied from the fingertips to the opposite shoulder joint and fixed to the trunk with a bandage, kerchief or belt. A damaged forearm and wrist joint is immobilized by a short ladder splint from the fingertips to the upper third of the shoulder. If the brush is damaged, a plywood splint is used to the elbow joint. In these cases, the upper limb is suspended on a kerchief, bandage or belt. With the transport immobilization of the upper limb, the shoulder should be adducted to the trunk. The elbow joint must be flexed at an angle of 90°, the forearm – in the middle position between the supination and pronation, the hand – in the position of the dorsum flexion. It is achieved with the help of a cotton marble roll inserted into the palm of the wounded patient.

In case of trauma to the hip, thigh and knee, immobilization is carried out by the Dieterichs’ splint and the Cramer splint on the dorsal surface or by three long ladder splints. Along the back surface of the leg it is performed from the toes to the middle of the back, along the inner surface – to the perineum and along the outer surface of the injured limb to the wing of ilium (fig. 2.29).

The technique of immobilization with Dieterichs’ splint:
1. An adjustment is made along the length of the outer and inner branches of the splint (the outer branch must rest against the axillary fossa, the inner branch – against the perineum of the patient).
2. The "pile" of the splint is bandaged to the foot (with a shoe worn or with a cotton-gauze pad on the back surface).
3. Splint branches are carried through the metal staples of the sole and are applied to the limbs. This position is fixed by wide cloth tapes attached to the branches (one of the straps is necessarily held around the shoulder from the opposite side of the wounded patient’s body).
4. A twist is prepared, which is carried out through the sole and slit in the projection of the outer branch.
5. Cautious traction is carried out behind the distal part of the limb. It is completed by tightening the
6. Bony protrusions (areas of the large trochanter, condyles of the knee joint, ankles) are additionally protected by cotton-gauze pads.

7. The Dieterichs’ splint is strengthened by two ladders: on the posterior surface (with modeling in the knee joint) and around the pelvis at the level of the hip joints. It is bandaged then to the limb (fig. 2.30).

In the case of a shin and ankle joint trauma, three stages of the splint are applied to the lower limb for immobilization. It is placed from the tips of the toes to the upper third of the thigh along the posterior, outer and inner (in the perineum) surface of the limb. Immobilization of the foot is carried out by two ladder splints (on the posterior surface from the toes to the knee joint, along the outer and inner surfaces after the U-shaped bending of the second splint is applied).

In case of trauma to the lower extremity, the transport splints are modeled so that the foot is at an angle of 90°, and the knee joint – 170°.

Premedical aid is provided by a paramedic who monitors the correctness of previous activities and eliminates noted shortcomings. To the injured patients in a state of shock, jet intravenous injection of plasma substitutes is introduced, cardiac and vascular preparations, analgesics are administered.

The first medical aid to patients with trauma to the limbs includes the following activities:

1. Medical help for urgent indications:
   - control the correctness of the applied tourniquet;
   - control, rectification or replacement of transport splints in cases where it is associated with...
the development of shock;
- anti-shock activities for shock of III degree (anesthesia, novocain blockades, cardiovascular drugs);
- intramuscular injection of antibiotics;
- intramuscular injection of tetanus toxoid.

2. List of acts that can be delayed:
- elimination of transport immobilization shortcomings that do not threaten the development of shock;
- cutting off a completely destroyed limb, hanging on the musculocutaneous flap (transport amputation);
- infiltration of the edges of the wound with a solution of antibiotics (paravulnar);
- control, correction or replacement of dressings and transport splints;
- novocain blockades in the trauma of limbs without traumatic shock phenomena.

Qualified surgical care for the patients with limb injury includes the following activities:

1. Qualified surgical care for urgent indications:
- operations that are performed for the final arrest of bleeding and for increasing hematomas, (stitching and dressing of both ends of the vessel, imposition of a lateral suture with tangential wound of the vessels, imposition of temporary vascular endoprostheses);
- operations for anaerobic infection (primary surgical treatment of the wound, longitudinal
incisions according to indications);
- necrectomy with deep circular burns of the limbs;
- primary amputation with complete destruction of limbs;
- surgery for open dislocation of limb segments (primary surgical treatment of the wound, removal of dislocation, suturing of the joint capsule).

2. Qualified surgical care of the first stage:
- amputation of limbs in ischemic necrosis due to lesion of the main vessels;
- primary surgical treatment of wounds with large destruction of soft tissues, long bones;
- operations for open fractures (stabilization of bone fractures by external fixation devices).

3. Qualified surgical care of the second stage:
- primary surgical treatment of soft tissue injuries according to indications.

The main tasks of providing qualified surgical care are: saving lives of the wounded patients, removing them from the condition of shock, preventing complications, especially purulent one, ensuring a favorable course of the wound process and healing wounds, and improving immobilization of the limb. After stabilization of hemodynamic parameters, an X-ray examination and primary surgical treatment of a gunshot wound (fracture) are performed. This is the main activity for preventing the development of wound infection.

Primary surgical treatment is indicated for extensive wounds of soft tissues, pinpoint wounds in the projection of the main vessels accompanied by the growth of the hematoma and peripheral circulation disturbance, with multi-lobed and fractured bone fractures with significant displacement of fragments and bone fragments in the wound canal, large joint injuries with damage to the articular surfaces of bones, detachments and fractures of limbs, damage to the main vessels.

Primary surgical treatment is not indicated in multiple superficial pinpoint wounds (not involving large foreign matters), which are not accompanied by the growth of the hematoma and peripheral circulation, in uncomplicated transverse, comminuted, gunshot fractures of the bones without displacement of fragments with small wounds of soft tissues, as well as in perforating wounds of large joints without damage to the articular surfaces of bones.

Surgical treatment is carried out in the early period with a full general anesthesia with a conductive or intraosseous anesthesia.

After anesthesia, a thorough cleaning and disinfection of the operating field and skin are performed.

**Primary surgical treatment of wounds of the extremities includes the following stages:**
- careful operating room cleaning and mechanical treatment (cleaning) of the wound, profuse washing of the wound and evacuation, ultrasonic cavitation);
- wide dissection of the wound with saving excision of the edges of the damaged skin;
- decompression fasciotomy of the basic bone-fascial sheathes throughout the damaged segment;
- revision of the wound canal and all wound nooks with the removal of blood clots, foreign matters, small bone fragments, which are not associated with soft tissues;
- removal of the destroyed and deprived blood supply tissues (mainly subcutaneous adipose tissue and muscles) taking into account the topography of the vascular-neural formations;
- multiple irrigation of the operating wound during the operation with an isotonic solution of sodium chloride, 3% hydrogen peroxide solution, antiseptic solutions with aspiration of the wash liquid;
• preservation of all significant bone fragments, as well as small ones associated with the periosteum and soft tissues (more than 90% of bone fragments retain their connection with surrounding soft tissues);
• restoration of the main blood flow in the wounds of large arteries by means of their temporary prosthetics;
• complete draining of the wound by performing counter-percutaneous sections along the posterolateral surface of the segment with the introduction of drainage tubes with a diameter of at least 10 mm to create a natural outflow of wound contents;
• circumfluous infiltration and parenteral administration of broad-spectrum antibiotics;
• loose tamponade of wounds with napkins, moistened with antiseptic liquids and osmotic sorbents;
• stabilization of bone fractures by the simplest designs of external fixation devices. In the absence of such an opportunity – adequate immobilization of the damaged segment of the limb with removable plaster or circular plaster bandages cut along, and in the absence of such a possibility, by splints strengthen with plaster rings.

Plaster immobilization in a functionally advantageous position is also indicated to wounded patients after surgical treatment of large wounds of soft tissues even without damage to bones. A blind suture of wounds when performing qualified medical care is prohibited.

The surgeon must predict the result of primary surgical treatment. If the forecast is not satisfactory, due to massive contamination of the wound, late delivery, inferior treatment, etc., after 24–48 hours it is necessary to perform a repeated surgical treatment of the wound.

After 48 hours, late surgical treatment of the wound is performed.

In the postoperative period, if there was a suppuration of the wound, it is necessary to perform a secondary surgical treatment of the wound as early as possible. In some cases, when soft tissues can hermetically seal the wound, it is possible to establish a system of flow drainage.

The technique of amputations in primary indications:
• it is advisable to carry out amputation with the bundle applied, with the skin-fascial flaps being cut, depending on the wound configuration and as close as possible to the wound, but also within the viable tissues;
• muscles are crossed, retreating 1.5–2 cm from the base of the skin-fascial flaps;
• it is better to saw a bone with a Gigli saw, the bone marrow is not pressed, the crest of the tibia is knocked down by the chisel, the fibula is crossed 1.5–2 cm proximal to the tibia;
• the great vessels are ligated separately with suture threads at two levels, and at the distal level the vessel is sutured and circularly bandaged;
• the nerve is cautiously isolated and after endoneural injection of 1% solution of novocaine is crossed with a razor blade as proximally as possible;
• after removing the bundle, small vessels are ligated;
• the stump wound is thoroughly irrigated with a 3% solution of hydrogen peroxide and antiseptic solutions and drained with tubular drainage;
• provide immobilization of the limb in the functionally advantageous (rectified) position of the truncated segment by longuette-gypsum dressings.

At this stage, osteoplastic amputations are not performed.

In the postoperative period, the wounded patients are transfused with erythrocyte mass, plasma substitutes and protein preparations, correction of disturbed metabolic forms, antibiotic therapy with
broad-spectrum antibiotics, preparations that improve the rheological properties of blood, early therapeutic gymnastics and physiotherapy are prescribed.

**Specialized surgical treatment. The main activities of surgical care are:**
- a full examination of the wounded with the involvement of specialists of different profiles, as well as the use of laboratory, instrumental and radiation research methods;
- intensive care with correction of disturbed homeostasis, regional circulation and microcirculation;
- prevention of infectious complications, fat embolism and thromboembolism;
- treatment of fractures using all modern methods of fixing bones. Primary, delayed and late osteosynthesis are applied. When choosing a method for fixing fragments, one is guided by the general condition, the time that has passed since the injury, the type of wound and fracture, their localization, and the intention for the minimal traumatism and the possibility of observing mechanical principles (comparing fragments and creating a strong contact between them for the entire period of consolidation). Skeletal traction is used as a temporary method of treatment;
- performing repeated and secondary surgical treatment, as well as reconstructive and restorative operations on bone structures, soft tissues, vessels and nerves, taking into account modern surgical possibilities;
- complex therapy of developed complications;
- medical rehabilitation of the wounded.

By indications a surgical treatment at this stage can be supplemented with adaptive resection of sharp ends of bones fragments, without periosteum. It should be completed with a full closure of wounds with active drainage.

Repeated surgical treatment of musculoskeletal wounds should be performed in case of incomplete primary surgical treatment, with pronounced necrosis of tissues along the wound canal, as well as with undeveloped large foreign matters lying in the joint cavity or in the projection of the neurovascular bundles.

Secondary surgical treatment should be performed in cases of wound infectious complications development. The content and amount of this surgical intervention are determined by the specific form and extent of the infectious process. As a rule, secondary surgical treatment of musculoskeletal wounds includes opening and draining of purulent focuses. According to indications, necrectomy and sequestrectomy, muscular plastics of the cavities are performed. In cases of anaerobic infection, longitudinal incisions are performed to decompress the segments, drain and aerate the wounds.

With a general satisfactory (compensated) state of the wounded and correct position of the bone fragments, immobilization of the limb is carried out with a plaster circular bandage. This method of medical immobilization during the period of military operations is used for most of the wounded patients.

**Extra-focal osteosynthesis is used in the treatment of 20–25 % of the wounded patients.**

**Indications for its use are:**
- gunshot and open fractures with primary defects of bone tissue;
- multi-commiunting and fragmented fractures;
- intra-articular fragmentation fractures;
- fractures of bones complicated by soft tissue defects, large wounds and burns of the damaged segment, as well as gunshot osteomyelitis and purulent arthritis.

Based on experience in providing trauma care in recent local conflicts and wars, the concept of
a “saving” primary surgical treatment of gunshot fractures was developed. This concept is aimed at improving the functional results of fracture treatment. The main ideas of it are focused only to the specialized stage of care and are as follows:

1. Primary surgical treatment of gunshot fractures is not indicated without significant displacement of fragments, with puncture (up to 1 cm) soft tissue injuries, without bleeding and strained hematomas. An alternative to it is the immobilization of the fracture by the rod apparatus of external fixation with the installation in the postoperative period of the system of flow-washing drainage.

2. In the course of primary surgical treatment, with bone fractures, the bone tissue remains as long as possible, only small bone fragments are removed.

3. In the “saving” surgical treatment of multi-comminuted fractures with extensive soft tissue damage, extra-osseous fixation of bone fragments is performed as its final stage.

4. An obligatory element of surgical treatment is fasciotomy. The local effect is administered which is the introduction of antibiotics in the wound area and intraosseous Novocain blockades with antibiotics, prolonged infusions, etc.

5. The wound after the primary surgical treatment is sutured with the primary suture with the superimposition of the system of flow-washing drainage, or is conducted openly with the use of water-soluble ointments and is closed by the initially stitched seams.

Even with a brief description of the technique of “saving” primary surgical treatment, there are obvious significant requirements to the conditions of its implementation. They are possible only when organizing the provision of early specialized trauma care. In the wounded patients with long-bone gunshot fractures, with the treatment by the principles of the “saving” primary surgical treatment concept were used, for significantly shorter periods wounds are healed, consolidation of gunshot fractures occurs, joints and bone defects are formed significantly less often, compared with those who had undergone radical primary surgical treatment. At the same time, the incidence of wound infectious complications and gunshot osteomyelitis in patients who underwent “saving” primary surgical treatment did not differ significantly from the wounded patients who underwent radical primary surgical treatment.

If it is necessary to perform the primary surgical treatment for long-bone gunshot fractures at the stage of qualified medical care, the indications and procedure of the operation should be standard. The treated wound remains open. At the end of the surgical intervention, it is advisable to perform medical-transport immobilization.

When using external fixation devices, the following conditions must be strictly observed:

- ensure uncomplicated course of wound process;
- with a bone defect up to 5 cm, one-stage adaptation of fragments with compression of the end surfaces is possible, the next stage of intervention is proximal or distal osteotomy followed by elongation of the segment by the Ilizarov method.

At the stage of aid of specialized care, it is advisable to use the concept of "primary extra-focal and secondary internal fixation", which consists in the primary stabilization of a long bone with a gunshot fracture with an external fixation device before healing soft tissue wounds. After that the device is dismantled and transferred to the skeletal traction system for 10–14 days. Obtain uncomplicated healing of wounds of soft tissues from the rods. Next, it is needed to perform intramedullary osteosynthesis, or osteosynthesis with a bone plate.

If the bone defect is more than 5 cm, the fracture should be fixed with an apparatus of extra-focal fixation, the bone fragments should be brought together with a segment shortening to 5 cm, followed by proximal or distal osteotomy and fracture transport before compression of the end surfaces and
subsequent lengthening of the segment to normal anatomical length (fig. 2.31, 2.32).

The use of compression-distraction apparatus provides a rigid fixation of bone fragments.

Infectious complications at the stage of specialized medical care develop in 35% of the limb wounded patients. These include abscesses, phlegmons, purulent leakage, as well as ischemic gangrene, arthritis, gunshot osteomyelitis, ulcers, wounds of long-term healing stumps, etc.

The development of wound infection is promoted by large volumes of tissues with reduced viability in the zone of molecular shock of the gunshot wound, high microbial contamination of bone and muscle wounds, posttraumatic disorders of regional hemodynamics, microcirculation and nervous trophism, general and local immunity disorders. In addition, it must be remembered that after purulent wounds accompanied by blood loss and shock, purulent complications develop more often in those patients, who did not undergo correction of homeostasis the first day after injury (introduction of sorbilact, rheosorbilact, Ringer’s solution, Aminol, polarizing solutions, soda, albumin, etc.) or if it was inadequate.

One of the dangerous infectious complications is still gunshot osteomyelitis. Pathogenetic factors that contribute to the development of gunshot osteomyelitis are divided into general and local. The general factors include traumatic illness, the course of which is accompanied by: anemia, hypovolemia, multiple organ failure, immunodeficiency, etc. The local factors include the spectrum and concentration of wound microflora, necrosis, violations of regional circulation and microcirculation, inadequate reactions of inflammation and immune response. Huge importance in the development of gunshot osteomyelitis has irrationally conducted general and local treatment. Treatment of purulent complications should be comprehensive and directed primarily to the elimination of anemia, correction of disturbed metabolic forms, detoxification of the body. Apply targeted antibacterial therapy with the introduction of massive doses of drugs and drugs that increase the body’s overall resistance (immunomodulators), oxigenobarotherapy against the background of adequate infusion-transfusion therapy.

Fig. 2.31. Gunshot fracture with a large (more than 5 cm) bone defect:
A – immobilization of a fracture by a rod external fixation device; B – adaptive resection of bone fragments with subsequent reduction and shortening of the segment (up to 5 cm), proximal osteotomy followed by distraction for elongation of the shortened segment; C – restoration of limb segment length
Fig. 2.32. Stages of surgical treatment of a gunshot fracture of the lower leg: A – primary X-ray after injury; B – X-ray after installation of external fixation device and proximal osteotomy; C – X-ray of completion of replacement of the defect of the tibia; D – the appearance of the right shin of the patient with an external fixation device; E, F – X-ray after replacing the fixation method.
In the acute period of wound infection (the period of suppuration) surgical tactics should be active, aimed at cleaning and delimitation of the infectious focus. Widely uncovering and full drainage of purulent focuses is performed. Restorative operations during this period are not used.

After acute events decreasing and stabilizing the general condition, necrectomy and sequestrectomies are performed, according to indications with resection of the ends of fragments or articular surfaces, secondary surgical treatments, amputations for repeated indications and reamputation.

After cleaning of purulent-necrotic wounds, various methods of their closure are used by applying secondary sutures, plasticizing local tissues, dermal and other types of plastics, performing a variety of reconstructive and reconstructive operations, including using microsurgical techniques.

The main requirements for the provision of surgical medical assistance to victims with injuries of the limbs are continuity in consistently conducted treatment and prevention activities and timeliness of their implementation. Continuity is ensured by unified, pre-regulated and mandatory principles for the medical staff to provide surgical care and treatment.

COMPARTMENT SYNDROME OF THE EXTREMITIES

CP is a symptom complex, in which there is an increase in subfascial pressure in the closed fascial space, which leads to ischemia and necrosis of the contents of the fascial nook and the development of ischemic contracture.

For the first time the term "compartmental syndrome" was used by P. A. Reszel (1963).

The reasons for the increase in subfascial pressure are as follows:
1. Post-traumatic hematoma, gunshot wounds, fractures and dislocations of bones.
2. Positional compression.
3. Syndrome of late revascularization.
4. Reperfusion damage in unsuccessful or even successful reconstructive operations on vessels.
5. Inflammatory diseases of soft tissues.
6. Tumor-like formations.
7. Frostbites and burns.
8. Iatrogenic lesions (during intramedullary osteosynthesis, IV regional anesthesia, with tight bandage of limbs or applying tourniquets to the extremities, with arthroscopic operations, imposition of skeletal traction).

Pathophysiology of compartment syndrome

The compartment syndrome is caused by ischemic edema of the muscles, enclosed in dense fascial sheathes (forearm, shin). As a result of edema subfascial pressure rises. This leads to a disorder of microcirculation of the muscles and the growth of ischemic edema. There is a "vicious circle", leading to secondary microcirculatory infarctions and necrosis of nerves and muscles located in the bone-fascial case. Great vessels blood flow is often preserved ("water pipe syndrome" – Wasserleitungssyndrom), and ischemic syndrome progresses up to the gangrene of the limb.

Irreversible neuromuscular lesions occur after 12 hours from the onset of clinical manifestations.

Diagnosis of compartment syndrome
1. Severe pain in the limb, which is not stopped even by narcotic drugs.
2. Skin discoloration, blanching.
3. Tensed swelling of the soft tissues of the limb.
4. Reduction or absence of active muscle movements of the injured limb.
5. Numbness or paresthesia in the zone of autonomic innervation of a damaged nerve.
6. Increase in subfascial pressure.
7. Decreased temperature of the limb.

The consequence of the compartmental syndrome is Volkmann's ischemic contracture.

Measurement of subfascial pressure is a mandatory manipulation to confirm the diagnosis of compartmental syndrome. The subfascial pressure was measured by the injection method according to Whiteside (1975). At present, subfascial pressure measurement is performed by the device of "Stryker Intra-Compartmental Pressure Monitor System".

Normally, the pressure in the limb myofascial space does not exceed 8–9 mm Hg. If it is less than the diastolic pressure by 30–40 mm Hg "compartmental syndrome" can be diagnosed. For example, if the patient has a blood pressure of 140/90 mm Hg, the pressure in the myofascial space is 50 mm Hg.

Classification of compartmental syndrome by severity according to Strafun S.S. (1991)

Light degree – the distal segment of the limb is warm to the touch, the pulse on the main arteries is preserved. The level of subfascial pressure is 30–40 mm Hg lower than diastolic pressure (the lower criterion for diagnosing compartmental syndrome).

Medium degree – the temperature of the skin of the affected limb is reduced. Hyposthesis or anesthesia of the limb fingers is observed. The pulse is weakened. Subfascial pressure is equal to diastolic pressure.

Severe degree – there is no pulse on the great arteries. The fingers are anesthetized. The level of subfascial pressure is higher than the diastolic level.

The compartmental syndrome should be differentiated with such injuries and diseases as:
1. Damage to the main vessels and thrombosis of the arteries and veins.
2. Damage to nerve trunks.
3. Clostridial and non-clostridial myositis.

Differential diagnosis is carried out according to the following criteria:
- presence of peripheral pulsation;
- the presence of edema;
- impaired limb sensitivity;
- the presence of intoxication and leukocytosis in the blood;
- subfascial pressure level.

Peripheral pulsation will be preserved in all cases, except for damage and thrombosis of the main vessels (there will also be no impairment of sensitivity). Edema will be absent only in the defeat of nerve trunks. The presence of intoxication is typical exclusively for the infectious process (clostridial and non-clostridial myositis). An increase in the level of subfascial pressure is typical for compartmental syndrome and infectious myositis.
Conservative treatment of compartment syndrome

1. Unnecessary compression (pressure) on the affected segment must be prevented. This means the removal of pressure bandages, the dissection of the plaster bandage. These treatment measures are aimed at preventing increasing ischemia.

2. Improvement of peripheral circulation by removing vasospasm (papaverine, platyphylline, no-spa).

3. Improvement of rheological properties of blood (Rheosorbilact, Rheopolyglukin, Pentoxifylline).

4. Anesthesia (in the first day, the use of narcotic analgesics is permissible, in the subsequent – the transition to non-narcotic analgesics, non-steroidal anti-inflammatory drugs).

5. Drugs that increase tolerance of muscle tissue to ischemia (Actovegin solution, Solcoseryl, Actovegin tableted, vitamins of group B, vitamin E, Preaductal, enzymes – Wobenzym, Phlogenzym).

6. Reduction of the edema of the affected limb (L-lysine escinate, mannitol, furosemide).

7. Hyperbaric oxygenation, magnet therapy.

N.B. Skin temperature and peripheral pulse (on the radial artery or arteries of the feet) can be normal. This does not exclude compartmental syndrome (“warm ischemia”). Fasciotomy is indicated for the prevention and treatment of compartment syndrome with injuries of the brachial artery and vein, injuries of the ulnar fossa with damage to the vessels, injuries of the popliteal artery and vein. Fasciotomy is performed more often on the lower extremities than on the upper extremities.

Attention!!!! Due to the disorder of local blood circulation, that leads to ischemia, the bioavailability of drugs in tissues is REDUCED !!!

Surgical treatment

The compartment-syndrome is treated with an operative method in the case of ineffective conservative therapy. In this case, decompression fasciotomy is performed.

Decompression fasciotomy is an operation aimed at preventing and treating ischemic myoneural deficit resulting from increased subfascial pressure in compartmental syndrome.

Decompression fasciotomy – prophylactic fasciotomy

It is an operation performed in a patient without signs of increased subfascial pressure (fig. 2.33) during a fasciotomy (for example, a period of more than 6 hours between vascular injury and revascularization or severe damage to the veins that required a large vein ligation).

The main indications for preventive fasciotomy:

1. Severe venous insufficiency.
2. Damage to the popliteal artery or vein.
3. Unsuccessful arterial reconstruction.
4. Late arterial reconstruction (> 6 hours after injury).
5. Severe swelling of the soft tissues of the limb.
6. Haemostatic Esmarch bandage, imposed for 2 hours.

Therapeutic fasciotomy

An operation performed to a patient with signs of elevated subfascial pressure, determined by clinical examination or by measuring subfascial pressure (or both). Subfascial pressure is more than
30 mm Hg (fig. 2.34) should be considered as pathological. Elevated subfascial pressure is an absolute indication for the performance of therapeutic fasciotomy. Any of the following clinical symptoms should be considered as an indicator of increased subfascial pressure:

1. The tension of subfascial tissues and muscles with (or without) paresthesia.
2. The pain that occurs with passive extension of the fingers is a late and serious symptom.
3. Paralysis in the absence of nerve damage.
4. Weakening of the peripheral pulse in the absence of damage to the main vessel.

**TRAUMATIC OSTEOMYELITIS**

The term "osteomyelitis" was first applied in practice in the XIX century by the French surgeon Reynaud to determine the inflammatory complication of bone fractures.

Osteomyelitis is up to 7 % in the general structure of diseases of the organs of support and movement, characterized by high rates of unsatisfactory results of treatment (up to 35 %), and in a third of patients within the next months there are relapses of the osteomyelitis process.

Traumatic osteomyelitis is a purulent-necrotic process in the area of bone damage with different degrees of disturbance of reparative osteogenesis. It occurs due to open fractures of the bones, less often – after performing osteosynthesis (postoperative). Morphological substrate of the purulent...
necrotic focus is non-viable areas of bone tissue with inflammation in the surrounding tissues. Traumatic osteomyelitis can involve in the inflammatory process of the main vessels with the possibility of local formation (erosive bleeding) and general (sepsis) complications.

The negative factors contributing to the development of osteomyelitis, should include the degree and nature of the damage of soft and bone tissues, bacterial contamination of wound surfaces, disadvantages primary surgical treatment of open fractures without washing modern antiseptics and vacuuming, overlay blind suture the wound with a large tension, unstable osteosynthesis, underestimation of degree of skin and soft tissue complex damage in closed fractures, improper position of plaster bandage, peculiar properties of immunology and physical status of the patient.

There are acute, subacute and chronic traumatic osteomyelitis. Due to the clinical course there are: active phase, exacerbation and attenuation phase (remission resistant), localization – mono-osseous and polyossal lesion.

Since traumatic osteomyelitis develops against the background of bone tissue damage, the signs of bone fusion according to clinical and X-ray data must be taken into account:

- osteomyelitis, accompanied by a fracture of the bone without signs of its healing, regenerate between fragments is not determined;
- osteomyelitis in combination with a false joint;
- osteomyelitis with delayed bone consolidation;
- osteomyelitis, accompanied by a bone defect;
- osteomyelitis in the presence of a healed fracture.

There are the following kinds of osteomyelitis according to the pathological changes of soft tissues in the area of the osteomyelitis focus:

- fistula with satisfactory condition of surrounding soft tissues;
- a large scar of soft tissues with the presence of a fistula and areas affected by an ulcerative process with or without exposure of the bone;
- defect of soft tissues in the form of a purulent-necrotic wound, the bottom of which is bone;
- trophic ulcer.

Acute traumatic osteomyelitis

It is characterized by deterioration of the general condition of the patient, pain in the area of bone damage, increased body temperature to 40 °C, symptoms of intoxication, edema of the extremity.

During examination, the affected segment is swollen, expressed local hyperthermia, hyperemia and infiltration, exposures of bone fragments in the wound without signs of their adhesion or significant excretion of pus are determined. As a rule, the osteomyelitis process affects the fracture zone, but with the fragmentation nature of the lesion it can spread to significant areas. With the progression of the purulent process, interstitial purulent bays, phlegmons, thrombophlebitis, in severe cases sepsis may occur.

The hemogram changes significantly: leukocytosis is detected with a shift to the left, the number of lymphocytes decreases. The amount of hemoglobin and erythrocytes reduces, ESR increases significantly. In the protein composition of the blood there is dysproteinemia.

The therapeutic tactics in the acute period should include draining or opening the wound, removing necrotic and nonviable tissues, washing with solutions of antiseptics, dressings.
In addition, antibiotic therapy with taking into account the sensitivity of microflora, immunostimulants, detoxification and symptomatic therapy are prescribed.

Clinical manifestations of subacute osteomyelitis are presented rather weaker.

The general condition of the patient improves, the phenomena of inflammation of the wound weaken. The hyperthermia is preserved up to 37.5–38 °C. The purulent discharge from the wound becomes less. The necrotic area of the bone begins to be limited. ESR and leukocytosis are reduced, red blood indicators are at the level of the lower limit of the norm.

Disorder of osteoreparation is manifested in the form of false joints, nonunions or bone defects. In severe cases, bone sequestra are formed, signs of osteoporosis and osteolysis are revealed.

Therapeutic tactics include cleaning of the wound, its treatment with antiseptics. If there are signs of fracture fusion, it is possible to remove the internal fixative device with subsequent osteosynthesis by an external construction.

**Chronic osteomyelitis**

It occurs more often. The transition of an acute process into a chronic one or its primary formation is possible.

In the initial formation of the chronic process, the general condition of the patient doesn’t improve, pain and hyperthermia remain. Hyperemia and edema in the area of the postoperative wound increase. The appearance of purulent discharge is possible. The wound grows in size, on a significant area can be connected to the bone. The exposed bone is matte, the periosteum exfoliates, becomes fibrous (fig. 2.35). With the progression of the inflammatory process, the bone darkens, its surface becomes rough. Bone tissue loses its properties. It crumbles easily, the edges of the bone break down, and defects are formed. One of the first and reliable X-ray symptoms, indicative of the onset of the inflammatory process, are the areas of osteolysis. They have not quite clear contours, small size and irregular shape. They occur 4–5 weeks after the injury.

The disease becomes chronic in 4–6 months after the injury. The general condition of the patients is satisfactory, pain decreases, the temperature periodically rises to subfebrile numbers. X-ray examination shows distinct sclerosis around the pathological focus, hyperostosis, gradually formed cavities with sequestrae, confirming the presence of traumatic osteomyelitis. In the bone wound, proliferative processes predominate, inflammatory conditions weak, stable fistulas that do not heal for a long time.

The phase of remission is replaced by a phase of recrudescence of the process. During this the patient’s condition worsens, pains appear in the limbs, body temperature rises to 38–39 °C. Symptoms of intoxication increase (anemia, leukocytosis, increased ESR). Infiltrates, edema, hyperemia appear in the area of old wounds and scars or in a new site. Fistulas arise or are restored, from them pus is allocated, its amount can increase. After the
attenuation of the process, the remission phase again begins. It can last from several weeks to dozens of years.

During clinical examination the general condition of the patient (intoxication, vascular disorders, allergic reactions), impairment of the function of internal organs (amyloidosis of internal organs, anemia, septic state, etc.), local complications – trophic disorders, dermatitis, eczema, malignant fistula must necessarily be taken into account.

Usually for the diagnosis of traumatic osteomyelitis it is enough to know the anamnesis, the clinical and X-ray pictures are very representative and do not cause great difficulties. One of the main issues to be answered by a surgeon is the determination of the extent of the purulent damage to the bone, the state of the surrounding paraosseous tissues, the qualitative and quantitative characteristics of the inflammatory focus and bone regenerate.

None of the methods listed below has an independent diagnostic value. Only complex diagnostics, which combines clinical, radiological and laboratory methods, is able to reflect the localization and the real state of the inflammatory focus, the boundaries of the purulent-necrotic process.

Conventional radiographic methods are used to obtain additional data on the structure of the osteomyelitis environment. These are fistulography, stereophistulography, and contrast radiography of abscess cavity. Valuable additional information is obtained by such examination methods as dosed tense fistulography, fistulotomography, stereoradiography, X-ray fistulography under the control of an electron-optical converter.

Spiral computed tomography (CTD) with three-dimensional modeling, magnetic resonance examination (MRI), ultrasonic osteometry allow determining and estimating the features of pathological changes in the purulent necrotic focus in a short time with a maximum probability.

The method of infrared thermography has a sufficiently great diagnostic potential. It allows localizing accurately the focus of bone inflammation and observation the dynamics of the process. In addition, it allows determination the phase of the inflammatory process. This is necessary for the subsequent choice of the method and timing of surgery.

**The modern treatment of chronic traumatic osteomyelitis is based on the following methods:**

- surgical removal of all sequestra and purulent necrotic foci;
- activation of specific and nonspecific immunobiologic reactivity of the organism;
- reasonable antibiotic therapy;
- cleaning and plastics of the postoperative bone cavity;
- creating optimal conditions for the healing of bone fragments.

In the complex treatment of chronic osteomyelitis, the leading role is assigned to surgical interventions. The main principle of treatment of chronic osteomyelitis is the radical removal of the osteomyelitis environment. It is the main guarantee of cessation of chronic purulent necrotic process. The only way to achieve the goal is a necrectomy. The basic principle of this is that all nonviable tissues, pus, pathological granulations, necrotic tissues, sequestra are the subjects of mandatory removal within tissues capable of regeneration. Radical surgery on the lesion focuses includes removal of nonviable tissues, treatment of the bone cavity, active drainage of the wound. Along with radical surgical treatment of the purulent necrotic focus, extra-osseous osteosynthesis is performed by external fixation devices (on the spinal, stem-like basis, combined wires-rod).

Radical removal of the osteomyelitis (circular resection of the affected area of the bone) with further replacement the resulting bone defect according to the method of G.A. Ilizarov (mono- or bilocal osteosynthesis) is quite effective.
The size of the area of purulent-necrotic destruction, that must be removed, is determined visually. At the same time, the color, bone structure, and its ability to bleed are evaluated. With small defects (up to 4–6 cm), a satisfactory state of soft tissues in the defect zone and subsequent osteotomy, replacement of the bone defect is performed in one stage. That is, after resection of the purulent-necrotic destruction lesion and osteosynthesis of the affected segment, the device performs osteotomy of the proximal metaphysis of this bone. The postoperative wound is closed, the active drainage system is installed. After 10 days, wound healing and X-ray control, the free bone fragment is distracted. The rate of distraction is 1 mm per day.

For defects more than 6 cm, a large amount of purulent discharge in the wound, open management of the postoperative wound, replacement of the bone defect is performed in two stages. The first stage is performance of resection of the foci of purulent-necrotic destruction, osteosynthesis by the device, active flow drainage. The wound is sutured or performed openly using ointment dressings. The second stage is performed after 1–1.5 months in the absence of a relapse of the osteomyelitis process and healing of the postoperative wound, with a satisfactory condition of the soft tissues in the zone of planned osteotomy. Further, an osteotomy of the proximal bone is performed. After wound healing, after 10–14 days, a free bone fragment begins to be distracted.

The process of formation of distraction regenerate is quite long. It can last several months and depends on the length of the bone defect. After the termination of distraction and docking of bone fragments, their compression with fixation on usual for this segment time is carried out.

In patients with traumatic osteomyelitis, hemostasis is often detected, changes in the immunological status are observed. In this case conservative treatment should be complex and include, in addition to antibacterial drugs, immunomodulators, vascular, antithrombotic, desensitising drugs. A complex of conservative medical activities should also include detoxification, intra-arterial and endolymphatic infusions of antibacterial drugs.

Physiotherapeutic activities include laser therapy, ultrasound, ultraviolet irradiation of blood, microwave resonance therapy, etc. Effective was the use of hyperbaric oxygenation, X-ray therapy, hemosorption and plasmapheresis.

**TASKS AND TESTS**

**TASK #1**

The patient, who was delivered to the reception room after an accident, was found to have a wound on the outer surface of the right shin 3 × 5 cm in size, filled with a blood clot, the longitudinal axis of the shin was deformed. In the wound area, pathological mobility, bone crepitation is determined. Pulse is 96 bpm, rhythmic, has a weak filling, blood pressure 100/60 mm Hg. Indicate the preliminary diagnosis.

A. An open fracture of the fibula.
B. An open fracture of the bones of the right shin, the phlegmon of the lower leg begins.
C. An open fracture of the bones of the right shin, a traumatic shock of the 1st degree.
D. Syndrome of prolonged crushing with a fracture of the bones of the right shin.
E. An open fracture of the bones of the right shin.
TASK #2

Patient S., 65 years old, slipped on the street and fell to her straightened left arm, after which there was a sharp pain in the area of the wrist joint. During examination, the deformity of the wrist joint is determined, significant swelling, subcutaneous hematoma. At an axial load a sharp pain is felt. Which of the reliable symptoms will indicate a fracture?
A. Pain, swelling, haematoma.
B. Presence of elasticity of the injured limb segment.
C. Bone crepitation, pathological mobility of fragments.
D. Deformation of the injured segment.
E. Shortening of the limb.

TASK #3

After falling on the back, the patient felt a sharp pain in the spine. At a palpation the sharp tension of muscles and deformation in the lower thoracic spine is defined. What is the first medical aid for the patient?
A. Injection of painkillers and transportation in a semilying position.
B. Apply the Dieterichs splint.
C. Carry out a tight elastic bandaging of the trunk.
D. Introduction of painkillers and transportation on the immobilization shield.
E. Transportation on the shield in the "frog" position.

TASK #4

The patient, 66 years old, complains of pain in the region of the right humerus, a violation of limb function. A year ago he was conservatively treated for a transverse fracture of the right humerus (closed reposition, plaster immobilization). Objectively there is a painless mobility in the fracture region. X-ray picture: a gap between the bone fragments, osteosclerosis and infection of the medullary canal. What is the diagnosis?
A. Chronic osteomyelitis.
B. Neurodystrophy of the extremity.
C. Delayed fusion of fragments.
D. False joint.
E. Pathological fracture.

TASK #5

After manual repositioning and application of plaster splint the patient with fractures of the forearm bones was presented with edema of the hand and fingers, pain, and sensitivity disorder. What should be the primary tactics of the doctor?
A. This is a natural phenomenon, swelling will decrease on its own in a day.
B. Repeat the reposition.
C. Remove the plaster splint for an hour.
D. Cut the bandage, which fixed the splint.
E. Cut the bandage which fixed the splint.

TASK #6

After a car accident, patient V., 33, complains of pain in the right side of the pelvis. On examination, the hemodynamic parameters are stable, there is no asymmetry of the pelvis, pronounced swelling and hemorrhage in the right inguinal region. Choose the best way to transport the patient to the hospital.
A. Transportation in the sitting position.
B. Transportation on a hard surface on the left side.
C. Transportation on a hard surface with a roller under the popliteal fossae.
D. Transportation on a hard surface on the right side.
E. Transportation in semisitting position.
TASK #7

Patient M., 40 years old, clinically and radiologically diagnosed with an oblique fracture of the lower third of the humerus with a displacement of fragments along the length by 1 cm. The hand hangs; the patient cannot completely extend it and abduct the first finger. What is the treatment tactic?

A. Open reposition of fragments, metal osteosynthesis, revision of the radial nerve.
B. Application of a splint-plaster bandage with fixation of the hand.
C. The usage of skeletal traction beyond the elbow.
E. Elastic bandage of the upper limb, cold on the fracture region.

TASK #8

Patient S., 49 years old, has chronic traumatic osteomyelitis of the middle and lower third of the left tibia, remission phase, fracture at the border of the middle and lower third of the left tibia without signs of fusion, soft tissue defect over the fracture zone. On examination, the left lower limb is edematous, along the anterior surface of the lower third of the shin – a skin defect of 6 × 3 cm is present, the bottom of the wound is the tibia, which has a dark color. X-ray reveals areas of osteolysis. What medical tactics are appropriate in this case?

A. Bandaging the wound with antiseptics, fixing the lower leg with a plaster bandage.
B. Osteosynthesis of the tibia with an external fixation device, wound dressing.
C. Necrectomy, skin plastics for the purpose of closing its defect.
D. Radical removal of necrotic bone tissue with subsequent replacement of the formed defect.
E. Osteosynthesis of the tibia with external fixation device, skin plastics for the purpose of closing its defect.

TASK #9

Patient C., 48 years old, 3 months ago received an open fracture of the middle third of the right femur. In urgent order a primary surgical treatment of the wound, osteosynthesis of the right femur with a plate was performed to him. Postoperative wound healed by primary tension. Five days ago, the patient had pain and swelling at the site of the fracture, body temperature increased to 38.5° C. The day before in the field of a postoperative scar a fistula occurred, from which about 30 ml of thick pus was secreted. On the X-ray of the right thigh are signs of fracture fusion. What additional methods of examination are appropriate for the patient?

A. Ultrasonography.
B. X-ray investigation with the introduction of contrast agents in the fistula.
C. X-ray in three projections.
D. Electromyography.
E. Immunological test for sensitivity to metal construction material.

TASK #10

Patient F., 47 years old, suffers from chronic traumatic osteomyelitis of the lower third of the left tibia, fistula along the anterior surface of the left tibia, false joint of the indicated localization. Patient is ill with diabetes for about 15 years. From the anamnesis it is known that 2 years ago as a result of an car accident, an open comminuted fracture of the lower third of the left tibia, a skin defect in the fracture zone occurred. A primary surgical treatment of the wound was carried out, blind sutures were applied to the wound. He was treated by the method of constant skeletal traction. The wound was healed by secondary tension, after 3 months a fistula with a moderate amount of purulent discharge opened. What is the most probable cause of chronic osteomyelitis?

A. An open character of the fracture.
B. Localization of the fracture.
C. Disadvantages of surgical treatment and improper medical tactics.
D. The concomitant disease – diabetes mellitus.
E. Comminuted character of the fracture.
11. What clinical symptoms of fractures are reliable?
A. Pathological mobility of segment fragments, crepitation.
B. Alteration of limb function.
C. Deformity of the limb.
D. Shortening of the limb.
E. Pain, swelling.

12. What complications of fractures should be considered as early?
A. Neurodystrophic disorders.
B. Traumatic shock.
C. Stiffness in the joints with muscle atrophy.
D. Slow fracture fusion.
E. False joint.

13. Delayed healing of fractures is manifested by clinical symptoms:
A. Nonunion of bone fragments.
B. Increase the period of healing by 1.5 times.
C. Edema of the tissues around the fracture.
D. Closure of the medullary canal on the X-ray.
E. Sclerosis of the extremities of fragments.

14. With open fractures at the prehospital stage, the following should be done:
A. Bleeding arrest, transport immobilization.
B. Anesthesia and subsequent suturing of the skin.
C. Reposition of fragments.
D. Imposition of temporary skeletal traction.
E. Primary surgical treatment of wound.

15. Which transport splints are extensible?
A. Cramer’s splint.
B. Plywood splint.
C. Yelanskiy’s splint.
D. Chin sling.
E. Dieterichs’ splint.

16. The cause of secondary early bleeding is:
A. Evacuation of a thrombus from a blood vessel.
B. Vessel arrosion.
C. Cleavage of thrombus.
D. Thrombocytopenia.
E. Failure of coagulation factors.

17. A fracture-dislocation is a condition characterized by simultaneous:
A. Fracture and displacement of bone fragments.
B. Fracture and the interposition of muscles between fragments.
C. Fracture with impaction of the fragments.
D. Dislocation of one bone and fracture of the other.
E. Dislocation and fracture of articular and periarticular bone sections.

18. The patient has an open fracture of the shin bones as a result of a hit by the front bumper of the car. What kind of fracture is most likely?
A. Impacted.
B. Compression.
C. Multi-fragment.
D. Detachable.
E. Helical.

19. Eliminate the incorrectly indicated layer of callus:
A. Paraosseous.
B. Periosteal.
C. Intermediary.
D. Endosseal.
E. Medullary.

20. What should be the limits of transport immobilization of the patient with a fracture of the humerus?
A. Fingers – scapula of the healthy side.
B. Hand – scapula of affected side.
C. The wrist joint – scapula of the affected side.
D. The wrist joint – the shoulder joint of the affected side.
E. The forearm – the shoulder of the affected side.

2. Traumatic disease. Multitrauma. Modern principles of medical aid supply during fractures
Amputation is the operation of limb dissection along its segment. Dissection of the limb at the level of the joint is defined as exarticulation or disarticulation.

The establishment of indications for limb amputation is a crucial issue. It is decided on the doctors’ case conference with the obligatory participation of the vascular surgeon. A patient should give a written permission for the operation. In the unconscious state of the patient amputation is performed according to vital indications. The parents give permission for the operation of the patient under the legal age. Indications for amputation, level of amputation, method of performance are always decided strictly individually. When deciding amputation performance, the surgeon takes into account the general condition of the patient, the nature of the pathological process, the psychological emotional condition, the age of the patient, the most rational level for prosthetics.

INDICATIONS FOR AMPUTATION

Absolute indications for amputation are:

1. Traumatic injuries of the limbs – avulsion of the segment of the limb, if its replantation is impossible or in cases when its absence will not significantly affect the function of the limb (complete and incomplete traumatic amputation of the phalanx of the toe, finger), crushing of the segment for a considerable length with the crushing of 2/3 muscles, major vessels, nerves and smashing of the bones.
2. Extremity gangrene of various origins (thrombosis of the major artery of the limb, white phlegmasia — total thrombosis of arteries and veins of the extremity, blue phlegmasia — total thrombosis of all venous trunks, embolism, endarteritis in the stage of critical irreversible limb ischemia, decompensated diabetes mellitus, burns and frostbites of the IV degree, etc.).
3. Dry gangrene of the limb with the formation of the demarcation line of necrosis.
4. Wet gangrene of the limb with progression.
5. Acute purulent-necrotic post-traumatic processes (anaerobic infection, sepsis).
6. Traumatic toxicosis (crash syndrome), which does not respond to treatment and threatens the life of the patient.
Relative indications for amputation:
1. Chronic purulent limb processes (osteomyelitis, thrombophlebitis) with signs of progressive amyloidosis of internal organs or malignant degeneration of fistula, trophic ulcers of tissues; sepsis in osteomyelitis and purulent lesions of joints which are not responding to treatment.
2. Trophic ulcers in vascular pathology (arterial or venous), which are not responding to conservative and operative treatment.
3. Congenital and acquired severe limb flaws that do not respond to surgical treatment and interfere with prosthetics.
4. Malignant tumors of bones, if it is impossible to radically remove the lesion focus.

According to the time of performance, the following types of amputations are distinguished:
- primary – amputations that are performed to remove an obviously nonviable part of the limb in case of traumatic injury within the first 24 hours, in the volume of the wound primary surgical treatment;
- secondary – amputations that are performed after the formation of the demarcation line of nonviable tissues or the risk of acute renal failure;
- late – amputation performed in a planned manner.

The reamputation is performed repeatedly after a failed preliminary amputation: in residual limb defects, after complications in primary amputations.

METHODS AND TECHNIQUES OF AMPUTATIONS

The main stages of amputation are: soft tissue dissection, vascular ligature, nerve treatment, sawing of the bone, suturing of the wound.

According to the dissection of soft tissues, there is circular and flap amputations.

In circular amputation, soft tissues are dissected perpendicularly to the long axis of the limb. In guillotine amputation – at one level, with a two-stage amputation – the skin with subcutaneous tissue after the circular dissection is displaced proximally, and then crosses all other soft tissues and bone at the same level. In a three-moment (cone) amputation, a circular dissection of the skin, subcutaneous tissue and fascia is performed, then higher – the muscles, and then cut the bone higher. That is, three levels of section are formed relatively to the tissues mentioned above.

Today these methods are rarely used due to many complications. The most rational, and therefore widespread, method is flat amputation.

The operation is performed according to general surgical principles with a careful attitude to all tissues. In the two-flap method of amputation, the sum of the length of both flaps should be equal to the diameter of the dissected limb (1/3 of the circumference). A few centimeters (1/6 of the diameter) must be added to the indicated length of the flaps, taking into account the contractility of the skin (especially in children due to the rapid growth of bone in relation to soft tissues). Flaps are prepared in the ratio 2/3 : 1/3. This allows removing the future scar from under the load and prevents the development of keloid degeneration, the formation of ulcers and excoriations of the postoperative scar of the supporting surface of the residual limb.

The method of amputation is called fascioplastic, if the fascia is included in the flap. If the muscles are included, it is fasciomyoplastic method (fig. 3.1).

Bonesaw-line can also be overlapped with a bone fragment. Such methods of amputation are called osteoplastic and periosteoplastic. Such operations are mainly planned surgeries. They are
used only in cases when it is possible to rely on wound healing by primary tension. Historically, the osteoplastic surgeries of Pirogov on the lower leg (overlapping of the tibia bonesaw-line with a part of the calcaneus), Gritti—Shimanovsky on the thigh (overlapping of the femoral stump with the patella), Sabaneev (overlapping of the femoral stump with the tuberosity of the tibia) are known. Now, osteoplastic operations are used to synostose the tibia and fibula after amputation within the middle and upper thirds of the shin.

An important point in performing amputations is the treatment of nerves. This is due to the fact that such a serious complication as phantom pain occurs in the postoperative period and is a consequence of improper treatment of the nerves. The nerve should be crossed by a sharp blade under the alcohol-novocaine blockade after its isolation in the proximal direction by 4–5 cm without its extraction.

Treatment of bonesaw-line is important for the positive result after amputation and subsequent prosthetics. The edges of the bonesaw-line are treated with a rasp, and with respect to the tibia, an obligatory resection of the crest is performed, preserving the bone marrow. It is necessary to fix the antagonist muscles over the bonesaw-line, while preventing their considerable tension, as well as the formation of their excessive mass and pockets.

After amputation, it is mandatory to perform immobilization, which is aimed at preventing the pathological position of the residual limb in the adjacent joint.

**REHABILITATION AND PROSTHETICS OF THE DISABLED PATIENTS WITH EXTREMITIES DEFECTS**

After amputation of the lower extremity patient loses the ability to move, after amputation of the upper one—to perform vital functions in all areas of activity. The aim of rehabilitation of such patients
is to maximize the restoration of the functional capacity percentage of the extremity that they lost. This is achieved by providing disabled people with technical means of rehabilitation – prostheses replacing the partially or completely lost limb.

The choice of a prosthesis for each disabled person should be based primarily on medical indications. A doctor should take into account the area of their occupation, the need for comfort and cosmetic appearance of prosthesis – which for some people is important, for others it does not matter.

A medical report on the patient's state of health and the functional condition of the limb residual is the basis for deciding if prosthetics are possible. If it is necessary to prepare for prosthetics, the patient is referred for further examination and inpatient treatment in the profile department or prosthetic and orthopedic enterprise.

Contraindications to prosthetic of disabled people can be temporary, relative and absolute.

Temporary contraindications are concomitant diseases and residual limbs, which, do not interfere with prosthetics after conservative or surgical treatment.

Relative medical contraindications may be subcompensated diseases of the circulatory system, respiratory system, urinary system, central and peripheral nervous system, skin, eyes, benign tumors of residual limb and surrounding tissues.

Absolute contraindications to prosthetics are decompensated diseases of the organism.

The functional state of the residual limb is determined by its shape and length, the state of the circulation, the ability of its muscles to contract, the degree of atrophy, the range of movements in the adjacent joint, the condition of its ligament apparatus, the presence of faults and diseases of residual limb.

Long residual limbs slightly reduce the prosthesis limb support ability; medium residual limbs reduce it moderately, and short residual limbs – significantly (fig. 3.2 and 3.3).

Short residual limbs is amputation proximally to the Lisfranc joint according to Chopart, the scaphoid-wedge and heel-cube joints (according to Laborie), or the cube-metatarsal joint (according to Jober), or through the cuboid bone (according to Bon-Eger) can lead to a complete loss of support ability of the entire limb (fig. 3.4).

According to the clinical condition, all residual limbs can be divided into 3 groups: functional, low-functional and non-functional.
Functional residual limbs are characterized by a sufficiently preserved function of the muscles without circulatory disorders, painless, with constant volumetric dimensions, with full range of movements in the adjacent joint, without defects and diseases of bone and soft tissues, with a favorable level of amputation.

Low-functional residual limbs are characterized by a decreased function of the muscles, they are painful in palpation, unstable in volume, have atrophic, flabby tissues. There can be trophic skin disorders without inflammatory phenomena on their end surfaces. There may be flexion or extension contracture of the adjacent joint, moderately pronounced insufficiency of ligaments of the joint. The length of the residual limb is not sufficient to control the prosthesis (short residual limb).

Dysfunctional residual limbs include painful residual limbs characterized by lymphoid and blood circulation disorders, muscle atrophy, significantly reduced function and pronounced joint instability, numerous defects and diseases of residual limb, which are temporary contraindications to prosthetics. They require conservative or surgical treatment, or an exclusive set and a scheme for prosthesis constructing.

To determine a justified diagnosis of the condition of the residual limb, it is advisable to use the following classification, based on clinical signs:

I. Trophic disorders. They occur with an incorrectly defined level of amputation, or due to high ligation of the arteries and truncation of the nerves (fig. 3.5):

- hyperkeratosis, dermatitis, eczema, malignant degeneration of the trophic ulcer, non-healing wound, maceration, excoriation, decubitus.

II. Pain syndrome. It arises from the ingrowth of the nerve into the scar as a result of its improper treatment:

Fig. 3.4. Short residual feet (A – according to Chopart, B – according to Laborie, In – according to Jober, D – according to Bon – Eger)
- local pain of residual limb, hyperesthesia, neuritis, painful neuromas, phantom pains, causalgias.

III. Inflammatory processes. It occurs as a result of development of a secondary infection in the wound (fig. 3.6):
- phlebitis, pyodermia, infiltrate, abscess, furunculosis, phlegmon, ligature fistula, osteomyelitis.

IV. Anatomical defects:
- scars welded to the underlying tissues, keloid complications, clavate residual limb (excess soft tissues, and incorrectly evaluated length of flap or level of circular amputation);
- sharply conical stump (due to a lack of soft tissues, an incorrectly calculated length of flaps with flap amputations. In children the bone growth is faster than soft tissue growth, which forms such a residual limb);
- protruding end of the tibia;
- very short or too long residual limb;
- lateral deflection of the fibula;
- the growth of large osteophytes – comes as a result of damage to the periosteum, the left edge of the bone when it is sawed, or after the bone marrow is exhausted;
- the final necrosis of the bone, which occurs as a result of excessive removal of the periosteum more than 2 mm;
- valgus residual limb position;
- contractures, more often flexion, in the hip or knee joint;
- restriction of joint movements, ankylosis;
- instability in the knee joint;
- recurvation.

The aim of reamputation is elimination the deficiencies and creation of a good stent-capable residual limb. Amount of reamputation should be minimal and at the same time ensure the restoration of the shape and function of the residual limb. Plastic surgery involves excision and movement of local tissues or the closure of defects with loose grafts of healthy skin. Removal of painful neurons, osteophytes, ligature fistulas, excision of mucous bags, painful scars, etc. is performed. There are methods of muscle transposition to improve the functionality of the residual limb.

The goal of osteoplastic re-imputation is to create a residual limb with a supporting end surface by overlapping the filings with a bone autograft (fig. 3.7). Reamputations for synostosis of the bones of the shin and forearm are not carried out in children due to the disproportional growth of paired bones and the development of the residual limb deformation.

An operation was developed to restore the support function of vicious short residual limb of the foot. It is subtalar arthrodesis. With equinovarus deformation of the residual foot, a three-joint arthrodesis is performed.

Short residuals of upper arm, forearms, hands, feet can be lengthened with the help of the distraction method according to Ilizarov. Corrective osteotomies are performed to correct the axis during varus or valgus deformation of the residual limb. Defibulation is performed in short shin residuals in those cases when the functional insufficiency of the remained fibula is determined, such as deflection to the outside, exacerbation of the edges of the head, looseness in the intercellular joint, which makes
it difficult to use the prosthesis. Reconstructive operations are performed on the bones of the forearm and hand to restore the capture function (phalange of the metacarpal residual, cleavage of the forearm residual).

Temporary therapeutic training prostheses are designed for functional and cosmetic compensation of the lost limb of patients in the nearest postoperative period. They provide formation of volumetric parameters of postoperative limb residuals, clarification of the schemes for constructing prostheses, promote the acquisition of new walking skills and shorten the time for rehabilitation (fig. 3.8).

PROSTHESES OF UPPER EXTREMITIES

Prostheses of the upper extremities according to their functional characteristics and management methods are divided into cosmetic, functional-cosmetic, active (with traction control and control from external energy sources) and working prostheses.

Cosmetic prostheses are so-called passive prostheses that do not perform any active function or perform only a passive function of retention. The main purpose of this prosthesis is to fill the cosmetic defect of the segment (fig. 3.9).

Functional-cosmetic prostheses allow carrying out passive movements under the action of a healthy arm. In such artificial limbs, one can extend the fingers of the artificial hand and insert the handle, the handle of the instrument or the spoon, etc. They allow setting the hand in a convenient position for performing any operations, to bend the artificial arm in the elbow joint and fix this position (fig. 3.10).

The main technical mean of prosthetics are active (functional) prostheses. They contain mechanisms that allow active movements in large joints of the limb and partially restore lost functions in self-service and industrial activities. At the same time, the nature of the movement of
the prosthetic segments and its constructive execution imitate a healthy limb, which sufficiently masks the defect. Management of upper limb prostheses can be tractional. In this case the traction of the prosthesis is performed due to the contraction of any group of muscles, movement of the segment of the limb or part of the body is carried out. In bioelectric prostheses, the control is carried out from biopotentials registered by surface electrodes from the stump muscles. In myotonic prostheses it is made by a lateral muscular thrust on the control element. In contact management the effect on the control (switch) element is made by any part of the body. With combined control it is a combination of two or more control methods. However, having great positive advantages, bioelectric structures are not widely used due to the fact that the prosthesis reacts to external electric fields, which leads to its inadequate function.

Active prostheses of the upper limbs allow the patient performing:

- Moving and manipulating objects: lifting, carrying, lowering.
- Performance of the precise movements of the hand.
- Self-service: eating (taking coordinated actions and requirements when taking cooked food, rising to the mouth, consuming it in culturally acceptable ways: cutting, using cutlery), drinking (taking drinks, lifting them in the mouth, mixing, stirring and spilling liquids, opening bottles), dressing (putting on and taking off clothes, putting on and taking off shoes); physiological functions, hygienic activities performance (fig. 3.11).

Work prostheses are administered as the second (additional to the basic) prosthesis, taking into account the working operations that the patient performs at work and at home, and are equipped with a set of special working attachments.
LOWER EXTREMITIES PROSTHETICS

Functional purpose of lower extremities prostheses. Prostheses should be functional, i.e. they should provide the opportunity to stand and walk in conditions of everyday life and accessible professional activity, as well as take into account the cosmetic replacement of the amputated part of the limb. The product must fully meet the individual requirements of the patient. The prosthesis must be firmly connected to the residual limb. Close contact provides good control, optimal feedback and prevents local residual limb pressure (fig. 3.12).

General medical and technical requirements for prostheses:

- individuality, low weight and high functionality due to polycentric adapters, nodes (joint and foot structures);
- taking into account the anatomical and functional features of amputation residual limbs (the possibility of using vacuum fixing of the prosthesis in combination with other types of anchorages);
- providing support function and transfer of motor activity;
- the body of the receiving sleeve of the prosthesis should be made of plastics (injection resins reinforced with knitted sleeves) and have a certain mechanical strength
- softening and unloading elements of the prosthesis should be sufficiently soft, have the ability to quickly distribute the applied axial loads, good amortizing properties, sufficient pressure resistance and relative residual deformation upon compression;
- possibility of individual adaptation;
- the ability of the prosthesis to withstand different weight loads;
- the possibility of comfortable placement of the entire stump volume, taking into account possible changes in its parameters during the day;
- the possibility of hygienic treatment.

Fig. 3.11. Functional biomechanical prostheses of the upper extremity

Fig. 3.12. A – stump preparation for prosthetics; B – prostheses of the lower extremity; C – computer controlled prosthesis of the lower extremity
Orthotics

Orthotics is a kind of medical orthopedic aid aimed at restoring the function of individual segments of the support and movement apparatus using various technical means.

According to their purpose, orthoses can be preventive (for sports), therapeutic (temporary which are used at the stages of treatment (fig. 3.13B), and permanent – in case of persistent loss of function and shape of the limb).

Orthoses can be made in the form of tutors and orthopedic devices. Tutor is a technical device, which consists of a sleeve and fastenings designed to provide immobility in the joints and to stabilize the segment or the entire limb (fig. 3.13A).

Orthopedic apparatus is a technical device, which consists of pivotally connected splints, sleeves or cuffs with fastening parts. It fixes the limb in order to restore the impaired functions (fig.3.13B).

According to functional purposes, there are fixative (fig. 3.13D) and functional orthoses. For example, an orthosis for fixing the bone segments of the upper arm and forearm in the middle physiological position in a false joint, an orthosis on the knee joint to eliminate instability, an orthosis on the ankle joint to hold the foot in a corrected position, an orthosis to prevent the development of the non-physiological position of the limb.

Orthoses are prescribed for the treatment of fractures and fracture dislocations of the bone segments of the limb at the fixation stage before and after surgical treatment. It is administered also for fixing the limb after injuries to the musculoskeletal system and vascular-nervous systems of the upper limb, for stabilization in joint diseases, for prevention of position defects, limb deformities, consolida-

Fig. 3.13. Means of orthosis of the lower extremities.
A – tutors on the lower extremities of the child; B – orthosis for the knee joint; C – Functional orthopedic device for the ankle joint; D – fixation orthosis to the hip joint; E – bandage on the knee joint; F – varieties of orthopedic insoles for feet; G – children orthopedic footwear with a high and rigid back, which is adjustable with ankle retainer, orthopedic heel and insole with a footrest

3. Amputations of the extremities. Rehabilitation and prosthetics of disabled persons with defects of the extremities...
tion of the results of restorative treatment, correction of pathological conditions and contractures, development of movements in the shoulder, elbow and wrist joint, muscle training, self-service skills training.

Orthoses on the spine according to the design can be created in the form of a collar, a head-holder, a corset, a corset-apparatus, a posture corrector or a backboard. According to functional purposes, they are divided into fixing and corrective, but can be fixing-correcting and fixing-unloading. According to the materials used for manufacturing, the orthotic systems on the spine can be rigid, semi-rigid, soft or soft-elastic.

Bandage is an orthopedic device made in the form of a soft or softly elastic sleeve (fig. 3.13E) with details of attachment to the trunk with metal or plastic plates or frames (pelotes) in the lumbar region for partial stabilization of the spine during its diseases or injuries.

Orthopedic medical footwear (fig. 3.13F,G) is developed for wearing during pathology of the lower limbs with foot deformities, during a tip foot, a shortening of the foot more than 2 cm, foot amputation, a pronounced deformation of the foot (varus, valgus), when sizes of the two feet are different (a difference of 2 cm or more), in case of congenital foot overpronation, planovalgus deformity, other deformities of the feet and pathologies. Orthopedic shoes are made according to special individual molds. Modification of shoes is performed by changing the external and internal elements (soles, heels, expanders and other elements).

**Types of orthopedic insoles:**
- accommodative – ensure an even load distribution throughout the insole surface;
- functional – provide support and stabilization of the lower limb, improving its biomechanical function.

Individually formed insoles are made on the basis of the model-casting of the foot, taking into account the individual features of the foot. Orthopedic insoles CAD / CAM (computer-aided design/ computer-aided manufacture) are made on the basis of the digital computer model of patient’s foot. The use of individual orthopedic insoles gives a good therapeutic effect for patients with flat feet, with overloads of the lower limb, with diseases of the vessels, joints and spine.

Insoles of special shape (fig. 3.13F, G) are made for persons with plantar fasciitis, transverse flattening of the foot anterior segment, insoles with a recess for unloading the areas, which are subject to intense pressure in case of burrs and other foot problems.

**TREATMENT OF TRAUMATOLOGICAL AND ORTHOPEDIC PATIENTS IN OUTPATIENT CONDITIONS**

Visits concerning the diseases of the apparatus of movement and support are 8–10 % of all visits to outpatient clinics. The majority (85–90 %) of the total number of injured patients with trauma requires outpatient care. Among those hospitalized patients 95 % complete treatment at the outpatient department. Therefore, the organization of outpatient orthopedic and trauma care has a great importance for reducing the duration of treatment and rehabilitation of patients with injuries and diseases of the musculoskeletal system.

The orthopedic and traumatological office of the outpatient department or hospital is intended for outpatient admission, treatment and aftercare of discharged patients. It is also used for dispensary records of patients after conservative or surgical treatment, with chronic diseases that need to be restored, as well as disabled after trauma, acquired and congenital diseases of the musculoskeletal system.
The doctor carries out:

- ensuring further outpatient treatment of patients, including their treatment at home;
- expertise of temporary incapacity for work of patients;
- accounting for injuries and orthopedic diseases detected in the residents of the served area;
- systematic analysis of the causes of injury and its prevention, organization of first medical aid;
- dispensary supervision of patients;
- providing advice to patients sent from other medical institutions;
- the organization of continuity between outpatient polyclinic medical institutions.

The doctor helps with:

- shallow wounds of soft tissues without signs of inflammation with satisfactory general condition of the victim;
- bruises of various parts of the body without significant hemorrhages in the tissue and common disorders;
- stretching of ligaments of large joints of limbs;
- closed fractures of small segments without displacement.

The main task of medical examination is the maintenance or early restoration of health and working ability of patients, prevention of disability through regular observation, timely treatment, rational employment of patients, prevention of injuries and diseases.

Secondary specialized medical care for patients with traumas and orthopedic diseases in outpatient settings is routinely provided by traumatological and diagnostic centers of the appropriate profile in the outpatient setting, by the administration of the doctor of the outpatient department, the family doctor, in personal encounter or by the delivery of an ambulance.

The trauma station is a subdivision of a hospital or outpatient clinic. It provides twenty-four-hour provision of qualified emergency medical care to patients with injuries of the musculoskeletal system.

For children, the trauma stations are organized at a children's hospital or other medical institution where a child traumatology and orthopedic department is functioning.

A twenty-four-hour trauma station, regardless of the level of the hospital, is located in a separate placement. This placement should have in its structure an antechamber (waiting room), doctor's reception room, X-ray room, plaster and orthesis room, dressing room, operating room, utility rooms. The duty team consists of a doctor, 1 or 2 middle and 1 junior nurse.

The following is performed at the trauma station:

- reposition of fragments of forearm bones, metacarpal and metatarsal bones, shin bones, phalanges of fingers and feet;
- reduction of dislocations of the shoulder, forearm, fingers, feet;
- the application of plaster, immobilizing and orthesis dressings;
- primary surgical treatment of wounds of upper and lower extremities; external bleeding arrest;
- removal of superficially located foreign matters; primary tendon suture of extensors and flexors of fingers;
- Novocaine and other blockages and punctures of the joints;
- active-passive immunization against tetanus; aid against rabies is given.

If it is necessary to provide injured patients with inpatient care, hospitalization is carried out in a specialized department. In case of trauma of the head, chest and abdominal organs, if necessary, the experts such as surgeons or neurosurgeons working in a medical institution are involved...
to resolve the issue of hospitalization of the patient in one of the profile departments. If necessary, primary resuscitation and anti-shock aid are provided to patients with severe trauma.

At the trauma station, the patient is provided with a certificate of injury with recommendations for further treatment, tetanus immunization, X-rays required for further treatment. A disability certificate or domestic reference for up to 5 days is also issued. The patient is sent for further observation and treatment to the orthopedic traumatologist in the clinic at the place of residence.

Consultative and diagnostic centers can be part of hospitals or function as an independent institution.

The main task of the consulting and diagnostic center is to determine the scope of the examinations necessary to clarify the diagnosis and provide counseling to patients who have undergone diagnostic examinations at the center.

Highly qualified doctors of the center render a differential diagnostic complex of medical services in accordance with the developed guidelines for each nosological pathology and capabilities of functional subdivisions the center (radiation diagnosis and computed tomography, functional research methods, ultrasonic and MRI diagnostics, clinical diagnostic laboratory). They give clinical and advisory reports with recommendations for further treatment of patients, offer treatment services in a day hospital, etc. Being in the day hospital, patients receive the necessary medical-diagnostic, counseling and rehabilitation assistance.

In rural areas, outpatient care for injuries is provided at paramedic and paramedic midwife stations. In outpatient clinics of district and central district hospitals it is provided by surgeons, traumatologists. Consultative assistance to complicated patients is provided by specialists from the outpatient department of the regional hospital.

Traumatism is one of the main causes of temporary incapacity; disability and mortality, especially of young and working-age people.

Work on the prevention of traumatism is carried out by health workers of health centers, medical and sanitary units and outpatients clinics, traumatologists of trauma centers, inpatient departments of hospitals. The district traumatologist, who involves public organizations, uses mass media and public education (radio, press, lectures, talks, television, etc.), supervises the work.

**TASKS AND TESTS**

**TASK #1**

The patient after an amputation of the right lower extremity at the level of the upper third of the tibia has an edema and a painful residual with a wound up to 1 cm, as well as a flexural contracture of the knee joint. What is the main reason among the temporary contraindications to prosthetics:

A. Contracture.
B. Edema.
C. Painfulness.
D. A wound on the stump.
E. Contraindications to prosthetics are absent.
TASK #2

The patient of 32 years, 4 years ago had a traumatic dislocation of the left hip. Dislocation was reduced. About 6 months ago there was a pain in the hip joint, worse with walking, painless. Active and passive movements in the joint are limited, painful. The X-rays determine the deformation of the femoral head, the unevenness of its contours, and the spotted pattern of the structure. In the orthopedic-traumatological hospital, a diagnosis was made: aseptic necrosis of the head of the left femur, secondary coxarthrosis of the third degree. Choose the most effective method of treatment.

A. Total endoprosthetics.
B. Calm with unloading of the joint by cuff traction.
C. Calm, drugs that improve microcirculation, physiotherapy.
D. Endoprosthetics with a single-pole endoprosthesis.

TASK #3

The 38-year-old patient was taken to hospital in a shock state with an open fracture of the shin bones in the middle third and the presence of a large mass of tissue crushing. After reducing shock, an amputation of the tibia in the upper third was performed. A blind suture is applied. On the third day there were bursting pains in the stump, hyperemia, marked swelling, pain along the vessels. Body temperature is 39.9°С. During palpation crepitation occurs, and from the fissure of the operating wound, foamy liquid is released. What is needed to accomplish?

A. Remove stitches and perform longitudinal lancing.
B. Remove stitches from stump.
C. Assign antibiotics.
D. Observation in dynamics.
E. Introduce anti-gangrenous serum.

TASK #4

An amputation of the left upper arm in the lower third was performed to a 5-year-old child, injured in a car crash. Prosthetics were not performed. After 2 years at a clinical examination it was revealed: the shoulder stump is conical in shape, the painful butt end of the bonesaw-line is palpable under the skin. What is the tactic of treating a child with a pathological stump?

A. Conservative treatment with physiotherapy.
B. Individual prosthetics.
C. Reamputation.
D. Observation.
E. Temporary prosthetics.

TASK #5

The tractor driver (27 years-old) during field work due to injury gained an open fracture of the shin bones in the lower third, gas gangrene developed. The treatment was ineffective. The doctors' council recommended amputation. Specify the optimal level of amputation.

A. Lower third of the shin.
B. Middle third of the shin.
C. Middle third of the thigh.
D. Upper third of the shin.
E. Exarticulation at the level of the knee joint.
6. Amputation is:
   A. Isolation of the limb at the level of the joint.  
   B. Complete or partial excision of the peripheral part of the limb (organ).  
   C. Detachment of the limb.  
   D. Destruction of the distal part of the limb due to trauma.

7. Is this statement correct – the longer the amputation stump is better?
   A. Yes.  
   B. No.  
   C. There is no significant difference.

8. Amputation optimal for prosthetics is considered to be performed in:
   A. One-stage method.  
   B. Two-stage method.  
   C. Three-stage method.

9. In what cases amputations are called osteoplastic?
   A. When the bonesaw-line is covered with a skin-fascial flap.  
   B. When the bone is covered with a bone graft.  
   C. When the bonesaw-line is covered with muscles.

10. The operation of limb excision at the level of the joint is called:
    A. Amputation.  
    B. Exarticulation.  
    C. Primary surgical treatment.  
    D. Osteoplastic operation.  
    E. Fascioplastic operation.

11. Primary amputation is performed:
    A. When providing emergency surgical care.  
    B. When the limb is completely crushed.  
    C. With complete detachment and crushing of the limb.  
    D. All answers are correct.  
    E. A and B are correct.

12. In hospitals of prosthetic-orthopedic enterprises, it is made for patients:
    A. Permanent prostheses.  
    B. Temporary prostheses.  
    C. Treatment and training prostheses.  
    D. A and B are correct.  
    E. All answers are correct.

13. Express-prosthetics is:
    A. Prosthetics performed immediately after limb amputation.  
    B. Prosthetics performed 5–7 days after surgery.  
    C. Prosthetics performed 1 month after the operation.  
    D. Prosthetics performed 6 months after the operation.

14. Express-prosthetics include:
    A. Creating a primary prosthesis.  
    B. Creating of a medical-training prosthesis on the operating table.  
    C. Creating a temporary prosthesis.  
    D. Creating a permanent prosthesis  
    E. Rapid creating of cosmetic prosthesis.

15. After the amputation of the shin, the stump is fixed with a plaster splint in order to:
    A. Securing the rest of the limb.  
    B. Prevention of flexion contracture.  
    C. Prevention of bleeding.  
    D. Prevention of infectious complications.  
    E. Total listed.
SCAPULA is a flat, thin bone of approximately triangular shape, on all sides surrounded by muscles, basically held by them, movable relative to the thorax and therefore traumatized relatively infrequently. The main function of the scapula is the platform for all movements of the upper limb.

Fractures of the scapula constitute 1 – 1.5 % of the total number of fractures of the bones of the skeleton and are often combined with chest damage (hemopneumotorax, lung injury in 15– 55 % cases, ribs injury in 25– 45 % cases), humerus fracture – 12 %, brachial plexus injury— 5– 10 %, craniocerebral trauma —25 %, internal organs: spleen – 8 % and others.

There are the following types of fractures of the scapula (fig. 4.1).

Fractures of the body and spine of the scapula are mainly stable. They constitute up to 50 % of all scapula fractures. The category of unstable fractures include fractures of the neck of scapula in combination with damage to the acromial or coracoid process, fracture of the clavicle or dislocation of its acromial or sternal end. They significantly violate the anatomical integrity and function of the superior extremity girdle. Such fractures are manly with displacement. Fracture of the glenoid cavity of the scapula is an intra-articular fracture, often combined with a dislocation of the head of the humerus.

The mechanism of trauma. Fractures of the scapula are the result of mainly high-energy injury (accident, catatrauma, etc.). With an indirect mechanism (falling on the abducted arm) fracture of the glenoid cavity, neck, one of the processes of the scapula may occur due to axial compression by the head of the humerus.

Fig. 4.1. Types of fractures of the scapula: 1 – fracture of the acromion; 2 – fracture of the coracoid process; 3 – fracture of the glenoid cavity; 4 – neck fracture; 5 – fracture of the upper inner angle; 6 – fracture of the lower angle; 7 – longitudinal fracture of the body of the scapula.
Clinical picture. Stable fractures of the scapula do not change the shape of the upper arm and can be detected objectively only due to the presence of hematoma and local painfulness in palpation. The limb function is not significantly affected.

In fracture a limited edema due to hemorrhage, painfulness of movements in the shoulder joint, and crepitus, when pressure is applied to the processus, are determined.

The clinical picture of fractures with displacement (unstable) is characterized by alteration of the usual outline of the forelegs. In case of fracture of the neck of the scapula, the shoulder, together with the glenoid cavity of the scapula, is lowered downward. The contours of the scapula are altered (deformation of the foreleg): the acromion protrudes award, and the coracoid process is displaced backward. During palpation, pronounced soreness, crepitation in the neck of the scapula, abnormal mobility of the fragments is present. The limb function is impaired significantly. The integrity of the clavicle and its joints is determined.

Deformation of the shoulder joint with a sharp increase in pain during movements in the shoulder joint, hemarthrosis can be a clinical manifestation of the fracture of the articular cavity of the scapula.

Principles of diagnostics. To confirm the diagnosis, X-rays are performed in a frontal, lateral and, if necessary, oblique projections (fig. 4.2).

It is necessary to assess the condition of the articular surface of the scapula when the humerus is dislocated. During intra-articular fracture it is advisable to perform a computer tomography to determine the location of fragments. Given the possibility of damaging the brachial plexus, it is also necessary to carry out a neurological examination of the corresponding upper limb.

Principles of treatment

Since the scapula is surrounded by muscles that act as a fixation splint, most fractures (90 %) have minimal displacement and patients need only conservative treatment. In stable fractures, the scapula is immobilized with the Dezo's bandage for a period of 6 weeks. In fractures of the neck of the scapula without displacement and processes with a displacement of the fragments, the limb is fixed on the abductive splint or in the plaster thoracobrachial bandage. This prevents the occurrence of secondary dislocations and post-immobilization contracture in the shoulder joint.
Indications for surgical treatment are fractures of the glenoid cavity with a displacement of fragments and unstable fractures of the neck and processes of the scapula. In a patient with multitrauma, surgical treatment is delayed and restoration of vital functions and stabilization of the general condition are carried out. In case of unstable extra-articular fractures of the neck of the scapula and clavicle, it is first necessary to perform the metal osteosynthesis of the clavicle to stabilize the shoulder. This often leads to the reposition of the scapula fragments and the solution of the issue of the need for metal fixation of the scapula fragments under displacement conditions.

With stable fixation of fragments of the scapula in the postoperative period, temporary immobilization with the Dezo’s bandage or cravat bandages with subsequent early passively active development of movements in the shoulder joint is used for several days. A complex physiotherapeutic treatment (UHF, diathermy), massage the muscles of the upper limb are performed.

FRACTURE OF THE CLAVICLE

Functions of the clavicle:

- increases the strength mechanism of the upper limb;
- protects the neurovascular bundle (subclavian vessels, brachial plexus);
- place of attachment of the muscles of the shoulder joint.

Fractures of the clavicle constitute 10–15 % of the total number of bone fractures of different localization. More often, clavicle fractures occur in men of young age.

The mechanism of trauma. Fractures are inherent in the indirect mechanism of occurrence – falling on the shoulder and elbow area (90 %) or on the straight arm (1 %). A direct mechanism of injury is also possible with a strike in the clavicle area (9 %).

Site of the clavicle fracture:

- 80 % – at the border of the middle and external third of the body;
- 12 % – the middle third of the body;
- 7 % – the acromial (lateral) end;
- 1 % – sternal (medial) end.

Fractures are mainly with displacement, less often – without displacement of fragments (in children – subperiosteal, incomplete). Typical is the displacement of the central fragment up and back, which is due to reflex contraction of the sternocleidomastoid muscle, and peripheral – down and forward due to the weight of the upper limb and contraction of the deltoid and pectoral muscles.

Clinical picture. Patients complain of pain in the injured area, restricted movements of the upper limb. Edema in the area of fracture of the clavicle is present, supraclavicular fossa is smoothed. Deformation is revealed (fig. 4.3). The forearm in the side of injury is shortened.

With palpation, local soreness is noted; pathological mobility and crepitation of fragments are present. When the forearm is compressed in the frontal plane, there is an increase in pain in the fracture area.

Principles of diagnostics. To confirm the diagnosis, it is necessary to perform an X-ray of the clavicle in a frontal projection (fig. 4.4). If necessary – in the projection with the bend of the trunk backwards – “lordose” projection is settled.

Principles of treatment. Conservative treatment for clavicle fractures include about a hundred types of dressings and splints for comparison and fixation of fragments. In fractures of the clavicle
without displacement and subperiosteal fractures of the type of the "green branch" in children immobilization with figure-of-eight bandage or Delbe’s rings for 2–3 weeks (with tightening them on days 3 and 7–9), in adults – 4–6 weeks. In uncomplicated fractures with displacement, after local anesthesia with a solution of novocaine 0.5 % or lidocaine 0.5 % – 10–15 ml, one-stage apposition of the fragments should be performed. For this, it is necessary to observe the technique of correcting the peripheral fragments – lifting the forearm upwards and deflecting it back and outward – on the central fragment. In this position, limb is fixed with the splint of Kuzminsky, Chizhin, Beler, etc. (fig. 4.5). The average period of immobilization is 4–6 weeks. The period of working incapacity for work is 6–8 weeks.

**Surgical treatment of clavicle fractures is performed under certain indications. The absolute indications are:**

- open fracture;
- closed fracture, complicated by damage to the neurovascular bundle, compression of the nerve plexus, pneumothorax;
- a comminuted fracture with a position of fragments, which threatens skin lesions or a neurovascular bundle;
- interposition of fragments (muscular, periosteal, bone).

Relative indications are the inability to keep fragments in the corrected position with a bandage or splints, an ununited fracture of the clavicle.

Surgical treatment consists in an open reposition of fragments and their fixation by a rod, conducted intramedullary or bone-plate and screws (fig. 4.6). After the operation, the upper limb is immobilized with a Dezo’s bandage or a cravat bandage for 2–4 weeks.

With an open fracture or damage to the skin, the fixation of the fragments is possible with a rod external fixation device.

**N.B. Fractures of the clavicle:**

- more likely to occur in children;
- have mainly direct injury mechanism;
- 80 % of the fracture localization is at the border of the middle and outer third of the body;
- conservative treatment is used most often;
- surgical treatment has limited indications;
- even with improper healing, functional disorders are not expressed.
Fig. 4.5. Fixing bandages for the clavicle fractures: A – figure-of-eight bandage; B – Delbe’s rings; C – Kuzminsky’s splint; D – Chizhin’s splint

Fig. 4.6. X-rays of the clavicle in a frontal view – fracture of the clavicle in the middle third, fracture of the clavicle synthesized by the plate of the bone MOC

DISLOCATION OF CLAVICLE

Due to the joints, the clavicle can rotate to 45°, which is important in the biomechanics of elevation of the hand.

Dislocations of the clavicle occur 5–6 times less often than fractures, and constitute 3–15 % of all dislocations. They are more common in men of working age. There are dislocations of the clavicle in the acromioclavicular and sternoclavicular joints, complete and incomplete.

Dislocation of the acromial end of the clavicle occurs as a result of direct and indirect trauma. With the dislocation of the acromial end of the clavicle, its displacement occurs upward. In the complete dislocation, the clavicular-acromial and coracoclavicular ligament are ruptured, while for the incomplete fracture only the acromioclavicular ligament is ruptured (fig. 4.7).
Clinical picture. Step-like deformation in the region of the shoulder girdle is present. During palpation protrusion is painful. The "piano key" sign is pathognomonic: when pressed, the acromial end of the clavicle is reduced (immersed), if released, it returns to the initial position of the dislocation. Movement in the shoulder joint is limited due to pain in the acromioclavicular joint area. X-ray of the clavicle-acromial junction is performed in a frontal projection (fig. 4.8).

Principles of treatment. Fresh incomplete dislocations are reduced under local anesthesia. It is rather difficult to hold the reduced end of the clavicle. A plaster bandage of Pogorelsky, Shimbaretsky with a cotton-gauze bandage is used (fig. 4.9). However, it is not always possible to achieve healing of ligaments in the resuted position of the clavicle, the bandages are cumbersome, heavy and uncomfortable. Fixation lasts 4–5 weeks. Therefore, more preferable surgical treatment is the elimination of dislocation, the metal osteosynthesis of the clavicle to the acromion by one of the methods (with Weber’s wires and cerclage, a screw or an bone metal osteosynthesis hook-shaped plate), suturing the ruptured coracoclavicular ligament. After surgery, the limb is fixed with a cravat bandage for 2–3 weeks. Working capacity is restored after 7–8 weeks for treatment of complete dislocation and 5–6 weeks – for the treatment of incomplete dislocation.
Dislocation of sternal end of the clavicle

The indirect mechanism of injury prevails. Dislocation is rare.

Clinical picture. Step-like deformity (with anterior dislocation) or soft tissue recession (with posterior dislocation) in the sternoclavicular junction. Palpation of the area of deformation is painful. The displacement of the sternal end of the clavicle may be forward – anterior (episternal) and backward – posterior (retrosternal) dislocation (fig. 4.10).

Principles of diagnostics and treatment. The diagnosis is confirmed by chest X-ray in two projections or by CT. The reposition and fixation of the sternal end of the clavicle by a conservative method is usually ineffective. Therefore, preference is given to surgical treatment, the essence of which lies in the open repositioning of the dislocation and fixation of the clavicle to the sternum with the help of two wires or a transosseous ligature capronic suture (fig. 4.11).

After the operation, immobilization is 4–5 weeks. Rehabilitation is carried out within 2–3 weeks. The working ability is restored in 7–8 weeks.

SHOULDER DISLOCATIONS

Traumatic shoulder dislocations rank first among all dislocations. This is due to the anatomical and physiological characteristics of the shoulder joint: the globular head of the humerus and the flat glenoid cavity of the scapula, the lack of correlation in their sizes, the large joint cavity, the weakness of the capsular-ligament apparatus, especially in its anterior regions, the largest volume of movements in the joint.

"Achilles heel" of the joint is the lower part of the capsule – a weak spot in anterior dislocation of the shoulder.
According to the location of the head of the humerus, the dislocation can be:
- Anterior (95 %):
  - subcoracoid;
  - subclavian;
  - subgloidoid (subglenоidea).
- Posterior (5 %).

The mechanism of injury is mostly indirect: falling on the abducted arm in the position of the external rotation of the upper arm.

Clinical picture. Severe pain is present. In the case of anterior dislocation, the patient holds the injured limb in a forced position: abduction, external rotation and some deviation backwards. The abduction is sharply painful. With inferior dislocations, the patient holds the forearm and hand in the raised position or above the head.

The shoulder joint is deformed: the subclavian fossa is flattened, the acromion protrudes under the skin, and the occlusion is beneath it. Compaction is in the posterior and protrusion is in the anterior part of the joint. Positive symptom of a spring fixation is present during trying to perform passive movements. During comparative palpation alteration of the ratio of bone landmarks is determined; it is impossible to determine the head in a normal position relatively to the acromion and glenoid cavity of the scapula. It is palpated in an unusual place for it. Coracoid process is not defined.

When examining a patient with a dislocation, it is necessary to determine the pulsation of peripheral vessels, which can disappear due to the compression of the subclavian artery. It is necessary to test the motor and sensory functions of the long branches of the brachial plexus and axillary nerve. Check the tests for integrity of the rotator cuff of the shoulder, which is formed by the supraspinal, the sub-floor, the teres minor, subscapular muscles.

The leading additional investigation method is X-ray (fig. 4.12). Without its performance, a final diagnosis and efforts to eliminate the dislocation should not be made.

![X-rays: a) anterior dislocation of the shoulder, b) anterior dislocation of the shoulder with fracture of the greater tubercle of the humerus (fracture-dislocation)](image)
Treatment. Dislocation of the shoulder is reduced in order of emergency care under local anesthesia (30–40 ml of 0.5 % solution of novocaine is injected into the joint) or under intravenous narcosis. The decrease of the pain sensation to the patients and the relaxation of the muscles of the shoulder girdle are important for the reduction. There are many methods of correction (Hippocrates, Mukhin-Motu, Dzanelidze, etc.). The Kocher method is the most sparing, effective and widespread (fig. 1.58).

After the reduction, the control X-ray is performed, the Dezo’s plaster bandage is applied for 3 weeks, and then the relative immobilization is continued with the bandage for 3 weeks. Rehabilitation program lasts 4–6 weeks and includes: exercise therapy, physiotherapy, massage, manual therapy of the joint. The patient is forbidden to perform excessive external rotation of the hand, specific physical exercises for 6 weeks, so as not to provoke a recurrence of the dislocation.

Chronic (from 3 days to 3 weeks), old (more than 3 weeks) shoulder dislocations, dislocations with a fracture of a large tubercle of humerus, under anesthesia. If it is ineffective – reduction with the restoration of damaged tissues in a surgical method is performed.

Habitual dislocation of the shoulder

After a primary traumatic shoulder dislocation, dislocations may occur on average in 22.4 % of young patients. Dislocations occur without significant effort – just abduction and rotation of the arm in the shoulder joint.

The reason for the habitual dislocation is:

- avulsion of the labium with a capsule from the edge of the glenoid cavity of the scapula – damage of the Bankart (85 %);
- impression fracture of the anterior margin of the glenoid cavity of the scapula;
- bone posttraumatic defect of the posterior part of the head of the humerus (Hill-Sachs’ injury).

The habitual dislocation of the shoulder can be facilitated by gross manipulations when reducing the primary dislocation, failure to perform anesthesia while refilling, insufficient immobilization or lack of it, and early inadequate physical load.

Diagnostics. Positive symptoms of instability of the shoulder joint are determined. X-ray, MRI and ultrasound of the shoulder joint are performed.

Treatment. The cause of a habitual dislocation is eliminated in a surgical way: in case of Bankart injury, re-fixation of the labia with capsule to the edge of the articular surface of the scapula is used. In case of the bone defect of the edge of the scapula cavity, bone-plastics surgeries of Latarze and other methods are used. Preference is given to the arthroscopic technology of the surgery.
Fractures of the humerus are 7–12% of all bone fractures and divided into fractures of proximal epimetafysis – 65%, diaphysis – 20%, distal epimetafysis – 15%.

Fractures of the proximal humerus

The mechanism of the trauma. They occur more often due to indirect mechanical origin of the trauma.

Classification of fractures according to the segment:
- head of the humerus;
- anatomical neck;
- greater tubercle;
- lesser tubercle;
- surgical neck.

The muscles, attached to the greater tubercle, are external rotators and elevators of the shoulder: supraspinal, subspinal, teres minor. To a lesser tubercle subscapular muscle is attached – the inner rotator of the shoulder. A sulcus lies between the tubercles, in which the tendon of the long head of the biceps passes. Below the surgical neck, a greater pectoral muscle is attached to the humerus.

The multidirectional action of these muscles creates a wide range of displacements of the above-mentioned segments of the proximal part of the upper arm.

The number of displaced segments is the classification of fractures of the proximal humerus according to Neer:
- single-fragment;
- two-fragment;
- three-fragment;
- four-fragment.

Isolated fracture of greater or lesser tubercle occurs due to detachment mechanical genesis (avulsion fracture).

Fractures of the surgical neck occur most often, especially in the older age, and are divided into three types (fig. 4.13).

The abduction fracture of the surgical neck is formed when falling onto the abducted arm, the angle of deformation between the humerus head and the humerus is open to the outside. When falling on the arm, an adduction fracture with a deformation angle opened to the inside is formed.

Clinical picture. According to the type of fracture and the nature of the displacement, the following likely symptoms occur: the forced position of the limb, active and passive movements sharply increase the pain, are significantly limited; section of the shoulder joint is oval, uniformly deformed, smooth contours, local pain. Reliable symptoms are pathological mobility, crepitation of bone fragments, axial pressure on the shoulder increases pain, possibly subcutaneous protrusion of the bone fragment. A specific symptom is the palpation of the edge of the turned head. X-rays in two projections (the second projection – transthoracic or axial) specify the type of fracture and the degree of displacement of fragments.

Treatment. The complex of first aid activities provides anesthesia, transport immobilization according to one of the possible methods: the modeling by the posterior ladder splint of Cramer or the cravat bandage.
Fig. 4.13. Typical fractures of the surgical neck of the shoulder:
A – impacted, B – adducting, C – abducting
Fixation of the limb by a bandage or a cravat bandage may also be a treatment measure in patients, especially in the elderly, with fractures of the proximal humerus with an allowable displacement (fig. 4.14, 4.15). With fractures without dislocation in active patients, the limb is fixed with the posterior plaster splint from the healthy shoulder to the head of the metacarpal bones. With the adduction type of fracture of the surgical neck, detachable fracture of the greater tubercle, the limb is fixed on a wedge-shaped cushion or in a thoracobrachial plaster bandage in the abducted arm position (fig. 4.16).

Immobilization continues until signs of fracture healing within 4–7 weeks.

Fractures with displacement, especially in children, are corrected simultaneously or treated by skeletal traction with subsequent fixation in a plaster bandage. If the reposition fails, or prolonged immobilization is undesirable, open reposition and metal osteosynthesis with the plates on the screws in adults (fig. 4.17A, B), in children – with Kirschner’s wires are performed. With 4-fragment fractures, re-
Injury of bones and joints of the upper extremity

section of fragments, bone stump formation, biceps suturing with shortening or primary endoprosthesis of the shoulder joint is performed (fig. 4.17).

During the treatment, the control X-rays are performed. Particular attention is paid to early, stage complex rehabilitation by developing active-passive movements from 4–5 days after removal of immobilization. Working ability is restored in 6–8 weeks.

Fracture of the diaphysis of the humerus in the middle third

The mechanism of injury. More often, a fracture occurs with a direct mechanism of injury (transverse, comminuted fractures) — as a result of an accident, hit or gunshot wound. More rarely an indirect mechanism of injury (oblique, helical fractures) as a result of falling or arm wrestling occurs. The so-called "flexor mechanism" is characteristic: the proximal part of the upper arm is fixed in the shoulder joint, and the force is applied to the distal part of upper arm, which leads to a fracture in the middle third of the upper arm (fig. 4.18).

Principles of diagnosis and treatment. The fracture of the humerus is characterized by all the typical signs of fractures (pain, swelling, deformity, abnormal mobility of fragments, shortening of the limb). X-rays made in two projections, specify the degree of displacement of fragments. Fractures of the diaphysis, especially at the border of the middle and lower third, are often accompanied by damage to the radial nerve.
The radial nerve in the axillar region is behind the axillary artery, exits behind the humerus below the large round muscle and enters the interval between the long and medial heads of the triceps muscle of the shoulder. It lies in the spiral canal (canal of the radial nerve) at the border of the middle and lower third of the upper arm and round the bone, perforates the lateral intermuscular septum and exits into the anterior part of the upper arm. At the level of the lateral epicondyle it is divided into 2 branches: superficial (sensitive) and posterior deep interosseous (motor), which goes to the forearm.

Injury of the radial nerve is manifested by the wrist drop – the lack of active extension in the wrist joint and the abduction of the first finger, loss of sensitivity of the back surface of the hand and the first three fingers in the distal phalanges. When examining the patient, one should also compare the pulse on both radial arteries, since in this type of fracture, there is often a damage to the brachial artery.

Most fractures of the humerus diaphysis can be treated conservatively with a plaster bandage: in the upper third (above the place where the deltoid muscle is attached) on the branch line (with a bent elbow joint up to 90° and the shoulder withdrawal up to 40–45°), in the middle and lower third thoracobrachial bandage is used. Consolidation comes in 8–10 weeks. Surgical treatment is indicated for soft tissues, for primary and secondary damage to the radial nerve and vessels, for multiple, multi-fragment open fractures. For osteosynthesis, plates (DCP or LCP), intramedullary blocking rods, external fixation devices are used (fig. 4.19).

N.B. Anatomico-biomechanical features in this site of a fracture:
- physiological overextension in the elbow joint (elasticity of the anterior ligaments of the joint);
- physiological valgus angle in the elbow joint in women up to 110° in full extension;
- overextension converts the axial action of the traumatic force into an arc tension. The maximum concentration of the pressure of olecranon is on the distal humerus;
- strength of anterior ligaments of the joint;
- features of bone anatomy:
  - flattening of the bone: it is not a cylindrical, metaphyseal part (trabecular structure, thin cortical layer);
  - growth zone;
  - three fossae: coronary, radial, ulnar.

![Fig. 4.19. Techniques of osteosynthesis of fractures of the humerus diaphysis: A – fixation by intramedullary blocking rod; B – fixation by rod apparatus of external fixation; C – plate fixation](image-url)
Fractures of the distal segment of humerus

Supracondylar fracture of humerus. These fractures are related to extra-articular injuries. Most often this type of damage occurs with an indirect mechanism of injury – a falling on the over-extended arm. More often it occurs in children and women.

The extension type (97.7 %) – the acute anterior margin of the proximal humerus fragment. The fracture line goes up and backward. The flexion type (2.3 %) is the acute posterior edge of the proximal humerus fragment. The fracture line goes downward and forward. Rotational forces cause displacement of the distal fragment inside (cubitus varus) or, less often, outward (cubitus valgus).

Principles of diagnostics and treatment. In supracondylar fractures of the humerus, there are all typical signs of a fracture (pain, swelling, pathological mobility of fragments, crepitus, shortening of the upper arm). The intense swelling and pronounced S-shaped deformity of the upper arm in the lower third are visualized, and movements in the elbow joint are sharply limited (fig. 4.20). The bone landmarks of the elbow joint are not changed (there is no deformation). The equilateral triangle of Hunter (fig. 1.4) is preserved between three points: the medial, lateral epicondyle of the humerus and the apex of the olecranon in the 90° position of flexion in the elbow joint. The line of Marx is not elevated (fig. 1.4) – these points are located on the same line in the position of full extension in the elbow joint.

Using X-ray in two projections, the type of displacement of the fragments is determined (fig. 4.21).

With an extension type of fracture, an acute proximal segment may damage the median nerve, the brachial artery, or compress them in a circular plaster bandage (fig. 4.22). In case of damage to the median nerve, a disturbance of sensitivity along the palmar surface of I, II, III fingers of the hand and the inner half of the IV finger are characteristic. There are motor disorders – absence of pronation of the forearm, opposition of the I finger, flexion of I, II, III and IV fingers in the interphalangeal joints.

In fractures without displacement, the upper limb is fixed with a plaster splint on the back surface of the upper arm with the elbow joint flexing at an angle of 90°. In fractures with a displacement of fragments, an attempt of one-step reduction under local or short-term general anesthesia is made instantly and then fixation with a circular plaster bandage in a position medial between pronation and supination and hyperflexion in the elbow joint. The patient remains in the hospital under the supervision of a doctor during the day. In case of an unsuccessful attempt of closed reposition, surgery is performed. For metal osteosynthesis, plates with screws, external fixation devices are used.

Technique of closed manual reposition. During reposition, the lateral and rotational dislocation is first eliminated, then the posterior dislocation of the distal fragment along the proximal one. The assistant performs opposition with the middle-lower third of the upper arm, the doctor manipulates with the distal fragment into traction along the length (fig. 4.23A). It is possible to compare the fragments by traction along the length. To keep fragments, the doctor performs slight supination and flexion of the forearm (fig. 4.23B, C, D), followed by fixation with a plaster bandage.
From the first days after reduction, the patient is allowed to move in the shoulder, wrist and interphalangeal joints. After 4–6 weeks in adults, and after 14–21 days in children, the plaster bandage is removed and movements in the elbow joint begin to be developed. Massage and thermal physiotherapy are contraindicated, as they contribute to the formation of ossifying myositis, the formation of excessive bone callus and osteophytes, contracture of the elbow joint.

**Fractures of the condyles of the humerus.** Fractures of the condyles of the humerus refer to the intra-articular fractures of the humerus. In 16.8% of cases the distal epimetafysis fractures of the humerus are combined with a dislocation of the forearm or a fracture of the olecranon.
There are the following types of fractures of the humerus condyles:

- Fracture of the external (lateral) condyle of the humerus;
- Fracture of the internal (medial) condyle of the humerus;
- Frontal fracture of the head of the trochlea;
- T- and V-shaped intercondylar fractures of the humerus.

Fracture of the external (lateral) condyle of the humerus occurs as a result of a falling on the flexed elbow joint; accompanied by a deviation of the forearm to the outside, the internal (medial) condyle – to the inside. Frontal fractures of the trochlea, head elevation occur during falling on the wrist with the extended elbow joint. T- and V-shaped, intercondylar fractures occur due to the significant effect of the traumatic force, which influences along the axis of the humerus directly on the back surface of the elbow joint with the flexed forearm. There is a splitting of the condyle of the humerus on the olecranon, which is wedged between them. Their displacement in the frontal plane in different directions occurs.

Clinical picture. During intra-articular fractures, local pain, crepitation of bone fragments in the elbow joint, hemarthrosis of the joint are determined. When examining, the contours of the elbow joint are deformed – the Hunter’s triangle, the line of Marx, the axis of the upper limb are changed. The function of the joint is impaired. The limb axis is altered (cubitus valgus, varus). Axial rotational loads cause pain in the elbow joint. Often fractures injure the ulnar nerve. The patient notes numbness or hypesthesias of the IV-V fingers of the hand and the impossibility of their full extension.

Principles of diagnostics and treatment

X-ray and CT performance specify the type of fracture and the kind of fragments displacement. In fractures without displacement of fragments, the treatment consists in fixing the elbow joint with a back plaster splint from the upper third of the shoulder to the heads of metacarpals with a forearm flexed to 90° in the semipronation position for 4–5 weeks. In case of displacement of fragments, a closed reposition is performed under local or general anesthesia and fixation in the back gypsum tire. The impossibility of a closed reposition of fragments (restoration of congruence of articular surfaces) or their secondary displacement is an indication for surgical treatment – open reposition and fixation of fragments by a compression screw or Kirschner’s wires.

Similar therapeutic tactics is used for fracture of the internal condyle.

Frontal fractures of the trochlea, the head are complex fractures of the elbow joint and in all cases require open reposition and osteosynthesis with the direction of the screws or wires from the back to the anterior side.

For the possibility of assembling the fragments and osteosynthesis of the T- and V-shaped fractures of the distal epimetaphysis of the humerus, surgical access is used with the osteotomy of the olecranon and fixation of it in the end of the operation with a screw.

In the case of a T-shaped fracture, where the horizontal plane of the fracture passes above the condyle, in adults for osteosynthesis reconstructive plates are used along the medial and lateral margins of the distal metaepiphysis of the humerus.

N. B. Features of supracondylar fractures of humerus:

- In children take the second place after fractures of the bones of the forearm;
- Potential anatomical and biomechanical fracture factors;
- In 98% it is extensor type of fracture;
- Restoration of radiological anatomy of the bone is important;
- Closed reposition is complicated;
- For open reposition there are specific indications;
- Cubitus varus is a frequent complication.
DISLOCATIONS OF THE FOREARM

They take second position after shoulder dislocations. There are the following dislocations of the bones of the forearm:

I. No rupture of the proximal radioulnar joint:
   - Posterior (90 %):
     a) posterior-lateral;
     b) posterior-medial.
   - Frontal.

II. With a rupture of the proximal radioulnar joint (divergent dislocation): medial-lateral.

The mechanism of trauma. Posterior-lateral dislocations occur when falling on an straightened arm in a position of slight flexion in the elbow joint. During falling, the valgus deviation and twisting of the arm changes the axial load and it ruptures the ligaments of the joint.

Diagnostics. The patient keeps the injured arm in a forced position with a healthy arm. Deformity of the elbow joint with a violation of the bony landmarks – the Hunter’s triangle, the line of Marx; the tension of the triceps muscle is present (fig. 4.24). The axis of the limb is also changed – the forearm deviation appears. Active movements in the joint are impossible, and passive movements are sharply painful and springy. In the posterior dislocations due to injury of the ulnar nerve neurological disorders are possible. In the anterior dislocation the injury of the median, deep branch of the radial nerves or compression of the artery occurs.

The diagnosis is specified with X-ray in two projections (fig. 4.25).

Treatment. Dislocation of the forearm is reduced in urgent order under local anesthesia (30–40 ml of 0.5 % solution of novocaine is injected into the joint) or under intravenous anesthesia.

Technique of reduction of the posterior dislocation: the assistant creates traction from the forearm along the axis of the upper arm at the position of 70° flexion in the elbow joint. The surgeon first removes the lateral displacement, and then grasps the lower third of the shoulder with the palms of his hands. That creates a countertraction. Doctor presses with his first two fingers on the apex of the elbow and reduces the dislocation. The moment of reduction is accompanied by a slight click. The upper limb in the middle physiological position is fixed with a posterior plaster splint from the shoulder to the wrist joint. The control X-ray is performed. Immobilization lasts 3 weeks. It is not recommended to massage the joint area, thermal procedures that promote scarring and the appearance of paraarticular ossification. Workability is restored in 6–8 weeks.

Fractures of the olecranon. Fractures of the olecranon refer to intra-articular fractures, account for 1–1.5 % of all fractures of the bones. The cause of such fractures is the influence of direct traumatic force – a hit when falling on the elbow. Fractures are possible due to a sudden contraction of the triceps arm muscle, the so-called “avulsion fractures”, since the muscle is attached directly to the olecranon. Fractures of the olecranon are mainly with displacement, are divided according to the plane of the fracture into transverse and oblique-transverse; according to localization – to fractures of the apex, fracture of the body and multi-fragments fractures (fig. 4.26).

N.B. Possible consequences of intra-articular fractures:
- contracture in the elbow joint;
- impairment of the growth zone;
- slow union, non-union and vicious union;
- cubitus valgus, cubitus varus;
- neuropathy of the ulnar nerve;
- avascular necrosis of the fragment;
- posttraumatic osteoarthritis.
Principles of diagnosis and treatment. During palpation sharp soreness at the site of the fracture is determined. The contours of the elbow joint are deformed due to the displacement of the olecranon, hemarthrosis. Active movements, extension in particular, in the elbow joint are significantly limited. Passive movements increase pain. Positive pain symptom with axial load is present. There is a change of the Hunter’s triangle.

Diagnostics of fractures of the olecranon is based mainly on clinical signs and data of X-ray examination. During examination of children, it should be remembered that the nucleus of ossification of the olecranon appears at the age of 10–12, and their fusion at the age of 16–18. Therefore, adolescents need to use comparative X-ray with the opposite elbow joint.

Treatment. On the lateral X-ray, an assessment of the degree of displacement of fragments is decisive in the choice of the method of treatment. Conservative treatment is chosen for fractures of the olecranon without displacement or when the diastase between fragments is up to 4 mm. If the distance between the fragments is 5 mm, a one-stage reposition of fragments and plaster immobilization of the upper arm and forearm to the base of the fingers should be performed at an angle of 100–120° in the elbow joint and in the middle position between the supination and pronation for up to 4–6 weeks. Control X-ray is mandatory.

If there is a separation of fragments more than 0.5 cm there are indications for surgical treatment – osteosynthesis of fragments of the olecranon with the obligatory elimination of the interposition and restoration of the integrity of the tendon of the triceps muscle of arm.
Fractures of the head and neck of the radius. Such fractures result from an indirect injury when falling on a straightened arm. At the moment of the collision, the forces of resistance act on the forearm, which is diverted outward, and the head of the radius hits the head eminence of the humerus.

Fractures of the neck and the head of the radial bone are divided into groups (fig. 4.27):

**Principles of diagnostics and treatment.** The elbow joint is enlarged due to hemarthrosis. Sharp soreness in the external part of the joint with the rotation of the forearm is determined with palpation. Deformation in the form of cubitus valgus is possible. The nature of the fracture and the degree of displacement of fragments are determined with X-ray in two projections. If necessary, it is supplemented in the position of supination-pronation of the forearm, as well as in the anterior-posterior projection – when flexing in the elbow joint.

In fractures of the head and neck of the radius without displacement of the fragments, conservative treatment is indicated. The forearm is bent at the elbow joint at an angle of 90–100° and fixed in the middle physiological position by the posterior plaster splint from the upper third arm to the head of the metacarpal bones. The period of immobilization in adults reaches 3–4 weeks, and in children – 10–14 days.

Fracture with displacement is an indication for surgical treatment. With marginal fractures of the head, a small fragment is removed. A large fragment should be carefully repositioned and fixed with a screw or a figured plate. With a comminuted fracture, the fragments are removed, the annular bundle is necessarily retained. Good results of treatment are achieved by endoprosthetics of the head. After the operation, the immobilization regimen mentioned above is used. Removal of the head of the radial bone in children is unacceptable. In the rehabilitation period, the main task is the prevention of contracture. Particular attention is paid to the restoration of rotational movements.

**Fractures of the bones of the forearm.** It is 30% of all bone fractures. According to localization, fractures of the forearm bones are divided into:
- fractures of both forearm bones;
- isolated fracture of radius or ulna;
- fracture-dislocations of Monteggia or Galeazzi;
- fracture of the radius in a typical site with or without avulsion of the styloid process of the ulna.
Fractures of the bones of the forearm are possible as a result of a direct mechanism of injury (hit) or indirect mechanogenesis. It is possible also when falling on a straightened arm with the support of the palm or the dorsum of the hand. Isolated fracture of the diaphysis of the radial bone occurs as a result of a direct impact, less often – with a fall with support on the palm. With an isolated fracture of the diaphysis of one of the forearm bones, displacement of fragments along the length does not happen, due to the integrity of the intact twin bone.

With the fracture of both forearm bones, the displacement of the fragments is interrelated, due to the tension of the surrounding muscles. With a fracture in the upper third, the proximal fragment of the radius is displaced anteriorly and supined, and the peripheral part of the forearm under the influence of a round and quadrate pronator is in pronounced pronation.

With diaphyseal fractures of the forearm bones in the middle third, the proximal fragment of the radius is held in the middle position between supination and pronation, the distal one is pronated. In the diaphyseal fractures in the lower third of the forearm bones, its distal part and hand are in the position of pronation.

**Isolated fracture of the diaphysis of the radius or ulna.** Isolated fracture of the diaphysis of the radius is more common than the ulna’s.

**Principles of diagnostics and treatment.** Palpation is determined by soreness. Crepitation of bone fragments is possible. Positive symptom of the axial load on the broken bone is present. Forearm fractures are diagnosed with X-ray of the injured segment with adjacent joints.

With diaphyseal fractures of one of the bones without displacement of fragments, the forearm is fixed in the back plaster splint from the middle of the upper arm to the heads of metacarpal bones for 5–6 weeks in the middle position of the upper limb. In cases of transverse fracture of one bone with displacement of fragments, reposition is performed and the limb is fixed with a similar plaster bandage for a period of 6–8 weeks.

In oblique and comminuted isolated fractures of the ulna or radius diaphysis, the fragments tend to its repeated shift (unstable fractures). Therefore, open reposition of fragments with bone osteosynthesis or intramedullary osteosynthesis is used.

The period of adhesion is 6–8 weeks, the working capacity is restored in 2–3 months.

**Fracture of both forearm bones.** **Principles of diagnostics and treatment.** During examination, the arm is in a forced position. Edema, deformation, and sometimes shortening of the segment are determined. During palpation soreness in the area of fracture and pathological mobility is determined. During supination, crepitation of fragments occurs. The symptom of the axial load is positive. X-ray of the fracture site with adjacent elbow and radiocarpal joints is performed (fig. 4.28).

In case of fracture of the diaphyses of both bones of the forearm without displacement of the fragments, the limb is fixed by the posterior plaster splint from the middle of the upper arm to the heads of the metacarpal bones in the position of flexion of the forearm at the elbow joint to 90° and the semipronated forearm. With subperios-

**Fig. 4.28. Transverse fracture of diaphyses of both forearm bones**
teal fractures in children, one cannot even leave a slight angular displacement, since the deformation progresses with the age of the child. The term of immobilization in adults is 1.5–2 months, and in children 3–4 weeks. The period of incapacity for work is 2.5–3 months.

In fractures in the upper third of the forearm diaphyses for the correction of fragments, a distraction should be performed. The peripheral fragments should be translated to the maximum supination position and compared with the central ones.

In fractures in the middle third, the forearm fragments should be placed in the middle position between the supination and pronation. After the fragments are repositioned, the position of the forearm in the plaster splint should be similar.

In fractures of the bones of the distal end of the forearm, fragments must be inserted in some pronation; in the same position they are fixed in a plaster bandage from the middle third of the shoulder to the heads of the metacarpal bones.

However in most cases, the fragments cannot be fixed, especially with oblique, helical and multi-fragment diaphyseal fractures of both forearm bones. Therefore, open reposition and metal osteosynthesis using plates, intramedullary blocking rods of external fixation devices are carried out.

FRACTURE-DISLOCATIONS OF THE FOREARM BONES

**Fracture-dislocation of Monteggia** is a fracture of the upper or between the upper and middle third of the ulna with displacement of the fragments at an angle with simultaneous dislocation of the head of the radius in the elbow joint. It occurs from a direct hit on the flexed in elbow and straightened forearm, with protection from the hit or when falling on a curb or other solid obstacle (fig. 4.29A).

**Fracture-dislocation of Galeazzi** is a fracture of the radius, as a rule, on the border of its middle and lower third, and dislocation of the head of the ulna in the radiocarpal joint. It occurs when falling onto a straightened and pronated arm resting on the palm or the dorsum of the hand. Less often it occurs from a direct hit to the forearm (fig. 4.29B).

**Principles of diagnostics and treatment.** With the fracture-dislocation of Monteggia, the forearm is shortened, swollen. During palpation, soreness, pathological mobility and deformity of the ulna are determined. The head of the radius is located in front of the elbow joint. Active flexion and rotation movements in the elbow joint due to pain are limited, passive movements are elastic.

When examining a patient with Galeazzi fracture-dislocation, there is edema in the area of the diaphysis of the radial bone, protrusion of the head of the ulna during motion – pathological mobility
and crepitation of bone fragments, a positive symptom of the axial load. To determine the nature of the displacement of fragments, X-rays of the forearm with adjacent joints are performed in two projections (fig. 4.30).

In the presence of a Monteggia’s fracture-dislocation under general anesthesia traction of the wrist and complete supination of the forearm is performed, eliminating the angular and lateral displacement of fragments of the ulna with simultaneous immersion of the head of the radius. The surgeon presses a finger on the protruding head of the radius and simultaneously bends at the elbow the supine forearms to an angle of 50–60°. The limb is fixed with a back plaster splint from the upper third of the upper arm to the heads of the metacarpal bones in adults for 5–6 weeks, and in children – for 2–3 weeks. In the case of soft tissue interposition between the fragments and the irreparability of the dislocated head or a recurrence of the dislocation that is constantly arising, an open reposition of the ulnar bone and metal osteosynthesis is performed. The head of the radius is repositioned and the ligamentous apparatus is restored.

Patients with Galeazzi’s fracture-dislocation can be treated conservatively. To do this, under the anesthesia, traction along the axis of the radius bone is performed, the fragments of which are repositioned and the dislocation of the ulna head is simultaneously reduced. The limb is fixed with a deep plaster splint from the upper third of the upper arm to the base of the fingers, with the elbow bent at 90° and the supined forearm. The period of fixation in the splint is 2–2.5 months. Assign the development of movements in the joints, massage and physiotherapy. Duration of incapacity for work – 3–3.5 months. When interpreting soft tissues and the impossibility of reinforcing the radius, osteosynthesis with a plate or an intramedullary rod should be used.

FRACTURE OF RADIUS IN A TYPICAL SITE

Fracture of the radius is 2.5 cm more proximal to the articular fissure of the wrist joint. There are two variants of the fracture – the extensor (type of Collus) and the flexural (Smith’s type) (fig. 4.31). The Collus’ type happens more often (15–20 %), which occurs as a result of falling on a straightened arm, extended in the wrist joint. In 50–60 % of cases this type of fracture is combined with the avul-
Fracture of radius in a typical site: A – extensor type (Collus’ fracture); B – flexor type (Smith’s fracture).

Significantly less common is the flexural fracture, which occurs when falling on the dorsum of the hand.

**Principles of diagnostics and treatment.** In fracture of the radius in a typical site, there are all the absolute signs of a fracture (pain, swelling, visible deformity, pathological mobility of fragments, limb shortening, crepitation). The pathognomonic symptom of this fracture is the deformation as the “dining fork” (displacement of the hand with the distal fragment of the radial bone to the dorsum of the hand) and bayonet protrusion along the palmar surface (fig. 4.32).

X-ray is used in two standard projections to confirm the diagnosis and determine the degree of displacement of fragments (fig. 4.33).

One-step reduction is usually performed in case of fresh fractures. The limb is fixed with a plaster bandage from the upper third of the forearm to the base of the fingers for 6–8 weeks.

**Technique of manual reposition.** Reposition to the patient is carried out necessarily under local or short-term general anesthesia. Repository the doctor can conduct independently, but better with the help of one assistant (fig. 4.34).

**Flexion type.** A doctor holds the hand together with the distal fragment with під one hand, and with the second – the wrists at the level of the proximal fragment. The I stage is traction for elimination of displacement along the length and angular displacement of the distal fragment. The II stage – performance of flexing and simultaneous pronation of the distal fragment, while repositioning of the distal fragment is performed with the thumb of the doctor, who presses it to the palm and down. After correction, the limb is fixed with a plaster bandage from the heads of metacarpal bones to the elbow joint in the position of palmar flexion and a minor ulnar deviation with the removal of the thumb of the hand.

**Extension type.** On the I stage the limb is flexed at the elbow joint, the physician holds the patient’s wrists so that his thumbs are above the projection of the distal fragment, the assistant exercises a counterweight to the humerus, the two perform traction along the limb axis to eliminate displacement...
along the length. The II stage is removing the displacement along the length of the doctor with the thumbs, a quick pushing movement is made to the dorsum of hand and upwards, which eliminates the displacement along the width. If the traumatologist works alone, then he removes the displacement along the length by means of preliminary traction, and then covers with one hand the section of the tenor and the back surface of the distal fragment so that his fingers converge on the front surface. At the same time, doctor performs hand a counterforce on the front surface of the forearm with the other. The distal fragment is displaced to the dorsum and slightly pronated.

Plaster immobilization is carried out from the heads of metacarpal bones in the position of dorsiflexion and minor ulnar deviation with the abduction of the thumb of the hand. After the correction, X-ray control in two standard projections is mandatory. If the displacement cannot be completely eliminated,
then another attempt is made to correct it. If it was unsuccessful, or if it is impossible to keep the fragments, surgical treatment is performed.

At the 5–7th day, with a decrease in post-traumatic edema, control X-ray is mandatory. In the absence of secondary displacement, the free plaster bandage is strengthened. From the second day the patient is allowed to move in the shoulder and elbow joints and fingers.

In the presence of displacement, an attempt of transcutaneous fixation the fragments with wires should be made, followed by fixation with a plaster cast for 6–8 weeks. In the open reposition, the fragments are fixed using a plate with screws or EFD (external fixation device).

Unsuccessful attempts of manual repositioning, unstable fractures (with damage to the styloid processes and distal radiolar synostosis) are indications for surgical intervention.

Complications. The displaced central fragment may injure the quadrat muscle, tendon sheaths and tendons of the flexor muscles of the fingers of the hand, the median nerve, and also the interosseous sensitive branches of the radial nerve. In some cases, a sharp fragment can perforate the skin, and a closed fracture become the open one. Sometimes neurodystrophic syndrome, ischemic contracture of Zudeck-Turner can develop.

In the case of multi-fragment fractures in a typical site, fragmentation of the distal fracture of the radial bone occurs. Such a break is not yet an absolute indication of an operational intervention. Closed reposition should be performed. Sometimes it is possible to perform a precise reposition and restore the anatomical integrity of even the severe multi-fragment fractures of the radius.

Barton's fracture is an intraarticular fracture of the posterior margin of the distal end of the radius (fig. 4.35). Meanwhile, part of the facet joint at the time of the fracture turns by 180°. That is why it is also called a "reverse fracture", which distinguishes it from other fractures of the radius in a typical site. The mechanism of the trauma is falling onto the extended and pronated wrist joint with a strong impact on the dorsal part of the joint space. Closed repositioning and retention of the achieved results are possible only in rare cases. The main treatment is an open repositioning followed by fixation with a T-shaped plate.

Injury of the wrist bones. The bones of the proximal wrist are more often damaged: a fracture of the scaphoid bone, a dislocated lunate bone, fracture of the trihedral bone, perilunate dislocation of the wrist.

Fracture of scaphoid bone. It occurs due to forced trauma (falling on the palm) with the emphasis of the styloid process of the radial bone to the scaphoid bone, or when it falls on the elongated hand, due to a fist strike against a solid object. As a rule, two fragments are formed. As a result of a violation of the blood supply of the proximal fragment, its aseptic necrosis may occur. Fracture can be complicated by a false joint, deforming joint arthroses near the scaphoid bone with varying degrees of function impairment.

Principles of diagnostics and treatment. When examined, the smoothening of the area of the "anatomical snuffbox" is determined. During palpation there is a local soreness that increases with axial load and hand movements. The strength of adduction of the 1st finger is reduced. X-ray examination is performed in standard projections. There is a special position, for which the hand is rotated out-
ward to an angle of 15–20° and provides an ulnar deviation with the location of the X-ray tube in the sagittal direction. In doubtful cases, X-ray examination should be repeated after 2–3 weeks. During this time, the fracture gap expands due to the resorption of bone tissue along the plane of bone destruction.

With fresh fractures of the scaphoid bone, immobilization is carried out with a circular plaster bandage from the level of the upper third of the forearm to the heads of II–V metacarpal bones, and on the I finger (with its retraction) to the nail phalanx. The hand is slightly abducted in the direction of radius and towards the dorsum. The duration of immobilization depends on the nature of the fracture line and is not less than 10 weeks. In the case of a fracture with displacement an open reposition and metal osteosynthesis is performed (fig. 4.36).

Upon detection of aseptic necrosis of the proximal fragment, in the presence of signs of the false joint of the scaphoid bone, excision, removal of the proximal row of the wrist bones, arthrodesis of the wrist joint and endoprosthetics are performed. In the process of treatment of fractures, physiotherapeutic effects, upper limb massage, and motor therapy are used. With a favorable current, working ability is restored in 3–6 months.

**Fracture of the trihedral bone.** It is a consequence of the direct mechanism of injury. Clinically, the symptoms of local edema, tenderness in palpation and axial load distal to the head of the ulna are present.

**Principles of diagnostics and treatment.** X-ray examination in standard projections confirms the assumption. Immobilization of the hand and forearm with a plaster bandage is performed for 3–4 weeks. From the first days therapeutic exercises for fingers is prescribed. The ability to work is restored in 4–8 weeks.

**Perilunate dislocation of the hand.** It occurs when the forearm is over-extended. The semilunar bone is held near the radial (from the carpal side), and the remaining wrist bones are displaced in the volar direction.

**Principles of diagnostics and treatment.** Patients complain of pain and restriction of movements in the wrist. When examined, there is pronounced edema and joint deformity, more often – bayonet. Treatment consists in the closed correction of the dislocation, which should be performed with the help of a distraction apparatus, while the hand is overextended in the posterior direction, and the semilunar bone is inserted into the fingers. The joint in the bending position up to an angle of 135° is fixed with a plaster bandage from the level of the fingers to the elbow joint. After another 2 weeks, the brush is removed to the physiological position and the fixation is continued for up to 4 weeks. Workability is restored in 2–3 months. In case of unsuccessful closed correction, surgical intervention is performed using a distraction apparatus and open repositioning.

**Fractures of metacarpal bones.** There are intra-articular (Bennett, Rolando) and extra-articular fractures with a transverse and oblique fracture line (fig. 4.37). Bennett fracture is intra-articular fracture of the base of the first metacarpal bone, in which the triangular form remains in place, and the distal part shifts in the posterior direction with the reduction of the bone along the axis. Multiple-
fragmentation fracture of the base and metacarpal bone, when the fissure resembles the letter Y, is called the Roland fracture.

**Principles of diagnostics and treatment.** Clinically manifested swelling of the carpometacarpal joint, flattening of the "anatomical snuffbox", the finger is slightly flexed and adducted. X-ray of the finger in two projections allows clarifying the nature of the fracture. Displacement, which occurs with fractures of the base and metacarpal bone, should be eliminated as quickly as possible. It is performed under local anesthesia, providing traction along the axis of the I finger and its withdrawal, pressing the base of the metacarpal bone in the elbow direction. Without termination of load along the axis of the finger, with the maximum abduction of the I metacarpal bone, fixing the finger with a plaster cast, well modeling at the base of the metacarpal bone. In the case of secondary displacement, osteosynthesis is performed with Kirschner’s wires or a miniature bone plate. Transverse diaphyseal fractures of the metacarpal bones are treated conservatively by immobilization in a gypsum splint, which is fixed on the wrist and forearm for a period of 3–4 weeks. Metacarpal bones with an oblique fracture line, including multiple, after the open reposition, are fixed with Kirschner’s wires, bones plates, devices of extra-osseous osteosynthesis. The period of immobilization is 4–6 weeks. Working ability is restored in 6–8 weeks.

**Fractures of the fingers phalanges.** It occurs due to direct trauma in people working. Under the influence of the interosseous and vermiform muscles, the fragments of the phalanges of the fingers slightly shift at an angle. There are fractures distinguished: diaphyseal (helical, transverse, oblique), periarticular (unstable) and intra-articular.

**Principles of diagnostics and treatment.** Clinically, local soreness, edema, shortening, pathological mobility, crepitation of fragments are revealed. X-ray examination in two standard projections allows clarifying the nature of the fracture and displacement lines. Such fractures require an ideal repositioning, since wrong consolidation significantly impairs the function of the hand. After repositioning, conservative treatment requires immobilization with a splint in the physiological half-flexion position of the finger for a period of 3–4 weeks. Surgical treatment provides closed or open reposition of the fracture with fixation along the axis of the finger with the Rosov’s, Kirshner’s wire or miniature bone plate. With peri- and intra-articular fractures, it is advisable to use external fixation devices, endoprosthetics or arthrodesis of joints. Working capacity is restored in 6–8 weeks after injury.

*Fig. 4.37. Fractures of the base of the first metacarpal bone: A – Bennett’s; B – Rolando’s; C – extraarticular*
TASKS

TASK #1
Patient N., 18 years old, fell from a bicycle. Patient complains of pain in the left shoulder, limitation of movements in the shoulder joint. During examination the patient presses his left arm to the chest and supports it under the elbow by the right arm. The left upper arm is shortened in comparison with the right, in the projection of the clavicle, swelling and deformity are determined. During palpation of tumescence painfulness and crepitation occur. Active movements in the shoulder joint are limited and painful. Make a preliminary diagnosis.

A. Fracture of clavicle.
B. Fracture of the surgical neck of the humerus.
C. Shoulder dislocation.
D. Fracture of the acromial process of the scapula.
E. Fracture of the coracoid scapula.

TASK #2
The patient N., 22 years old, applied to the reception room with complaints of pain in the region of the right shoulder joint, which is intensified during movements. On the day before he fell on the outer surface of the shoulder. During examination in the region of the acromioclavicular joint there is edema and a step-like deformation. During palpation soreness, a positive symptom of the "key" is present. Make a preliminary diagnosis.

A. Dislocation of the acromial end of the clavicle.
B. Fracture of the head of the humerus.
C. Shoulder dislocation.
D. Fracture of the acromial process of the scapula.
E. Fracture of the acromial end of the clavicle.

TASK #3
Patient A., 42 years old, after falling from the horse to the abducted arm, felt a sharp pain in the shoulder joint. Gradually, the swelling of the shoulder was increasing, he could not lift his arm up. During examination by an ambulance physician, a diagnosis is made beforehand – a fracture of the proximal end of the humerus. What fractures of the proximal humerus are related to intra-articular fractures?

A. Fracture of the anatomical neck.
B. Fracture of the surgical neck.
C. Supracondylar fracture of humerus.
D. Abduction fracture of the surgical neck.
E. Fracture of the upper third of the diaphysis of the humerus.

TASK #4
Patient B, 69 years old, turned to the reception department with complaints of pain, deformity of the shoulder and the inability to move the hand. The examination revealed edema, deformation of the upper third of the shoulder, local soreness with palpation of its proximal part occurs, which is strengthened with axial loads. On the X-ray, a fracture of the surgical neck of the shoulder is determined. What is the tactic of treating fractures of the surgical neck of the humerus without dislocation in elderly people?

A. Immobilization with a cravat bandage.
B. Plaster immobilization with thoracobrachial bandage.
C. Plaster immobilization on a wedge-shaped cushion.
D. Skeletal traction.
E. Plaster immobilization by Chizhin’s splint.

4. Injury of bones and joints of the upper extremity
TASK #5

The patient S., 38 years old, the driver of the car, got an arm injury in an accident. During examination by the paramedic of the “First Aid”, a deformity of the shoulder in the middle third, mobility and crepitation in this area were detected. Which method of treatment in this case of fracture of the humerus diaphysis with a transverse fracture line should be preferred?

A. Conservative.  
B. Transosseous osteosynthesis by external fixation apparatus.  
C. The tactics of treatment depend on the age of the patient.  
D. First, skeletal traction is necessary.  
E. Internal osteosynthesis.

TASK #6

Child K., 13 years old, fell from a tree on a flexed elbow joint. Patient complains of pain in the elbow joint, the impossibility of movements in it. During examination an edema in the field of an elbow joint, the Hunter’s triangle is correct. Sharp tenderness in palpation of the supracondylar shoulder zone and crepitus occur. Make a preliminary diagnosis.

A. Contusion of the elbow joint.  
B. Fracture of the condyle of the humerus.  
C. Fracture of the head of the radius.  
D. Fracture of the elbow process.  
E. Supracondylar fracture of humerus.

TASK #7

Student K., 23, fell on a flexed elbow during a football game. When falling, I felt crepitus in the place of impact. Immediately after the injury, severe pain appeared in the lower third of the shoulder, deformation, protrusion of soft tissues along the posterior surface of the shoulder. What kind of supracondylar fracture of the shoulder is possible with such trauma?

A. Flexor.  
B. Abduction.  
C. Extensor.  
D. Adduction.  
E. Impacted.

TASK #8

Student S., 28 years old, during skating, fell on his elbow, felt a sharp pain. During examination of the patient in the waiting room the arm was elongated, hanged, the patient spares it, holding it with a healthy hand. Edema of the elbow joint, painfulness in palpation, increasing with axial loads on the olecranon, hemarthrosis are present. Preliminary diagnosis: fracture of the olecranon. What is the absolute indication for surgical treatment?

A. Oblique fracture line.  
B. Consent of the patient.  
C. The diastase between fragments is more than 0.5 cm and there is no active extensor movement in the joint.  
D. The presence of hemarthrosis.  
E. The diastase is 0.2 cm.

TASK #9

Patient P., 36 years old, was injured during an accident. The fracture of both forearm bones at the level of the middle and lower thirds with displacement of the fragments was diagnosed. What position should be given to the forearm in the plaster bandage after a successful closed repositioning?

A. The middle physiological condition.  
B. Pronation of the forearm and flexion in the elbow joint at an angle of 90°.  
C. Supination of the forearm and flexion in the elbow joint at an angle of 10–20°.  
D. The position between pronation and supination of the forearm and flexion in the elbow joint at an angle of 110°.  
E. Supination of the forearm and flexion in the elbow joint at an angle of 90°.
TASK #10

Child B., at the age of 2, fell during a walk, but was held by his mother’s hand. During examination, the child cries, cannot bend the arm in the elbow joint. At palpation, a slight swelling is detected along the anterior surface of the elbow joint. Active and passive movements are impossible, sharply painful. X-rays of the elbow joint and forearm in two projections showed no pathology. Make a diagnosis.

A. Osteoepiphysiolysis of the humerus.
B. Fracture of the neck of the radius.
C. Pronational subluxation of the head of the radius.
D. Contusion of the elbow joint.
E. Damage to the lateral ligament of the joint.

TASK #11

The patient S., 62 years old, slipped in the ice and fell on her right palm. There was a sharp pain and bayonet deformation in the area of the wrist joint. Make a preliminary diagnosis.

A. Extensor fracture of radius in a typical site (Colles).
B. Fracture dislocation Galeazzi.
C. Fracture dislocation Monteji.
D. Flexion fracture of radius in a typical site (Smith).
E. Dislocation of the ulna’s head.

TASK #12

Patient P., 35 years old, fell on the right-angled right arm, felt a severe pain in his forearm, and couldn’t bend his arm at the elbow. The forearm is slightly shortened, swollen in the upper third and in the elbow joint area, palpation along the anterior surface is somewhat painful. On the border of the upper and middle third of the ulna, palpation is sharply painful, crepitus occurs. Make a preliminary diagnosis.

A. Fracture dislocation Galeazzi.
B. Fracture of radius in a typical site extensor (Colles).
C. Fracture dislocation Monteji.
D. Fracture of radius in a typical flexion site (Smith).
E. Dislocation of the head of the radius.

TASK #13

The patient D., 45 years old, the driver, started the truck with a crank handle. At the factory, the handle kicked back into the palm of the hand, there was a lot of pain in the area of the first finger of the right hand, the full restriction of movements. Palpation of the first metacarpal bone is sharply painful, active finger movements are impossible. On the X-ray examination, a diagnosis was made: Bennett’s injury. What is Bennett’s injury?

A. Damage to the flexor tendon of the first finger.
B. Fracture dislocation of the main phalanx of the first metacarpal bone.
C. Dislocation of the main phalanx of the first finger.
D. Fracture of scaphoid bone.
E. Fracture dislocation of the main phalanx of the first finger.

TASK #14

Patient R., 32 years old, was taken to the emergency room of the regional hospital with an open fracture of the lower third of the shoulder. The paramedic has imposed the splint of Cramer, preliminary having modeled it on a healthy hand; the bandage covered the shoulder, forearm and the wrist to the metacarpophalangeal joints. The hand is suspended on a scarf. What mistake did the paramedic?

A. An aseptic bandage was not applied.
B. Incorrect splint model.
C. A scarf is not needed.
D. It is inappropriate to use the Cramer’s splint.
E. There is no mistake.
A 33-year-old patient during the week was treated with a skeletal traction for an oblique fracture of the humerus diaphysis in the distal third. However, it was not possible to eliminate the displacement of fragments along the width. On the 10th day, an open reposition of fragments followed by osteosynthesis with a metal plate was performed. The next day after the operation, on examination, it was found that the patient cannot actively extend fingers and a hand, and also abduct the first finger. What is the diagnosis?

A. Damage to the median nerve.
B. Damage to the radial nerve.
C. Injury of the ulnar nerve.
D. Damage to the ulnar nerve.
E. A, B, C are correct.
5.1. INJURIES OF THE SPINAL CORD

Injuries of the spinal cord occur under the influence of significant forces and refer to the most severe traumas of the musculoskeletal system. Spinal trauma compounds from 2.2 to 20.6% in the general structure of the skeletal bones fractures. Injuries, which are complicated with neurological disorders and are more often observed in the lower thoracic and lumbar parts of the spinal cord and compounds 39.2% and 48.5% correspondingly. Epidemiologic data indicates, that spinal trauma is more often observed in young men, and dissatisfactory results of treatment consist the significant percent. Approximately 43% of patients with spinal trauma have multiple and combined injuries, that complicates diagnostics and choice of the adequate treatment tactics.

CAUSES AND MECHANISMS OF SPINAL INJURIES

The primary value at initial stages of spinal injuries has the determining of circumstances of the trauma. Causes of the spinal column and spinal cord injuries are more often: fall from a height (cata-trauma), traffic accidents, diving with stroke of the head against the water reservoir, fall of the weight on different parts of the spinal column, sport injury and others.

Direct and indirect trauma mechanisms are defined.

When the force is applied to the spinal cord in direct mechanism (strike with the blunt item or compresion in the posteroanterior direction), that leads to the bruise and also isolated injury of the posterior spinal structures.

Injuries in indirect mechanism of the trauma occurs due to the forceful bending (Fig. 5.1A) or unbending of the cervical, thoracic and lumbar parts (abrupt and sudden single-staged forced bending of the trunk or head bending, and also as called “whiplash movement”, when during the car crash the head abrubtly moves backwards with sharp forced neck unbending and the following to this sharp bending) (Fig. 5.1B), in rotation – turning (during sports in fighters in incorrect or incompetent conduction of actions with head rotations) (Fig. 5.1C), compressions (traumatic force in this mechanism acts strictly along the vertical axis of the spinal cord with the term, that at the moment of the force action cervical or lumbar physiological lordosis is smoothed – compressive-comminuted or bursting vertebrae fractures occur (Fig. 5.1D), from the shift (occurs in the force action in strictly frontal or
sagittal plane and more often in rigid parts of the spinal column, when the lower part has the solid basis) and from distension. Inertial movement of the upper part relatively to the fixed lower half is leading in distension. That more often occurs in the fixation of the trunk with seat belt during car driving. In the movements of the upper part of the body, the inertial distension of the lumbar part of the spinal column occurs, the rupture of intervertebral disks, anterior and posterior longitudinal ligaments, all structures of the posterior capsular-ligamental complex occur, and sometimes of the spinal cord. Each of this trauma mechanisms can act separately, as well as in different combinations, that leads to a certain form of the spinal column injury.

**CLASSIFICATION OF SPINAL INJURIES**

According to the character of integrity anatomical structures integrity impairment the following types of injuries are defined:

1. Injuries of the ligamentous apparatus (isolated or multiple ruptures of the capsulo-ligamentous apparatus).
2. Fractures of vertebrae bodies (compression, horizontal, vertical, avulsion, comminuted, explosive). 3 degrees of compression are determined in compression fractures (I degree – decrease of the vertebral body height or its anterior part for less than the half of the height of the adjacent vertebra, II degree – decrease of the vertebral body height or its anterior part for the half of the height of the adjacent vertebra, III degree – decrease of the vertebral body height or its anterior part for more than the half of the height of the adjacent vertebra).
3. Affection of the intervertebral disc with rupture of the fibrous ring and dislocation of the nucleus pulposus.
4. Fracture of the posterior hemicircle of the vertebra (arch, atricular, transverse or spinous processes).
5. Subluxations, luxations and dislocation fracture of vertebrae, that are accompanied by dislocation by axis, in sagittal or frontal planes with deformation of the spinal canal.
6. Traumatic spondilolysthesis.

Injuries of the spinal column and spinal cord are divided into **closed and opened** (non-gunshot and gunshot). Opened fractures are accompanied by the impairment of skin integrity in the projection of the spinal column at the injury level.
Injuries of the upper cervical part of the spinal column (in the C₁–C₂ segment) are divided into luxations in the atlanto-occipital joint, “burst” fracture of the atlas (Jefferson’s fracture), atlas luxations and subluxations (Kienbeck’s luxations) combined with fracture of the C₂ odontoid process and traumatic spondilolysthesis of C₂.

In injuries of thoracic and lumbar parts of the spinal column, and also cervical part at the C₃–C₇ level universal classification introduced by F. Magerl in 1994 year is used, which is based on pathomorphological criteria. According to it, the most common types of fractures are characterized by the main mechanisms of force influence of the spinal column – compression (A), distension (B) and rotatory-axial torsion (C) (Fig. 5.2).

**Type A injuries** occur due to the compression, anterior parts of the vertebra are affected in it and compression or explosive fractures of their body occur (Fig. 5.2A).

Injuries in this type are usually stable, ligamentous apparatus is not affected and isolated impairment of the posterior supporting complex structures are observed (supraspinous and intraspinous ligaments, articular and transverse processes, vertebral archs). Only elements of the anterior column of the spine are exposed to destruction. Posterior wall of the vertebra remain intact. Neurologic disorders occur rarely.

**Type B injuries** occur due to the influence of compression or distension force, and anterior and posterior columns of the spine are affected in it. (Fig. 5.2B). Flexion-extension, “explosive fractures” occur in it with rupture of the posterior capsulo-ligamentous apparatus (capsula of facet joints, yellow ligament, inter- and supraspinous ligament, sometimes with the involvement of extensor muscles of the spine and fasciae). Affection of the anterior and middle column is characterized by the rupture of the intervertebral disc. Rupture of the posterior capsulo-ligamentous structures are characterized by the occurrence of subluxations, luxations of the articular processes, their fractures are possible. Injuries of the ligamentous apparatus can also be connected with compression fractures of vertebral bodies of different types – comminuted and explosion. Injuries of this type refer to instable and are often accompanied by the development of neurologic symptoms.

**Type C injuries** refer to the most severe. They occur due to the influence of compression, distraction and rotation and are accompanied by the affection of all three supporting columns of the spine, in which neurologic disorders are usually observed (Fig. 5.2C, D).

Injuries of the spinal column are divided into stable and instable. Proceeding from the term stability, the model of the spinal column was introduced by F. Denis in 1983 year, according to which the osteoligamentous apparatus of the spine is conditionally divided into three columns. Anterior column is formed from the anterior longitudinal ligament, anterior part of the fibrous ring and anterior part of vertebrae. Middle column includes posterior longitudinal ligament, posterior parts of the fibrous ring and posterior parts of vertebral bodies. Posterior column consists of posterior osseal complex (roots of arches, facet joints, spinous and transverse processess) and ligaments (Fig. 5.3).

To stable refer such injuries, when the dislocation of spinal structures is not observed in usual movements. Spinal cord is not affected in this and there is no direct danger of its trauma. Typical example of such a trauma – compression wedge-shaped fracture of the vertebral body, if the decrease of its height does not exceed 1/2.

In the opposite to this, to instable refer injuries, when there is a danger of further dislocation with the danger of compression of neuro-vascular formations of the spinal canal. They occur in destruction of minimum two supporting columns of the spine. Instable are considered traumas with the impairment of the posterior ligamentous complex (interspinous, supraspinous and yellow ligaments), intervertebral joints, and also in the impairment in the area of as called middle column, that is topographically directly adjoin with whe spinal canal. Two types of instability are defined: acute (occur
Fig. 5.2. Types of spinal column fractures

Fig. 5.3. Tricolumnar model of the spine according to F. Denis (marked with dashed line)
directly after trauma) and chronic (develops with time and manifests with the occurrence or increase of the postraumatic spine deformation and aggravation of neurologic disorders).

Presence of neurologic symptoms, decrease of the vertebra body height at the radiogramm in lateral projection for more than 25 % for cervical and 50 % for thoracic and lumbar parts in compression fractures or horizontal dislocation for more than 3.5 mm are considered as signs of instability. Posttraumatic kyphosis in cervical part for more than 30°, and more than 20° in thoracic and lumbar parts indicates the instability. Luxation and subluxation also refer to the instable injuries.

In addition, spine injuries are also divided into non-complicated and complicated. Complicated – affection of the spine structutres in connection with the affection of the spinal cord and its roots. Objective signs of injuries due to the trauma influence can sometimes be absent or not determined, while neurologic disorders manifest in various forms. In this variant, injury refer to the complicated and occur due to the closed trauma of the spinal cord.

According to the level of the spinal cord and horse’s tail trauma, injuries can be in the cervical, thoracic and lumbo-sacral parts of the spine, and of the horse’s tail roots.

INJURIES OF THE CERVICAL PART OF THE SPINE

Injuries of the upper cervical vertebrae are assigned in separated anatomical zone and are divided into fractures, luxations and dislocation-fraction.

Fractures of the upper cervical vertebrae

Fracture of the С 1 vertebra (atlas). Atlas fracture (Jefferson fracture) occurs due to the axial load, when the ring-shaped atlant bursts as a roll, and its lateral masses shift aside (Fig. 5.4).

Fractures of the odontoid process of С 2 (other names С2: axial vertebra, аxis). This type of injury can be with the deviation of the fractured odontoid by angle, by width or deviation of the odontoid together with atlas and with the head towards or backwards. Fracture of the odontoid process of С 2 refer to the severe and dangerous injuries. In large process deviations together with the first vertebra, fatal outcome is possible due to the compression of the medulla oblongata (Fig. 5.5).

Fracture of the axial vertebra arch (C 2) (traumatic spondilolisthesis or “Hangman’s fracture”). This fracture occurs due to the abrupt axial load and overextension. The fracture of the C 2 archs leg occurs and deviation of its body together with superior parts fo the vertebra and head towards. Deviation of the body could be minimal, and the disloaction on the width of the C 2 body can occur with the compression of the spinal cord with the posterior arch of the atlas (Fig. 5.6).
Luxations and dislocation-fractures of the upper cervical vertebrae

Rotational luxation of the atlas – the most common type of atlanto-axial junction injury, more often occur in children due to the abrupt rotation of the head and in athletes during wrestling (Fig. 5.7).

Atlas luxations (transdental, transligamentous and peridental). Injury occurs due to the fall from a height on the head due to the odontoid process fracture of the axial vertebra, rupture of the atlas transverse ligament or slip of the dens from under the transverse ligament with anterior, rarer posterior, atlas subluxation. Atlas shifts towards together with head.

Injuries of middle and lower cervical vertebrae

Among the injuries of cervical part at the level of C2–C7 (the most mobile part of the spine) subluxations, luxation and dislocation-fraction are observed more often. Luxations occur due to the extensive flexion, extension and rotation. Unilateral and bilateral luxations, anterior luxations, very rare – posterior luxations are defined.

In extensive bending, body of the superior vertebra shifts towards relative to the inferior, and articular surfaces shifts upwards – subluxation occurs. If the force influence continues, than the upper luxation occurs, when the articular processes collide with their tips, and then the shift of the lower articular process of the luxated vertebra in the upper vertebral fissure of the inferior vertebra occur; hitched luxation is formed (Fig. 5.8). In such injuries, injured intervertebral disc can migrate in the direction of the spinal canal and cause severe neurologic impairments of the spinal cord and its elements. Extensor injuries, in the opposite to flexion, usually end with self-reposition.

Fractures of C2–C7 vertebrae. Among fractures, injuries of the vertebral bodies are observed more often due to the force action along the vertebral axis. Compression and bursting ("explosion"), and also avulsion fractures are defined. In presence of compression-comminuted fractures, shift of the fragments backwards, towards the spinal canal can be observed, that cause neurologic disorders of different severity (Fig. 5.9).

Luxations and subluxations in the cervical part refer to instable, and injuries of the spinal cord segments at this level – to most sever and prognostically unfavorable.

Fig. 5.6. Schematic pattern of the traumatic spondilolisthesis of C2: injured(fractured) arch of C2 and slip of the C2 body towards

Fig. 5.7. Rotational subluxation of the atlas. A – radiographic pattern, B – CT-pattern with 3D-modelling
INJURIES OF THE THORACIC AND LUMBAR PARTS OF THE SPINE

Injuries of the spine at the thoracic and lumbar levels are characterized by a big variety of integrity impairment of vertebral and paravertebral anatomical structures, that are often located at the area of XI, XII thoracic and I ,II lumbar vertebrae – at the area of transition from rigid thoracic part to the mobile lumbar part.

In abrupt and excessive flexion, isolated rupture of the supraspinous and interspinous ligaments, spinous process fractures occur. Due to the direct influence and abrupt excessive contraction of the lumbar quadrant muscle, that attaches to the 12th rib and transverse processes of I–IV lumbar vertebra, fractures of transverse processes are observed.

Due to the direct application of the force or overextension of the spine, fracture of archs without dislocation and with dislocation towards the spinal canal can occur, that leads to the injury of the spinal cord and its elements.

Fractures of the vertebral bodies are observed more often (compression, compression-comminuted, explosion) and dislocation-fraction of the vertebrae, when the anterior and posterior structures are injured especially in the thoraco-lumbar part, that occur due to the indirect trauma: axial load on the spine with flexion or flexion and rotation (Fig. 5.10). Instable forms of injuries are often formed in it with the formation of kyphosis and shift of the superior vertebra relatively to the inferior, that leads to the deformation of the spinal canal and affection of its structures.

DIAGNOSTICS OF SPINAL INJURIES

Patients with suspicion of spinal injuries require careful and complex examination, that includes clarification of the medical history (conditions of the trauma), where special place is given to the trauma mechanism, clinical examination and use of additional methods of the investigation.

Clinical examination

In conduction of the clinical examination of the patient with spinal injury, forced movements of the head and body should be completely excluded in recent trauma, especially axial load on feet and head, as they can increase traumatic changes of the spine and anatomical structures of the spinal ca-
nal. Presence of scratches, hematomas, deformations, information about the trauma mechanism can help with the determining of areas of possible injuries.

Common clinical symptoms are pain, that can be diffuse at the beginning, and than is gradually limited by the area of injury. Pain intensity can be various and depends not only on the severity of bone injuries, but also the trauma of soft tissue structures of the spine. Often, especially in combined trauma, patient does not direct the doctor’s attention to the pain in the spinal area, that leads to diagnostic mistake and possibility of occurrence or deterioration of neurologic complications in different terms after trauma.

Depending on the level of the spine injury, pain can irradiate to the occipital area, arm, between the scapulas, along the spine, in the area of buttocks and lower limbs, and also in the area of the anterior abdominal wall. In instable injuries, pain increases sharply in minor movements.

Clinical examination of the patient with spinal injury is conducted in the dorsal recumbent position on the hard surface. Forced head position as its flexion, bending aside, rotation, disappearing of cervical lordosis, occurrence of kyphosis turns attention to it during examination. Destruction of supportive structures of the vertebral mobile segment in the cervical part can manifest with head instability, where severe degree is defined – patient’s head does not hold and fall down (“guillotining” symptom). In moderate degree, patients holds head with hands, and in mild degree of instability patients hold head immobile relatively to the body (“head of a statue”). In traumas of thoracic and lumbar parts, attention during examination is paid to changes of physiological kyphosis and lordosis, occurrence of lateral deformation, tension of paravertebral muscles like a “cord” along spinous processes of the injured part. This is a reflex reaction, that prevent pathologic mobility and shift of the fragments. The level of injury is determined with palpation (superficial or deep) along the line of spinous processes, and in paravertebral zones – state of the longitudinal spinal muscles and tenderness of transverse processes in their fractures. Increase of the pain intensity in fractures of transverse processes of lumbar vertebrae is also observed in the attempt to raise straight legs, and the most intensive pain is observed in bending towards the healthy side. Severe trauma of the thoraco-lumbar part of the spine can manifest with the clinical pattern of “acute abdomen” (“pseudoabdominal syndrome” – abdominal pain and even tension of the anterior abdominal wall), that is explained by the irritation of the solar plexus and retroperitoneal hematoma. Differential diagnosis in some cases can become a complicated task, that require dynamic observation, and in doubtful cases use of the diagnostic laparocentesis is not excluded (laparoscopy).

After examination and palpation you should proceed to the assessment of all types of sensitivity and possibility of movements in the joints of upper and lower limbs. Presence of neurologic disorders indicates the complicated injury, high probability of instability at the corresponding level. In fractures of the transverse processes, pain in the lifting of straight legs in the dorsal recumbent position is not excluded up to the occurrence of the “stuck heel” symptom – impossibility to tear the heel from the surface.
Complicated closed injuries of the spine can manifest with the following clinical forms:

- **spinal concussion** – the most mild form of the spine injury; only functional disorders are observed in it, that regress completely in terms of several minutes to 5–7 days after conservative treatment;
- **spinal contusion** – along with functional disorders, irreversible morphological changes in the form of contusion foci or anatomical rupture of the spinal cord are observed. Spinal contusion in the acute period clinically manifests with spinal shock with symptoms of incomplete conductance disorders and anesthesia below the level of injury;
- **compression of the spinal cord** – can be conditioned by the compression with bone fragments or elements of the injured intervertebral disc, intraspinal hematoma (epidural, subdural, intramedullar localizations).

By the time of development, compression of the spinal cord are divided into:

- **acute compression** – occur in the moment of trauma and does not clinically differ from the spinal contusion;
- **early compression** – develops during several days after trauma and manifests with occurrence or worsening of the neurologic deficit;
- **late compression** – manifests in months and years after trauma and is conditioned by the formation of an excessive callus, cicatrical-comissural process in the spinal canal. Clinically manifests with progressing myelopathy with presence of conductive and segmentar disorders.

**Clinical manifestations of the complicated spinal injury**

Injuries of the spinal cord depending on the clinical manifestations and severity of conductive disorders are divided into:

- syndrome of complete conductance impairment of the spinal cord at the level of injury;
- syndrome of partial conductance impairment, that manifests clinically with muscular paresis or palsies, areflexia, sensitivity disorders below the level of the spinal cord injury, impairment of pelvic organs functions;
- segmentar impairments like muscular paresis, hyporeflexia, sensitivity disorders in the area of affection.

Spinal shock can occur due to the injury of the spinal cord ("physiological" rupture of the spinal cord), that clinically manifests with temporary suppression of reflex activity, peripheral palsy, complete loss of the sensitivity and disorders of pelvic organs functions (urinary retention), trophic disorders, possibility of the diaphragmatic breathing in the patient. Phenomenon of the spinal shock aggravate the absence of the spine stability, not removed compression of the spinal cord with bone fragments, hematoma or foreign body. Typical feature of this syndrome is reverse development of neurologic disorders.

Quiescent of differential diagnosis between traumatic and neurogenic shock is actual in this aspect, especially in polytrauma. In the opposite to the typical traumatic shock, skin coverings of hands and feet are usually warm during examination, hypotone and bradycardia are determined during examination. Such deviations are primarily connected with the fact, that the cause of the neurogenic shock is an impairment of neurologic regulation, while typical manifestations of the traumatic shock are realized through other pathogenic mechanisms.
Additional methods of the investigation

After conducted clinical examination, additional methods of the investigation are included into the diagnostic algorithm, that specify the level and character of the spinal structures affection. Diagnostic algorithm of the complex of instrumental investigations in the acute period of spinal injury starts with X-ray performance (spondilogramm) in two standard (antero-posterior and lateral) projections, that allows to estimate the presence or absence of the injury of spinal bone structures, but does not provide information about the condition of soft tissue structures of the spine (Fig. 5.11).

For the determining of injuries at the area of C₁–C₂, X-ray in antero-posterior projection through the opened mouth are required. Presence of neurologic disorders and radiographic signs of bone structure injuries require the obligatory conductance of the following spine investigation by the method of radiographic computed tomography (CT) and magnetic resonance tomography (MRI), that allows to specify the level and degree of spine, soft tissues and intervertebral discs injuries (Fig. 5.12).

Ascending or descending myelography, CT-myelography, lumbar puncture for the determining of the arachnoid space passability and liquor content are also performed for diagnosis clarification (Fig. 5.13).

TREATMENT OF SPINAL INJURIES

Help rendering to the injured at the pre-admission stage is directed on the prevention of additional trauma during patient’s transporting in the hospital. Practically every injured should be considered as potential patient with instable and complicated spinal injury. depending on conditions of trauma at the place of an accident, injured person should be moved away from potentially dangerous, life-threatening factors (open fire, danger of explosion, etc.). Patient should be lifted by at least three persons. Patient is put to the hard stretcher or board in the dorsal recumbent position.
Patient’s body is fixed to the board, head is additionally edged by the bags with sand from both sides and fixed with wide woven band. It is inadmissible to seat patient or put him/her in the lateral recumbent position. Immobilization is carried out with hard head holder in the suspicion of the injury of the cervical part of the spine. Physiological fixation of the cervical and lumbar lordosis should be provided with rolled clothes in the patient in dorsal recumbent position. Breathing and circulation should be assessed at the place of an accident, resuscitation measures should be performed if necessary for recovery of vital functions, and also anti-shock measures. If patient is in the consciousness, primary assessment of the spine and spinal cord is possible (complaints of pain, fatigue and numbness in limbs, presence of the spine deformation, muscular tone, sensitivity).

**Hospital stage of the medical aid.** The task at the stage of providing qualified and specialized aid to patients with spinal injuries is the final diagnostics with use of necessary additional methods of investigation, and also designing and performing of the corresponding treatment tactics.

Anti-shock therapy, correction of the breathing and hemodynamics, urinary bladder and central vein catheterization is continued in the patient’s hospitalization. Diagnosis formulation with use of additional methods of investigation is conducted simultaneously: spondilography, lumbar punction with liquorodynamic tests, myelography, MRI and computed tomography. Consultations by physician, neurologist and urologist are conducted.

Metylprednisolone according to scheme, broad spectrum antibiotics, analgetics, neuroprotectors, nootropic drugs, anticoagulants, antioxidants, symptomatic treatment are adminestred in the complicated spinal trauma.

**Methods of the spinal injuries treatment and reasons for their choice**

Main purpose of treatment – recovery of the normal topographo-anatomical interrelations between the spine and spinal cord by liquidation of the vertebra dislocation and fixation of the injured spinal segment in the position of reached correction for the entire period of reparative regeneration.

Methods of the spinal injuries treatment can be fundamentally divided into conservative and operative. Choice of the treatment method depends on the results of investigation and correct interpretation of the obtained data.

**Treatment of injuries of the cervical part of the spine**

Stable injuries of the cervical part of the spine (isolated rupture of the anterior longitudinal ligament, fractures without deviation of the arch laminas or lateral masses, fractures of spinous processes in the absence of deviation or angular deformation) are treated conservatively with fixation method, performing immobilization of the cervical part of the spine with firm collar (Fig. 5.14A) or cervico-thoracic jacket (Fig. 5.14B) for 2–3 months.
Subluxations, luxation, dislocation-fracture of the vertebra (especially complicated with the compression of the spinal cord and its roots) require quick reposition by the one-step closed manual reposition (Rische-Gunter, based on principle of the lever action), slow cervical overhead traction or fixed skeletal traction through the parietal tubers (Fig. 5.15A). Further conservative treatment provides for external immobilization with thoraco-cranial bandage in the position of mild extension for 3–4 months (Fig. 5.15B). Non-complicated compression-comminuted fractures of the cervical vertebrae bodies without signs of the lamina and affection of disc are treated with conservative methods with the thoraco-cranial plaster cast application for 2–3 months. Then fixation is performed with Schanz collar for 1–2 weeks, exercise therapy, massage of muscles are performed.

Luxations and dislocation fracture of cervical vertebrae, that are not removed in closed reposition, and also explosion fractures with the fragments dislocation, complicated with the spinal cord compression and increase of neurologic deficit, require emergent (in first 4–6 hours operative treatment. Opened repoision, anterior decompression, resection of the injured vertebra body with replacement of the defect with transplants from different materials are performed during operation.

**Treatment of injuries of the thoracic and lumbar part of the spine**

Conservative treatment is indicated in stable non-complicated injuries, their criteria are loss of the ventral height for less than 50 %, kyphotic defromation for less then 20°, absence of the posterior supportive complex injury (compression, stable explosion fractures of the vertebral bodies and isolated injuries of posterior structures). Treatment is performed by the prolonged bed rest and adequate analgesia in expressed and stable pain syndrome. Patient is further settled in vertical position in standard jacket and exercise treatment is performed.
Method of one-step reposition is based on the maximal extension and recovery of the anterior vertebral body height, that was impaired due to the trauma, with the following immobilization by extensive jacket till the fracture consolidation. This method is indicated in stable non-complicated compression fractures of vertebral bodies, but has a significant number of contraindications (extension fractures, injuries of the middle column, dislocation fractures and other instable injuries), due to which it's use is limited (Fig. 5.16).

Method of the gradual reposition provides for gradual reposition performing on reclination rollers with gradual increase of their height or special recliners (flexible metal shield with the device of dosed reclination, pneumorecliners and others) for 12–20 days, as well as in the functional method. But then immobilization with the extension jacket is performed, as well as in the one-step reposition. By the content, the method is similar to the method of one-step reposition, so the indication for their use are practically identical.

Functional methods, or methods of early mobilization, were in details developed by VV Gorinevskaya and EF Dreving in the year 1933, indicated to patients with stable compression fractures of the vertebral bodies. In the opposite to the previous method, functional method is most spare and has no such a variety of contraindications, but does not provide for the posttraumatic deformation removal. The method purpose – to create full-fledged “muscular jacket” by the spine immobilization and early exercise therapy with the use of physiotherapy and massage with the working capacity recovery in 5–6 months after the trauma. Complex of exercise therapy usually consists of 4 periods (for 10–15 days) with increasing motor activity, first three of which require bed rest. In the first period (2–10 days after the trauma) gradual reclination of the vertebral body due to the patient positioning on the special rollers, that perform the role of recliners; general hygienic exercises are administered. Second period (10–20 days after trauma) provides for movements with upper and lower limbs with involvement into the work of spinal muscles (body elevation on elbows and forearms, elevation of lower limbs). In the third period (20–60 days), exercise for the spinal and abdominal prelum muscles are mainly performed, that are directed at the spinal cord extension (movements towards the spine flexion are categorically forbidden!). During the fourth period (60–80 days after trauma) patient is educated to dosed walk with the maintenance of the necessary posture.

Limitation of this method is significant term of the in-patient treatment, including bed rest. So, there is a variant of this method use, when in one month after the trauma, when all requirements of first three periods are fulfilled, patient is raised in soft “spinal extensor jacket”, that does not exclude continuation of administered exercise, but significantly decrease the bed rest period and in-patient treatment.

Operative treatment of injuries of thoracic and lumbar parts of the spine is indicated in instable and complicated injuries.

The purpose of operative treatment – decompression of the spinal canal structures (posterior, anterior, combined) for creation of conditions of maximally neurologic recovery; correction of the posttraumatic spine deformation, recovery of the spine stability by anterior or posteriorspinal fusion. In certain cases, operative treatment can be used in stable fracturues without neurologic symptoms. This is performed particularly in the significant compression of the vertebral body, “explosion” comminuted fractures. The purpose of the intervention in this case is more solid and controlled, than in the conservative method, reposition and stabilization, earlier beginning of the patients rehabilitation.
Existing methods of operative treatment of instable and complicated injuries of the spine can provide for posterior as well as anterior surgical approach. Particularly, anterior decompression and interbody vertebral fusion with osseal transplant with fixation with special lamina are the most wide-spread interventions in different pathologic conditions of the cervical part of the spine (Fig. 5.17).

Necessarity of the surgical intervention in istable injuries of thoracic, lumbar and lumbo-sacral parts of the spine are conditioned by the possibility of the secondary dislocation with the following increasing of neurologic manifestations. As called transpedicular fixation is effective in such cases allows to perform reposition and stabilized injured segment and interbody vertebral corporodesis (Fig. 5.18).

**Rehabilitation**

Patients with injuries of the spine require medical, social and professional rehabilitation. Early medical rehabilitation is performed in acute period of the trauma in in-patient conditions, that is directed at

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**Fig. 5.17. Radiographs of instable cervical vertebral injuries before and after the operative treatment:** renovation of the anatomical interrelations and anterior spine fusion with a plate

**Fig. 5.18. Radiograph with instable compression-comminuted L₂-vertebra body fracture with posttraumatic kyphotic deformation, stenosis (narrowing) of the spinal canal before and after operative treatment**
the prevention of postoperative complications (decubitus, contractures, urinary fistulas and others). Patients are then transferred to the rehabilitation department, and then are directed to the sanatorium-and-spa treatment in specialized sanatorium. Working rehabilitation is directed at job placement of injured in specially created conditions. Questions of professional activity restitution of persons of manual labour should be resolved individually. Submission of such patients to medico-social expertise with corresponding decision about labour ability. According to general medical rehabilitation, the regimen without excessive physical activities should be recommended to such patients, that are directed at the support of own muscular jacket, swimming, in case of pain exacerbation – physiotherapy course.

In injuries of the spine with the spinal cord trauma, prospects of the rehabilitation are determined by the possible level of its functions recovery. Many of such patients become disabled, their treatment is conducted in specialized departments and spinal centres. Individual approach is necessary to all rehabilitation types in such patients, and if possible – solution of the question of professional rehabilitation, that will correspondingly improve the social rehabilitation conditions of the patient in the society.

5.2. INJURIES OF THE PELVIS

Injuries of the pelvis (bones rupture of pelvic junctions) can be referred to the severe trauma of the musculoskeletal system, because they are accompanied by the high mortality rate, continuous disability and invalidity. Cause of such phenomenon is a feature of pelvic anatomical structure and presence of important internal organs structures in this area (great vessels, nervous plexus, intestines, urinary organs and genitalia), that can be injured in traumas of this localization. Severity of the pelvic trauma is determined by the expressive pain syndrome, massive blood loss, traumatic shock, injuries of internal organs.

Among injuries of pelvic bones, special place takes fractures of the aceta
tabulum with or without hip luxation, when the negative factor, that is connected directly with pelvic trauma, additional consequences of the hip joint injury are added (aseptic necrosis of the femoral head, posttraumatic coxarthrosis, etc.) with corresponding orthopedic lesions.

CLASSIFICATION AND MECHANOGENESIS OF PELVIC INJURIES

According to the AO/ASIF classification, pelvic circle can be conventionally divided into two hemicircles relatively to the acetabulum – posterior and anterior. Posterior hemicircle is located behind the articular surface of the acetabulum. It includes sacral bone, sacroiliac joint with its ligaments and posterior part of the iliac bone. This part of the pelvis, that is loaded oneself up and provides the transmission of the load along the spinal axis to the lower limbs.

Anterior hemicircle is located towards the articular surface of the acetabulum, it includes pubic branches and symphysis (pubic junction). Pelvic diaphragm, that includes sacrotuberual and sacrospinal ligaments, connect mentioned hemicircles and participates in the support of their stability. AO classification, proceeding from the mentioned predispositions, is based on the injury localization determining (presence or absence of the posterior hemicircle injury) and the degree of the pelvic circle stability impairment (Fig. 5.19).

To type A refer injuries, when the integrity of osseo-ligamentous apparatus of the posterior hemicircle is not impaired. They are as called stable pelvic injuries. Stability is determined by that the pelvic diaphragm is intact, pelvis is able to resist usual physical activities without dislocations.
Fig. 5.19. Schematic pattern of pelvic bones fractures distribution according to AO classification

**Type B** includes injuries with incomplete rupture of the posterior pelvic hemicircle, in which the rotational instability can take place around the vertical and also transverse axis of the pelvis. This is partially stable injury with preserved partial integrity of the osseo-ligamentous apparatus of the posterior hemicircle and intact pelvic diaphragm in some cases.

**Type C** specify the complete rupture of the posterior hemicircle with the impairment of the osseous and ligamentous elements integrity and as a consequence – possible dislocation in three planes and rotation instability. This is instable pelvic injury with the complete loss of osseo-ligamentous complex integrity. Pelvic diaphragm is always disrupted.

Each of mentioned types is divided into subtypes (A1, A2, A3, etc., which allows to specify each injury and to choose appropriate treatment tactics.

According to AO positions, acetabular fractures have separate classification (Fig. 5.20), taking into account specificity of such injuries and tactics of their treatment.

**Type A** – fracture is spreaded to the anterior and posterior part of the articular surface; besides, bone fragments involve the bigger or lesser part of one of the three columns. In all cases other column remains intact.

**Type B** – fracture line or its part is located in transversal direction, part of the articular surface remains connected with the ilium, fractures of the transverse form can be completely transverse, T-like or include posterior semidiameter and anterior column.

Fig. 5.20. Schematic pattern of acetabular fractures according to AO classification
Type C – fracture with the affection of both columns and corresponding parts of the articular surface of the acetabulum. There is no connection of any fragment of the articular surface with the ilium. Such fractures can spread to the sacroiliac junction.

According to the injuries variability, as well as in the mentioned above classification, each of the types (A, B, C) is divided into subtypes (A1, A2, A3, etc.), that provides diagnostics specification and determines the choice of treatment tactics.

DIAGNOSTICS OF PELVIC INJURIES

Clinical pattern in pelvic injuries depends on the fracture localization, possible complications and accompanying injuries. Specification of the trauma mechanism, determining of the typical fracture signs, and also X-ray in several projection provides appropriate quality and diagnostics reliability.

Examination of the pelvic part can direct to the idea of injury of one or another part of bones or interosseous junction. So, in case of the anterior pelvic hemicircle fracture, the hemorrhage into the scrotum is often observed, which was for the first time described by Destot. In affection of anterior and posterior pelvic parts, dislocation of the corresponding pelvic part into the proximal direction due to the muscles contraction and its external rotation can be observed. Relative leg shortening on the side of the injury can be observed. Changes of the pelvis form is possible in the fracture of the wing of ilium, when the free fragment moves laterally or medially and in the proximal direction.

For the specification of the fracture possible localization, the palpation of the pelvis part should be used. For determining the possible fracture localization the mechanisms and typical fractures localizations should be known. Palpation of the pubis, pubic and ischial rami, anterior iliac spines and iliac crest, sacral area and sacroiliac junction is usually conducted, where is possible to determine pathological mobility or local tender areas.

In fractures of the sacrum, coccyx, acetabulum, anterior pelvic hemicircle, the digital rectal examination is used. Rectal examination provides the information about local tenderness, determine protruding parts of the bone fragments in fractures, that is especially important in fractures of the sacrum for the determining of the bone fragments dislocation and in the fractures of the acetabulum with central hip luxation.

It is impossible to examine deeply located parts of the pelvic bone with usual palpation, so, we resort to methods of pathologic mobility investigation of the injured pelvic bones. So, pelvis compression in transverse direction and controversial diagnostic manoeuvre – transverse eccentric pressure – leads to the pain intensity increase in the place of fracture.

In pelvic bones fractures, as well as in the lumbar vertebrae fractures, "pseudoabdominal syndrome" can be observed, which occurrence is caused by the retroperitoneal hematoma presence. Such patients should be carefully examined for corresponding differential diagnosis with trauma or abdominal cavity diseases.

It is important to mention, that the symptoms of Gorinevska, Verneuil, Larrey, etc. (Fig. 5.21–5.23) are not always reliable. So, the "straight leg rising" test (inability to lift the foot from the surface on the affected side, that is observed in the anterior pelvic hemicircle fracture), can be positive on one side in the presence of bilateral fracture of the pubic horizontal ramus. More relevant is a symptom of sagittal instability, that indicates the instable pelvic injury, but is traumatic during its performance.

The tranverse pelvis compression and transverse eccentric pressure can not be assessed in the presence of big hematomas in the iliac wing area and also deep scratches due to the local injury of the soft tissues. So, tests, that are based on measurements, are widely used in the clinical diagnostics.
of the pelvic fractures (Fig. 1.4, 5.24, 5.25). Comparative measurements of both pelvic sides and lower limbs are conducted from the anterior superior iliac spines to the ankles, from the anterior superior iliac spines to the xiphoid process of the sternum.

Taking into account, that the lower limb shortening can take place in the hip neck or acetabulum fractures, these data can be checked by the measurements from the greater trochanters to ankles and from the anterior superior iliac spine to the greater trochanter at the same side, and also from sternoclavicular junction to the anterior superior iliac spines.

Clinical diagnostics in patients with pelvic trauma in the acute period of trauma in some cases can have different difficulties. In first turn, it is relevant to the rupture of the pelvic bones junctions, the most complicated from them – injury of the sacroiliac joints.

The following can be mentioned among the causes of such difficulties:

1. Severity of the patients general condition, that often arrive in the state of shock, that make the complaints, trauma conditions and mechanisms determining more complicated or even impossible, and also of the clinical symptoms, which are based on the patients answers (pain syndrome localization, etc.). Determinative role in such cases plays the data from radiographic investigation. But even in standard pelvic radiographs, junction ruptures without bone fractures was not always determined during the first hours of trauma.

2. Difficulties of clinical symptoms determining in some cases depends on, in the first turn, the extended pain syndrome in the pelvic area during 1–2 days after trauma, in the second turn, due to the insufficiency of the junction rupture symptoms theirselves, absence of pathognomic signs (symptoms of Verneuil, Larrey, Chelimskiy, Caralino, "sliding" are determined as in the junctions rupture as well as in pelvis fractures); in the third turn, due to the overlapping symptoms of the accompanying pelvis fractures.
3. Diagnostics is complicated by the presence of multiple and combined injuries, that in certain amount of investigation make examination more complicated, masking the clinical pattern of junctions rupture (injury of the lower lumbar part of the spine, hip joint, intrapelvic organs).

Taking into account mentioned difficulties of clinical method usage, additional methods of investigations, especially X-ray, acquire great value in the diagnostic of pelvic injuries. Difficulty of the radiographic investigation data analysis is connected with its three-dimensional anatomy, besides, accurate information about the character and quantitative indicators of injured fragments dislocation, which is connected with the trauma character and mechanism and impaired pelvic diaphragm function, is necessary for treatment.

The first step in the X-ray diagnostic of the pelvic bones injuries is the X-ray in the anteroposterior projection, which includes whole pelvic circle and both hip joints.

Then the places of bone tissue integrity impairment are determined and the impairment of the bone fragments interrelations in the sacroiliac and pubic junctions. The projection of "pelvic inlet and outlet" are used with this purpose.

Radiographs should be performed only in polypositional positioning. These allows diagnostics of almost all pelvic injuries in their correct conductance. There is certain diagnostics limitation of classic X-ray investigation in patients in severe condition, when it is necessary to make accurate investigation without repositioning and without delay. There is a modern method for this purpose – spiral computed tomography, that allows not only in details assess the state of the bone tissue, interrelations of pelvic bones in juction and dislocations character, but also to obtain the 3D-reconstruction of the pelvic part. Investigation at the magnetic resonance tomograph is used for the diagnostics of hip joint injuries (Fig. 5.26, 5.27).

Injuries of the urinary bladder and urethra can be determined by the contrast radiographic investigation with the contrast medium introduction through the urethra, or, which is more important in combined trauma (suspected kidney trauma, etc.), – by the excretory urography.

So, complete diagnostics with usage of the modern methods of investigations allows to determine the localization and character of the injury, which are the basis for the development of adequate treatment tactics.

TREATMENT OF THE PELVIC INJURIES

Treatment should be started with the first aid rendering to the patient at the place of incident. Its obligatory compounds are primary examination and clinical diagnostics.

During the pre-admission aid rendering it should be remembered about the possibility of traumatic shock development, considerable blood loss due to the bones fractures and joints injuries, internal organs injuries, which are quite often observed in patients with pelvic bones fractures. So, in the presence of corresponding indications, the conductance of adequate infusion antishock therapy, immobilization of other injured segments, adequate analgesia (including possible affection of other organs and systems) are important.

In suspicion of pelvic injury, the transportation, that provides for the prevention of the pain intensity increase, secondary fragments dislocation, development or progressing of the traumatic shock, has a great value. Patient should be transported in the dorsal recumbent position on the hard stretcher, with slight bending in the hip and knee joints and slight abduction in the hip joints due to the roller placement under the knee joints (Fig. 5.28). Additional placement of rollers under the iliac wings is also reasonable. Absence or insufficient pelvis immobilization in the acute period is a factor,
Fig. 5.26. Spiral computed tomography with 3-D-reconstruction in the pelvic injury

Fig. 5.27. Pelvis magnetic resonance tomography in the hip joint trauma

Fig. 5.28. Scheme of the inflatable transport-medical splint for patients with pelvic bones fractures

Fig. 5.29. Modification of the pelvic belt for emergency cases

that increases the severity of patients condition.

Sheet is placed under the pelvis, the ends of which are tied crosswise in the projection of the pubic junction (Fig. 5.29). The role of the fixing elements is performed by the folds of the used material. Simplicity and uniformity of the suggested modification of the pelvic circle fixation allows to use at the pre-admission stage of the medical help rendering.

Hospital period of the patients treatment with pelvic bones fractures include the detailed diagnostics of all injuries with the dominant injury determining, treatment of the traumatic shock and blood loss, control over the patients general condition, treatment of the internal organs injuries and the treatment of the pelvic bones fractures.
On the stage of the admission to the hospital, the complete clinical investigation is performed (including the data about the patients general condition dynamics at the pre-admission stage), X-ray diagnostics. Reasonability and terms of other additional methods using (computed tomography, etc) is determined by the general condition of the patient and presence of other injuries. taking into account the possibility of the internal organs trauma, participation of the related specialists is provided according to indications (urologist, surgeon, etc.).

Patients, that were admissed at the condition of the severe shock, with significant blood loss, the blockade by Shkolnikov-Selivanov is performed, but only after the blood pressure increase to the 80–90 mmHg. General analgesia is performed in this patients by the injection of narcotic analgesics or performance of the superficial narcosis.

Conservative and operative methods are defined among the methods of the pelvic bones fractures treatment.

**Conservative treatment**
Includes orthopedic positioning and method of the constant skeletal traction. Their positive features are the noninvasive character, absence of the additional tissue traumatization. Their limitations are the absence of the stable fixation of the pelvic bones fragments, impossibility of complete reduction in some types of injuries, long terms of the bed rest and in-hospital treatment, complications of the hypodynamic and hypostatic character, difficulties with nursing, etc.

**Operative treatment**
External osteosynthesis with screws and plates allows accurate repositioning of the bone fragments, start the patients activation earlier. But this method is traumatic and has limited used in the acute period of the trauma.

Alternative type of the operative fixation of the bone fragments in pelvis fractures is a method of external fixation. It is less traumatic, so can be used as a part of antishock complex, but in some types of fractures is worse than internal osteosynthesis by reduction capabilities. Development of the apparatus and methods of the external fixation of the pelvic injuries is directed towards the construction of apparatus with possibilities of the stable fixation and controlled reposition.

Taking into account the possibility of several method using in the treatment of the pelvic bones fractures, the main in the clinical practice is the use of the differential approach to the choice of treatment tactics and methods depending on the trauma localization and severity, patients general condition, stability degree of the injury and classification type of the fracture.

In stable pelvic injuries type A treatment is usually performed by the orthopedic positioning by Volkovich. In the injuries of the anterior part of the pelvic circle (pubic or ischial bones) patient is positioned in bed with slightly adducted and half-bent legs (for better muscles relaxation. High roller is placed under knee joints. The duration of the bed rest for patient and the term of the load on the lower limbs depends on the character and the size of injury. In pelvic bones fractures without impairment of the pelvic circle integrity, the patient can be activated in 4–5 weeks.

In case of the avulsion of the anterior superior iliac spine, conservative treatment is grounded, if the avulsed fragment preserves connection with the maternal bed after patients positioning and manual reposition. Operative treatment is indicated in other cases: fragments reposition and fixation with screws and pins introduced from different directions.

In dislocation fractures of the coccyx, fragments reposition is performed through the rectum. In a long-term period pain in the coccyx or sacrum area can disturb the patient; this is an indication to the physiotherapeutic treatment and novocaine blockades.
To rotatory-instable fractures type B refer longitudinal (in the frontal plane) fractures of the ilium, longitudinal (in the sagittal plane) and oblique fractures of the sacrum. Usually the mechanism of this fractures is direct. Significant dislocation of the fragments is not observed. So, the treatment is conducted by the traction according to the Volkovich during one month.

One-sided fractures of the pubis or ischium – one of the most common Type B pelvic bones fractures. Treatment of the patients with such fractures is usually also conservative – on the hard surface in the position according to Volkovich. In impairment of the pelvic circle integrity (for example, one-sided fracture of the pubis or ischium) the load on the lower limbs is allowed in not earlier than 2–2.5 months after the trauma. Patient is allowed to sit later than to walk.

Fragments fixation and the shortening of the bed rest of the patient with the one-sided fracture of the pubis or ischium is possible with the use of soft special belt, that was developed in the Donetsk research institute of traumatology and orthopedy (Fig. 5.30). It allows to keep both pelvic parts stably. After the end of the acute trauma period, on the 7–10 day after the fracture, patient with applied belt is allowed to walk with crutches, and on the 10–14 day – admissed to the out-patient treatments.

In case of the isolated rupture of the pubic symphysis with diastasis of above 2–2.5 cm, patients are treated using the pelvic belt. After the belt application patients are allowed to stand up (walking with crutches for the period of 2 weeks).

In ruptures of the pubic symphysis, fractures of the anterior pelvic hemicircle bones with the diastasis of above 2–2.5 cm, open reduction is with fragments fixation with the wire or plate or closed reduction with the external fixation (Fig. 5.31).

![Fig. 5.30. Scheme of the pelvoc belt of EV Lobanov construction](image)

![Fig. 5.31. Fixation of the anterior hemicircle injuries with cerclage wire, plate and external fixator of the pubic symphysis](image)
Ruptures of the pubic symphysis or fractures with diastasis of above 2–2.5 cm (B1 type), that occur due to the anteroposterior compression, are accompanied by the partial ruptures of the ventral sacroiliac ligaments.

To rotatory-vertical instable fractures of type C refer the injuries with complete impairment of the pelvic circle integrity with dislocations in different planes and complicated rotatory dislocations in all three planes, which are difficult for reduction and stabilization. The most modern method of their treatment is osteosynthesis, which is aimed at the reduction of the interrelations of the bone fragments and stabilization with metallic constructions till the fracture consolidation. Fixators (external an internal) for both halves of the pelvis should be usually used simultaneously for the stabilization of such injuries. Depending on the injury anatomy, degree of the pelvic stability impairment and interrelations in the hip joint, extrafocal osteosynthesis (Fig. 5.32А), as well as internal (Fig. 5.32B) can be used.

For the choice of the optimal conservative or operative treatment method of the acetabulum fractures and predicition of the results, AO classification should be reasonably used.

Treatment of the acetabulum fractures

Fractures of the one column (Type A) are prognostically more favorable, because the fracture line is usually not at the zone of the axial load and does not create a high risk of postraumatic arthrosis development. Such complications can often be treated with conservative methods, excluding fractures of the posterior or posterio-superior margins of the acetabulum, which are accompanied by the hip joint instability, and also in the transition of the fracture line to the roof of the acetabulum and fragments deviation of more than 5 mm.

In transverse fractures (type B), occurrence of significant dislocations is possible, that requires operative reduction, which is completely recommended in high transverse and T-like fractures of the acetabulum. Conservative treatment can be effective only in low transverse fractures with insignificant dislocation and without the destruction of the acetabular roof.

The most complicated in from the prognostic and tactic point of view are the injuries of both columns (type C), accompanied by the fragmentation of the acetabular roof with formation of the free fragment or significant dislocation of the fragments up to central dislocation fracture in the hip joint. Type C injuries of the hip joint should be treated operatively, excluding the fractures without dislocation.

It should be mentioned, that osteosynthesis in pelvic bones fractures is complicated and responsible intervention, that requires high qualification of the surgeon, proper provision with metallic constructions and drugs. Performing of the external osteosynthesis is also rather traumatic, that makes it performance possible only after certain stabilization of the patient’s general condition. Osteosynthesis performance is impossible or not reasonable in certain circumstances, and the treatment of the instable pelvic bones fractures is carried out by the method of the constant skeletal traction.

So, in fractures of the anterior and posterior parts of the pelvic circle (double vertical fractures of Nalgene) and acetabular fractures, skeletal traction through the distal metaphysis is used (supracondylar area) of the hip or the tibial tuberosity at the leg positioning on the Bohler frame. Skeletal traction lasts for 2–2.5 months in such cases and is tightly combined with the medical gymnastics.
Standing up from the bed and walking with crutches in instable pelvic and acetabular fractures is allowed in 2.5–3 months after trauma, if the treatment was conducted with the skeletal traction use, and in 4–6 months, if the patient was treated with external osteosynthesis. Full load on the leg is possible in the acetabular fractures, as well as in the injuries of sacroiliac junction in terms of 4–6 months. Combination of the rest regimen for the injured area and timely mobilization of joints using active exercises promotes bones fusion in the correct position, preservation of the locomotor function of the lower limb, prevents the development of deforming athrosis.

**TASKS AND TESTS**

**TASK №1**

Patient T, 36 years, was delivered from the car accident. Complains of the pain in neck, body numbness below the shoulder girdles and inability to move with upper and lower limbs. During examination: is in the forced supine position. Head is bent towards the chest and to the right side. Cervical muscles are tensed; spinous process of the VI cervical vertebra protrudes. Pain intensity increases after the pressure applying to the spinous process and head (axial load). Sensitivity is absent below the shoulder girdle level, movements with lower and upper limbs are absent. Make the preliminary diagnosis.

A. Injury of the cervical part of the spine complicated with the spinal roots injury.
B. Spinal cord injury.
C. Cervical muscles injury.
D. Noncomplicated injury of the cervical part of the spine.
E. Complicated injury of the cervical part of the spine complicated with the spinal cord injury.

**TASK №2**

Patient, 52 years, fall from 1 m on buttocks. Complains of the intensive pain in the lumbar part of the spine, that irradiate to the hip. Commune fracture of the L1 vertebra was determined during the examination with its height decrease for more than 1/3, integrity impairment and depression of the vertebral body endplate, elbow kyphosis. What is the optimal treatment method in this case?

A. Traction at the pelvic girdle.
B. Single-stage reclination with the plaster brace fixation.
C. Operative method (spondylodesis).
D. Functional method.
E. Gradual reclination with the plaster brace fixation.
TASK №3

Patient D, 21 years, heated the bottom with his head during diving. Complain of the pain in the neck, limited and painful head movements. During examination: support head with hands, it is bent towards and to the left side. Cervical muscles tension, spinous process of the IV cervical vertebra protrudes. When the pressure is applied to it and head (axial load) – pain intensity increase. Neurologic deficit is not determined during the examination. Make the preliminary diagnosis.

A. Contusion of the cervical part of the spine.  
B. Complicated fracture of the cervical part of the spine.  
C. Cervical muscles injury.  
D. Noncomplicated fracture of the cervical part of the spine.  
E. Spinal roots injury.

TASK №4

Patient P., 43 years, complains of the pain in the neck, head movements limitation. Injury after the car accident and cars collision. Presence of the CV noncomplicated stable compression fracture of the II degree. What treatment method is reasonable to use?

A. Traction with the Glisson’s loop.  
B. Functional method.  
C. Fixative method.  
D. Operative method (spondylodesis).  
E. Traction with the Glisson’s loop with the following fixation in the collar.

TASK №5

Patient R., 35 years, get trauma in the car accident. Complaint of the pain in the pelvic area, even slight movements increase pain intensity. General condition of the moderate severity. Skin is pale, BP 90/60 mmHg, HR – 110 beats per minute, of a good filling. Pelvic circle deformation is determined visually. Verneuil, Larrey, “stuck heel” signs are positive. Which feature of this injury influence the traumatic shock course more?

A. Pelvic circle stability impairment.  
B. Possibility of the blood circulation impairment in lower limbs.  
C. Possibility of the abdominal organs injury.  
D. Injury of the “cauda equina” with bone fragments.  
E. Massive blood loss and afferent pain impulsion.

TASK №6

Patient M, 52 years, during installation work get the strike with ferroconcrete construction at the right pelvis side. Preliminary diagnosis: pelvic bones fractures with the impairment of the pelvic circle integrity in the anterior part. What radiologic pattern corresponds to this diagnosis?

A. Fracture of both pubic bones.  
B. Fracture of both ischial bones.  
C. Unilateral fracture of the pubic and ischial bone.  
D. Pubic bone fracture on one side and ischial bone on another.  
E. Acetabular roof fracture.

TASK №7

Patient S., 40 years, knocked down by the car. Complain of the pain in the pelvis, involuntary urination, anesthesia in the area of buttocks. Deformation of the pelvic girdle is not determined during examination, Verneuil, Larrey symptoms are negative, “stuck heel” sign is doubtful. In what injury this clinical pattern is most typical?

A. Ischial tuber fracture.  
B. Transverse sacrum fracture.  
C. Iliac wing fracture.  
D. Pubic bone fracture.  
E. Fractures of the posterior acetabulum margin.
TASK №8

Patient, 28 years, was pressed down by the electric locomotive during working in the mine with body rotation around its axis. Complaint of the pain in the area of the pelvis, even slight movements increase pain intensity, hemodynamics is subcompensated. Pelvic circle deformation with upward dislocation of the left pelvis part, hematoma in the area of scrotum and perineum. When the pressure is applied to the iliac wing – pain intensity sharply increases. What injury is more probable in the patient?

A. Bilateral fracture of iliac wings.
B. Pelvic injury with the integrity impairment of the posterior semicircle.
C. Pelvic injury with the integrity impairment of the anterior semicircle.
D. Multiple fracture of pelvic bones.
E. Pelvic injury with the integrity impairment of the posterior and anterior semicircles.

TASK №9

Patient S., 37 years, fall in her buttocks from the 5 m height during work. During examination: Pain during the palpation of the gluteal areas and pubic bones, in compression of the iliac wings with the irradiation to the sacral area, function of the lower limbs is impaired due to the pain. Which is the most grounded type of the radiologic investigation in this case?

A. Plan X-ray of the pelvis in the lateral projection.
B. X-ray of the anterior part of the pelvic circle.
C. Plan X-ray of the pelvis in the anteroposterior projection.
D. Plan X-ray of the pelvis in anteroposterior and lateral projections.
E. X-ray of the pelvis in the axial projection.

TASK №10

Patient G., 30 years, during installation work get the strike with ferroconcrete construction at the pelvic area. During examination: hemodynamic indicators are stable, subcutaneous hemorrhages at the area of the posterolateral suraage of the right pelvis side, tenderness during palpation in the area of the right iliac wing and sacrum; Verbeuil, Larrey symptoms are positive. How will you transport the patient?

A. At the stretcher.
B. At the board with the reclination roller under the lumbar part of the spine.
C. At the board with rollers under the knee joints and in the iliac wings area.
D. At the board with immobilization with the Dieterich's splint.
E. At the board with immobilization with Kramer splints.

TASK №11

Patient Y, 36 years, get the trauma in the car accident. Closed instable fractures of the pelvic bones with the anterior and posterior pelvic circles integrity impairments with the dislocation of the right pelvis side proximally, traumatic shock of the III degree was diagnosed before the admission into the hospital. Antishock therapy was started immediately. Chose the optimal treatment tactics of the pelvic bones injury at the stage of the emergency care.

A. External stabilizing osteosynthesis with the apparatus.
B. Skeletal traction.
C. Treatment in the pelvic sling.
D. External osteosynthesis combined with the internal fixation.
E. Extramedullar osteosynthesis of pelvic bones.
TASK №12

Injured in the car accident was delivered to the admission department of the specialized traumatology center. The following was determined during the examination: unstable fracture of the pelvic bones with the integrity impairment of anterior and posterior semicircles, retroperitoneal hematoma, urinary bladder rupture, ureter ruptures, injury of the anal sphincter, traumatic shock of the III degree. Complains of the pain in the pelvic area, abdomen, which are interpreted as manifestations of pseudoabdominal syndrome. What is the cause of the pseudoabdominal syndrome occurrence is more probable?

A. Intraperitoneal rupture of the urinary bladder.
B. Injury of the rectum.
C. Pain irradiation from the area of dislocated bone fragments.
D. Retroperitoneal hematoma.
E. Urinary bladder overfilling due to the ureter injury.

TASK №13

Patient, 39 years, heavy weight fall on his shoulders, so he falls down and lost consciousness. During examination patient complain of the pain in the lower thoracic part of the spine, which intensity increases during movements. Your diagnosis:

A. Explosive fracture of the 10–12 thoracic vertebrae bodies.
B. Luxation of lumbar vertebrae.
C. Fracture of lumbar processes.
D. Injury of ligaments of the lumbar part of the spine.

TASK №14

Patient, 38 years, during work falls from the 5th floor. Complaints of the pain in the area of pelvis and abdomen. During examination tension of the anterior abdominal muscles is observed, upper part of the abdomen participates in the respiration, while the lower one is immobile ("two-storeyed" abdomen). After the intrapelvic blockade performance according to Selivanov from both sides, tension of the anterior abdominal muscles disappear in 3–4 minutes after the blockade. Your diagnosis:

A. Central hip dislocation.
B. Nalgen’s fracture with retroperitoneal hematoma.
C. Fracture of the anterior superior spine.
D. Fracture of the anterior inferior spine.
E. Diagonal Niederle’s fracture.
Fractures of the proximal femoral epimetaphysis are divided into two major groups: intraarticular (medial) and extraarticular (lateral). The boundary between such a division is a place of hip joint capsula adjunction – *linea intertrochanterica*.

Intraarticular fractures are divided into fractures of the femoral head and neck. **Fractures of the femoral head** refer to the severe intraarticular fractures, that occur due to the action of the high-energy traumatic force, and are almost always combined with the posterior (more rare anterior) hip luxation – femoral dislocation fracture, acetabulum fracture (from 10 to 75 %).

Clinical picture and diagnostics depend on the accompanying injuries, symptoms of which prevails over the signs of femoral head fractures. Assessment of the patient’s general condition is obligatory because these fractures are more often the consequence of the high-energy trauma and accompanying injuries require urgent treatment, often – immediate.

Radiologic investigation is conducted in the anteroposterior and oblique projections (in the angle of 45°) according to R. Judet. CT performing is obligatory.

**Treatment.** If the anatomical alignment of the femoral head fragments (dislocation is less than 1 mm) was provided by the closed reduction, which is approved during CT-investigation, further patients treatment using skeletal traction during 1 month is possible with obligatory control of the secondary fragments dislocations. Then the body cast is placed till the signs of the fracture fusion occurrence. But such a category of patients is in the group of a high risk of osteonecrosis and posttraumatic coxarthrosis development.

Operative treatment is indicated in the incomplete reduction, the size and the character of which depends on the type and character of the fracture, preservation of the blood flow and patients general condition. Big fragments are fixed by the screws, with their head positioning in the head deeper or below the level of the chondral surface with obligatory preservation of the *lig. teres* with a vessel, that supplies the head (Fig. 6.1)

Small, located under the ligament, dislocated fragments does not require anatomical reduction and are removed from the joint. Femoral head resection, hemialloplastic or total hip replacement are performed in comminuted fracture with multiple fragments.

**Fractures of the femoral neck** consists 6–8 % of the total amount of the skeletal fractures and up to 68 % according to the femoral bone.

In 90 % of cases, fractures occur in elderly patients (after 65 years), and three times more often in women than in men. Unfortunately, even in the developed countries, 30–50 % of such
patients die during the first year, which is conditioned by complications from forced lying position and exacerbations of accompanying pathology, cardiovascular and pulmonary in the first turn. Factors of this fracture differs a lot in elderly and young patients. If in the first group, on the background of involutional changes, the fracture can occur after the ordinary falling aside, than in younger patients such fractures refer to the high-energy trauma.

Fractures of the femoral bone are divided by localization into: subcapital (fracture line passes directly under the head), transcervical (through the middle) and basilar (fracture line is in the basis of the neck) (Fig. 6.2).

**Femoral head is supplied with blood from:**
- intraosseous vessels;
- lig. teres artery (supplies with blood only the small segment of the head);
- reticular vessels of the capsule.

Localization of the fracture line has a significance for prognosis: the closer it is to the femoral head, the less are chances of its supply preservation.

The main source of the blood supply preservation in the fracture area remain only reticular vessels of the capsule, which does not reduce the risk of aseptic necrosis of the head and fracture non-union (Fig. 6.3). Other negative factors of these consequences are: fragments dislocation, only end-

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6. Injuries of bones and joints of the lower extremity
osteoal way of the operation on the femoral neck, the lytic influence of the synovial fluid on the bone regeneration.

Avascular necrosis of the femoral head can be: early (65–84 %), late (7–27 %) collapse of the head segment – impression of the subchondral zone and the cartilage).

Depending on the neck-shaft angle (NSA – angle, that is formed by the axis of the neck and femoral bone diaphysis, consists 127° in average) femoral neck fractures are divided into:
- adduction (varus) – neck-shaft angle decreases;
- abduction (valgus) – neck-shaft angle increases (such fractures can be impacted) (Fig. 6.4).

For the determining of the fracture stability, the angle of the fracture line is important. The F. Pauwels classification is used for this purpose, where I degree corresponds to the angle below 30°, II – to the angle from 30 to 50°, III – to the angle above 50° (the bigger is the angle, the higher is probability of fragments dislocation and nonunion of the fracture) (Fig. 6.5).
Classification of R. S. Garden (1961) is used for the determining of the fragments dislocation degree: I – impacted fracture, II – fracture without dislocation, III – fracture with insignificant dislocation, IV – fracture with significant dislocation (Fig. 6.6).

Clinical picture and diagnostics. Patient is complaining of the pain in the hip joint area, which is localized under the Poupart’s ligament, loss of the support ability of the limb. Pain increases in palpation. Extremity is shortened and rotated outside (relative shortening take place) (Fig. 6.7).

Pain sharply increases in attempts of passive and active movements, and also in axial load (tipping the heel or along the femoral neck axis). Positive straight leg raise – patient could not raise and hold the straight leg, so he bends it in the hip and knee joints, that leads to the heel slipping along the surface.

In varus fractures, greater trochanter is above the Roser-Nelaton, in valgus – below; Shoemaker’s line in varus fractures passes below the umbo, in valgus – above, impairment of the isosceles Bryant’s triangle is determined (See Fig.1.4).

Radiologic investigation is conducted in two projections (Fig. 6.8). Due to the pain syndrome, the image in lateral projection is performed in the dorsal recumbent position with bending of the knee and hip joints under the angle of 90°. For the diagnosis clarification, especially in the suspicion of the impacted fracture, it is reasonable to conduct computed tomography.
Treatment. Realization of the conservative method requires the use of the body cast (fractures without dislocation) or skeletal traction (2–3 months) + the following body cast (fractures with dislocation). But the age of the patients, accompanying pathology, consolidation period, and mainly – necessity of the long bed rest makes the conservative methods of treatment impossible.

Proper method of treatment of patients with femoral neck fractures is operative, which is realized with two methods: osteosynthesis and endoprosthesis replacement.

Up to 55 years the purpose of the operative treatment is: early atraumatic reduction, compression along the fracture line and stable fixation of the head. Depending on the character of the fracture, treatment is provided by different metallic constructions (Fig. 6.9).

Continuous period (8–10 months) of the lower limb exclusion from the load in elderly patients after the conducted osteosynthesis with often development of the false joint, avascular necrosis of the head due to the weak age-related osteoreparative and devascularization processes, requires the choice of other method of the operative treatment – endoprosthesis replacement of the hip joint (Fig. 6.10).

The method of early patients mobilization is used if the operative treatment conductance is impossible (severe general condition of the patient). On the background of the possible complications prevention, for the saving of patients life, after the pain syndrome decrease in the joint, the patients activation is performed: changing of the position in bed, sitting with dropped legs in the beginning of the treatment, then (3–4 week) standing and walking with go-carts (crunches).

Fractures of the trochanteric area of the femoral bone. These fractures consists 6 % among the injuries of the musculoskeletal system, and up to 52 % among the patients with the femoral bone fractures.

Such fractures are more often observed in the elderly patients (from 66 to 76 years and older), in 4–6 times more often in women than in men. Medical problems of the treatment of patients with
the trochanteric area fractures are conditioned by that the 92% of them have the somatic pathology of one or another degree (chronic diseases of the cardiovascular system, respiratory system and others), which exacerbate after the trauma and lead to the fatal outcome.

Extraarticular fractures, more often comminuted. Depending on the fracture line are divided into: intertrochanteric, transtrochanteric, subtrochanteric and isolated fractures of the greater and lesser trochanters (Fig. 6.11).

AO/ASIF classification, which is represented in the Fig. 6.10, is reasonable for the treatment tactics determining and choice of the MOS method, fractures of the trochanteric area refer to the type A (extraarticular fractures) (Fig. 6.12).

Group A1 – includes simple fractures, which end at the medial side above the lesser trochanter;

Group A2 – fractures with the injury of the medial cortical layer at two or more levels;

Group A3 – fracture line passes through the lateral cortical layer of the femoral bone, as called reversible fractures, which begin laterally and more distal to the lesser trochanter and continue medially and more proximally according to the last one.

Clinical picture, diagnostics. Clinical picture is very similar with the femoral neck fractures:

- expressed pain in the area of the hip joint, especially at the area of the greater trochanter, that increases in the movement attempts and palpation;
- external rotation and relative shortening of the lower limb (multidirectional action of the muscles, external and internal rotators of the both femoral bone fragments);
- greater trochanter is located above the Roser-Nelaton line, Schoemacker’s line passes below the umbo, geometry of the isosceles Bryant’s triangle is impaired;
- Positive straight leg raise test;
- loss of the lower limb support ability.
Fig. 6.12. Trochanter fractures classification according to AO/ASIF
Diagnosis confirmation and determining the fracture character is performed on the basis of the radiologic investigation.

**Treatment.** Trochanteric area is a metaphyseal area, it has good blood supply, which condition the voluminous blood loss in the fracture, and from the other side – creates favorable conditions for fracture consolidation during 3–4 months. So, not only the fracture character influences the treatment tactics, but also the patient’s general condition, for which determining the American Society of Anesthesiologist classification should be used (ASA classification, 1977). In the assessment of the general condition as perfect or good (5 and 4 points) – operative, as well as conservative treatment is possible; in satisfactory and unsatisfactory condition (3 and 2 points according to ASA) operative treatment is indicated, in poor general condition (1 point) patient is inoperable.

Immobilization method as an independent method is practically not used due to the body cast solidity and probability of the incorrect consolidation with the significant shortening of the lower limb. The method of continuous (during 6–8 weeks) skeletal traction through the femoral condyles in the limb abduction position is used among the conservative treatment methods with the following orthosis use (Fig. 6.13). Dosed physical load is allowed in 3–4 months, full – in 5–6b months.

Nowadays preference in the treatment of trochanteric area fractures for earlier patients mobilization is given to operative method, which consists in the open reduction conductance (NDA renovation, liquidation of the rotatory fragments dislocation) and stable functional osteosynthesis of fragments with different constructions (angle plates, DHS-systems, GN-gamma nail. This method allows to start walking using crutches on the 2–3 day after the operation, dosed load – in 1–1.5 months and full load – in 2.5–3 months. Examples of the constructions for the fragments fixation are represented at the picture 6.14.

Method of early patients mobilization is used in patients with severe accompanying somatic pathology, which consists in temporary limb fixation with derotation brace during 2–3 weeks till the pain syndrome decrease with the following patients activation (walking with the go-cart, crutches).
Isolated fractures of the greater and lesser trochanters are observed rarely (are more often combined with other fractures of the trochanteric area).

Fractures of the lesser trochanter refer to the avulsion fractures (impact of m. iliopsoas). Patients complain of the pain in the inguinal area, local edema, hematoma presence. Limb support ability is limited due to the pain increase. Diagnosis is confirmed radiologically. Treatment is conservative: limb is flexed up to the right angle, slight adduction and external rotation. Working capacity recovers in 7–9 weeks.

Isolated fracture of the greater trochanter is a consequence of the direct trauma mechanism – falling on the greater trochanter, rare – due to the extensive tension of the gluteal muscles. Local tenderness, hematoma in the greater trochanter area, limited abduction and external rotation of the limb are typical. Limb support ability is limited due to the pain.

Fractures without dislocation are treated conservatively in the position of the maximal limb abduction, in dislocation – operatively (Fig. 6.15).

Working capacity recovers in 7–9 weeks.

HIP LUXATION

Hip luxation can be the result of the high-energy trauma (catatrauma, car accident, industrial, sports injury). Mechanism – impact of the extensive force along the femoral axis in the position of the 90° flexion in the hip joint – posterior hip luxation (70 %). Extensive abduction with external hip rotation and force impact along the hip axis promotes the anterior luxation (10–15 %). Impact of the extensive force in the frontal plane at the greater trochanter area – central luxation (rare).

Hip luxation is associated with other injuries of the human body (polytrauma), with danger of the femoral head blood supply impairment (capsula is ruptured, the remaining part of the capsule is stretched in the state of luxation – reticular vessels are damaged and compressed, lig. teres is ruptured).

Thomas – Epstein classification:
- **Type 1** – isolated luxation or combined with the fracture of the lesser part of the posterior acetabular margin.
- **Type 2** – luxation with the fracture of the big fragment of the posterior wall of the acetabular roof.
- **Type 3** – luxation with comminuted fracture of the posterior wall of the acetabular roof.
- **Type 4** – ”central” luxation of the femoral head.
- **Type 5** – luxation with the femoral head fracture.

Clinics, diagnostics. Forced limb position: in posterior luxation – hip is flexed, in internal rotation and adduction, in anterior luxation – hip is flexed, in external rotation and abduction. Expressed tenderness, positive symptom of the springing moves in the joint, relative limb shortening. Radiographic imaging of the hip joint confirms the diagnosis (Fig. 6.16).
Injuries of bones and joints of the lower extremity

Treatment. Patient requires the emergency care during the first 6 hours. Reduction is performed under the general anesthesia with muscle relaxants use. Reduction technique according to Allis: patient lies on the back, assistant holds the pelvis. Doctor gradually bends the leg in the hip joint up to 90° in the slight traction mode, increases traction and performs internal rotation.

After reduction:
- Patient is prohibited to adduct and perform internal hip rotation;
- is prohibited to flex the hip fo more than 60°;
- is allowed movements in the joint in the small range;
- walking using crutches without loading leg during 4–6 weeks;
- repeated X-ray control before the load starts.

Indications for operative treatment:
- Impossibility of the hip luxation reduction performed with opened method (tissues interposition);
- type 2, type 5 – requires the reconstruction of the posterior wall of the acetabular roof – opened reduction, osteosynthesis;
- bone fragment incarceration in the joint – requires removal and abrasive polishing of the defect.

Skeletal traction during 6–8 weeks can be performed incompletely reduced (incongruent) luxations in types 1, 3, 4; recurrence of luxation.

Possible complications: sciatic nerve neuritis (10 %), avascular necrosis of the femoral head (1–20 %), posttraumatic coxarthrosis, recurrence of luxation.

Fractures of the femoral diaphysis

Part of this fractures in the structure of the musculoskeletal system trauma consists 15–16 %. High-energy direct mechanism of the injury prevail.

Diaphysial fractures are divided by localization into the fractures of the upper, middle and lower third. Typical fragments dislocation occurs due to the muscles impact depending on the level of fracture (Fig. 6.17).
In femur fracture in the upper third, proximal fragment is abducted outside due to the impact of gluteal muscles, and due to the impact of iliopsoas muscle is dislocated towards and rotated outside; distal fragment – is dislocated inside and upwards (impact of the adductor muscles), that leads to the typical deformation occurrence – "riding breeches" (angle formed by the fragments is opened inside).

In fractures of the femur diaphysis in the middle third, proximal fragment shift aside (impact of the gluteal muscles), distal – inside (adductor muscles).

In fractures in the lower third of the femur, proximal fragment shift inside (impact of adductor muscles), and distal – due to the impact of the gastrocnemius muscle shift backwards.

It is rational to use AO / ASIF classification for fractures specification.

**Clinical picture, diagnostics.** Clinical diagnostics have no difficulties. Patient complains of intensive pain in the area of fracture, that increases in moving efforts, supporting function impairment, deformation, anatomical and projection hip shortening, pathological mobility and fragments crepitus, external limb rotation are determined. Control of the peripheral blood flow is obligatory, especially in fractures of the hip lower third. Except local changes, general condition of the organism is also impaired, the clinical pattern of shock is often observed. Radiography specifies the fracture localization and character of the fragments dislocation.

Providing of the medical care at the pre-admission period includes adequate limb immobilization with improvised materials or special splints.

**Treatment.** Conservative treatment method of hip fractures is realized through the continuous skeletal traction and use of the body cast. But continuous bed rest (8-10 weeks) in similar traction position cause discomfort in patient, need of individual care for patients in recumbent position from medical staff, prevention of complications, that are connected with this condition, difficult control of the reduction, possibility of the secondary fragments dislocation, necessity of the massive body cast use in the future for the continuous period of time, development of postimmobilization contractures in joints, continuous regenerative treatment, etc. – significant limitation of this treatment method.

So, the modern method of treatment of dyaphysial fractures of the femur is operative, which is realized through the stable OS of fragments with different metallic constructions (interlocking nail, plates), skeletal fixation device depending on the fracture character and patients general condition (Fig. 6.18).

**Fractures of the femur distal epimetaphysis.** These injuries consist 6–8 % of all femur fractures and refer to the high-energy injuries, which occur in car accidents, fall from a height, etc.

**Clinical picture, diagnostics.** Patients complain of the pain in the lower hip third, area of the knee joint; impossibility of the active movements in the joint, impairment of the lower limb function and also support ability. Deformation of the knee joint due to the fragments dislocation and hemarthrosis (group B,C fractures), impairment of the limb axis and limb shortening are determined during examination – local tenderness in this area; signs of hemarthrosis ("patellar ball-lottement" sign), pathological mobility of fragments. It should be remembered, that fractures of the distal femoral epimetaphysis are accompanied by the injuries of menisci and ligamentous ap-
Injuries of bones and joints of the lower extremity

paratus of the knee joint in 8–12% of cases. But testing of this condition is rather inaccurate in the acute period, so it should be delayed and conducted during and after osteosynthesis. Injury of the popliteal vessels with sharp distal fragment (due to the impact of gastrocnemius muscle distal fragment shifts backward) is observed in 3% of cases, so control of the peripheral blood flow is obligatory.

Radiological investigation allows specifying the fracture character.

Providing of the medical care at the pre-admission stage includes appropriate limb immobilization with improvised materials and special splints in the position of 30° flexion (for the relaxation of the triceps muscle of calf).

Treatment. In intraarticular fractures without bone fragments dislocation, knee joint puncture is performed, lower limb is fixed by the long leg cast up to 16 weeks. Fractures of this localization are mainly with dislocation, instable, so the skeletal traction (45–60 days) is used in conservative treatment for fragments reduction and retention, and after the primary callus formation – limb is finally fixed with the long leg cast (Fig. 6.19) for 8–12 weeks.

Operative treatment is realized through the opened fragments reduction and osteosynthesis, depending on the fracture character (Fig. 6.20).

![Image](image1.png)

*Fig. 6.18. Intramedullary blocking osteosynthesis. Extramedullary osteosynthesis with metallic plate and pin-nail device of external fixation (patients view)*

![Image](image2.png)

*Fig. 6.18. Intramedullary blocking osteosynthesis. Extramedullary osteosynthesis with metallic plate and pin-nail device of external fixation (patients view)*

![Image](image3.png)

*Fig. 6.18. Intramedullary blocking osteosynthesis. Extramedullary osteosynthesis with metallic plate and pin-nail device of external fixation (patients view)*

![Image](image4.png)

*Fig. 6.18. Intramedullary blocking osteosynthesis. Extramedullary osteosynthesis with metallic plate and pin-nail device of external fixation (patients view)*

![Image](image5.png)

*Fig. 6.18. Intramedullary blocking osteosynthesis. Extramedullary osteosynthesis with metallic plate and pin-nail device of external fixation (patients view)*

![Image](image6.png)

*Fig. 6.18. Intramedullary blocking osteosynthesis. Extramedullary osteosynthesis with metallic plate and pin-nail device of external fixation (patients view)*

![Image](image7.png)

*Fig. 6.18. Intramedullary blocking osteosynthesis. Extramedullary osteosynthesis with metallic plate and pin-nail device of external fixation (patients view)*

![Image](image8.png)

*Fig. 6.18. Intramedullary blocking osteosynthesis. Extramedullary osteosynthesis with metallic plate and pin-nail device of external fixation (patients view)*

![Image](image9.png)

*Fig. 6.18. Intramedullary blocking osteosynthesis. Extramedullary osteosynthesis with metallic plate and pin-nail device of external fixation (patients view)*

![Image](image10.png)

*Fig. 6.18. Intramedullary blocking osteosynthesis. Extramedullary osteosynthesis with metallic plate and pin-nail device of external fixation (patients view)*

![Image](image11.png)

*Fig. 6.18. Intramedullary blocking osteosynthesis. Extramedullary osteosynthesis with metallic plate and pin-nail device of external fixation (patients view)*

![Image](image12.png)

*Fig. 6.18. Intramedullary blocking osteosynthesis. Extramedullary osteosynthesis with metallic plate and pin-nail device of external fixation (patients view)*

![Image](image13.png)

*Fig. 6.18. Intramedullary blocking osteosynthesis. Extramedullary osteosynthesis with metallic plate and pin-nail device of external fixation (patients view)*
INJURIES OF KNEE JOINT MENISCI AND LIGAMENTS

Knee joint ligaments are divided into extraarticular and intraarticular. To intraarticular ligaments refer anterior and posterior crucial ligament, to extraarticular – tibial and fibular collateral ligaments, patellar ligament, and also ligamentous complex formed by the thickening of posteromedial and posterolateral parts of the knee joint capsule.

Lateral stability of the knee joint is provided by the following structures:

- Medial part: superficial and deep parts of the medial collateral ligament, articular capsule, posterior capsular part with posterior oblique ligament, patellar retinaculum.
- Lateral part: lateral collateral ligament, articular capsula, iliotibial tract, m. biceps femoris, popliteal ligaments.
- Anteroposterior stability of the joint is provided mainly by the anterior and posterior crucial ligaments.
- On the tibial articular surface lies medial and lateral menisci of the semilunar shape – fibrocartilaginous "padding" (Fig. 6.21).

Fig. 6.21. Anatomical features of menisci
Functions of menisci:

- complement ligament functions in the joint stabilization (mainly posterior horns);
- 40–70% of the axial load on the knee joint is transferred through menisci (protection of the articular hyaline cartilage of contacting surfaces);
- amortization function in extensive loads;
- increase congruence of the contacting articular surfaces by 40% (an adaptation of the spherical femoral condyles to the plane form of the proximal tibial epiphysis);
- reallocate the synovial fluid among articular bursae;
- complement the knee joint movement biomechanics (locking mechanism, rotatory movements control, etc.).

Injuries of the ligaments, menisci in the young age are more often observed during the active, team and contact types of sports (football, volleyball, downhill skis, wrestling, diving, etc.).

Combined mechanism of the injury is frequent:

- abduction, internal rotation with flexion in the knee joint (body rotations on the fixed supporting leg);
- adduction, external rotation with the flexion of the knee joint;
- overextension with rotation in the joint;
- anteroposterior dislocation of the shin in direct trauma mechanism.

Injury of the knee joint menisci. Frequency in the musculoskeletal system injuries structure consists up to 17%.

Each meniscus has an acute free margin, that is orientated in the articular cavity, and wide paracapsular part, that is usually tightly joined with the knee joint capsule. Each of the menisci has anterior horn, body and posterior horn (Fig. 6.23). Blood supply of the meniscus is provided by the small vessels and capillaries from the knee joint capsule. So, only the small part of the meniscus (paracapsular of 1 mm width) has good blood supply. This is a "red" zone of the meniscus. The following is the "red-white" of the meniscus with 1 mm width. It has capillaries, but a very small amount. The biggest zone of the meniscus (almost 80% of the width, or 8 mm) is the "white" zone, where capillaries are absent (Fig. 6.22).

Such division into zones is very important for the assessment of reparative capabilities in meniscus traumatic injuries – ruptured in the "red" or "red-white" zones meniscus can knit. In "white" zone rupture regeneration is impossible.
Trauma mechanism is combined – in extreme movement in the joint, meniscus is clutched between femoral and tibial condyles and is teared off the main part or fixation area; its crushing is also possible. Injuries of the internal meniscus are observed more often (71 %), because it is fixed more to the knee joint capsule – less mobile, bigger in diameter, thinner at the periphery, lesser in width. Lateral meniscus is mobile in traumas (can change its position in the joint). is fixed with separate ligament to the femoral condyle, is injured rarer. Injuries of the menisci are often combined with injuries of ligaments, knee joint cartilage.

Menisci in older people are less elastic, can be injured on the background of dystrophic processes in the joint (osteoarthrosis) and, particularly, degenerative processes in menisci. In such cases injuries can occur in usual movements in the joint, for example, during usual squat. Posterior meniscus horn is injured more often in the area without blood supply. Menisci are often injured on the background of chronic instability in the knee joint.

Menisci injuries classification

According to the rupture character: traumatic, degenerative; according to localization: anterior horn, body, posterior horn; according to ruptured zone: red, red–white, white; according to spatial orientation and rupture type: vertical, horizontal, radial, "bucket-handle", "parrot’s beak", horizontal flap (Fig. 6.23).

Acute meniscus injury (during 1 week after the primary injury), subacute (7–21 days) and old injuries (if more than 3 weeks passed from the moment of the primary injury) are defined. This division is important for the reparation position of the injured meniscus part – if the injury takes place in the area with blood supply (red, red–white), but more than 1 week passed from the moment of trauma, than the possibility of the injured parts union is low; especially, when more than 1 month passed from the injury (there is no sence to rely on the union of the injured parts).

Clinical picture, diagnostics. There is no clear clinical symptoms in acute meniscus injury, because all of them are masked under such relative symptoms as sharp pain along the joint space above the meniscus projection, swelling of the knee joint, impairment of the knee joint movement function and supporting function of all lower limb. Hemorrhage into the articular cavity – hemarthrosis – in injuries in the "red" or "red-white".

The only reliable symptom on the background of the typical trauma mechanism can be the locked knee joint – impossibility to completely unbend leg in the knee (entrapping of the meniscus part between the articular surfaces).

In suspicion of the meniscus injury (as well as in all other traumas of the knee joint) radiography in two projections, sonographic investigation and magnetic-resonance tomography (MRI) of the knee joint should be performed. Meniscus is not visualized at the radiograph, because it is a cartilaginous structure, but fractures of bones, that forms the knee joint, can be excluded. Sonography of the knee joint – quick, convenient and noninvasive method, that has a high efficacy for determining the pathology of the synovial sheath, extraarticular ligaments and menisci; there is also a possibility to perform their dynamic visualization during movements. MRI – even more efficient in determining of the examined structures pathology and also an exclusive sensitivity to the pathology

N.B. Hemarthrosis can also be in:
- injury of the anterior or posterior crucial ligament;
- osteochondral fractrue of the tibial, femoral bones, patella;
- complete rupture of the collateral ligament, capsula;
- luxation of the patella.
of the articular cartilage, intraarticular ligaments and bones. Dynamic MRI investigation is more informative, but it is almost not used in everyday clinical practice. There is some difficulties in conducting MRI in obese patients and patients with claustrophobia, it is impossible in patients with any metal with magnetic properties in the body. So, it is better to perform all the complex of additional investigations, because they do not replace, but complement each other.

Clinical diagnostics is considered informative in the remote period after trauma, when acute manifestations of the pain syndrome and reactive changes of tissues around the joint disappear. Main, but not mandatory symptom are periodic "locks" in the knee joint with pain and impossibility to unbent the leg completely, that occur after certain movements (recurrent entrapment of the ruptured part of the meniscus between articular surfaces) or patients feeling, that something impede normal movements in the knee. Joint lock can dissolve spontaneously – enough for patient to bent-unbent the knee and to shake with leg.

Patient can periodically feel a "click" with pain in the corresponding part of the joint. It is difficult for patients to walk down the stairs ("stairs" symptom of VP Perelman). Provocative palpatory tests on the side of injury along the joint space are performed, that determine local pain, "click" or local protrusion (Table 1). But any test is not diagnostically reliable. They should be determined in combination – reliability 60–90 %.

Synovitis often occurs in patients with old injuries of menisci, that limits the maximal movements amplitude in the joint. Significant help in making the diagnosis provides additional methods of investigation, that were mentioned above at diagnostics of acute injuries.

Treatment. Providing of medical help at the pre-admission stage includes limb immobilization with special splints for excluding movements in the joint, unloading the leg (crunches), nonsteroidal anti-inflammatory drugs, analgesics, ointments.

If there is an acute meniscus injury in the "red" zone, which is accompanied by hemarthrosis, is confirmed by MRI, the possibility of the damaged part reparation is high. Conservative treatment (elimination of the knee joint lock and limb immobilization for 4 weeks with plaster splint or standard splint with unloading of the injured leg and expectations, that the meniscus injured part will adhere to the articular capsule) as well as operative treatment (suture of the meniscus injured part up to the place of rupture with following knee joint immobilization for 3 weeks, that provides higher chances of the meniscus injured part healing).

Reduction of the injured meniscus in the knee joint lock is performed by the following way. Intraarticular fluid is evacuated from the joint (blood in hemarthrosis or synovial fluid in synovitis, 50–60 ml of 0.5 % novocaine solution is injected. After 15 minutes in the internal meniscus block, flexed under the right angle knee is maximally abducted and then in this position external and internal rotation is performed, supporting the abduction. In maximal internal rotation and extension by the shin, it extension is performed immediately. Complete extension and painless movements indicate the lock elimination (Fig. 6.24).

If there is a meniscus injury in the "white" zone according to MRI results, then the union of the injured part is impossible. In this case, operative treatment consists in the deletion of the damaged meniscus part.

Following rehabilitation treatment in both cases includes physiotherapeutical methods, exercise therapy for the strengthening of limb muscles. Working capacity is recovered in 5–6 weeks in the absence of any other injuries in the area of the knee joint.

Operative treatment is indicated in old traumatic and degenerative injuries of the meniscus –

N.B. Symptoms of periodical "lock" in the knee joint should be differentiated with:
- foreign, osteochondral free bodies in the joint in osteoarthrosis, Koenig's disease;
- recurrent patella luxation;
- fracture of intercondy lar eminence of the tibia.
**Table 1**: Clinical tests for diagnostics of the menisci injuries

<table>
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<th><strong>NI Baykov symptom</strong></th>
<th><strong>Local pain in passive extension of the knee joint</strong></th>
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| **Apley’s test** | **Patients lies on the belly, leg is flexed in the knee joint under the 90°. Doctor fix the hip and rotate shin with axial load** |

| **McMurray’s sign** | **Local pain, “click” of meniscus in passive bending and undending with internal shin rotation and second stage of the external rotation** |

| **Steinman test** | **Patient is sitting, legs are hanged down. Doctor perform shin rotation** |
deletion of the injured meniscus part (partial meniscectomy). It is very important to leave intact part of the meniscus for the preservation of stabilization and amortization functions. Suture of the meniscus is not reasonable in old injuries, as the possibility of reparation is minimal. A significant advantage is minimally invasive arthroscopic technology of the knee joint surgery (Fig. 6.25).

It has a number of significant advantages towards the operative interventions: significantly smaller intraoperative trauma, lesser postoperative pain syndrome and posttraumatic joint reaction, correspondingly – absent or short-time limb immobilization and fast rehabilitation. Working capacity is recovered after arthroscopy in old injuries of menisci in 2–3 weeks, in arthrotomy – in 4–6 weeks.

If timely treatment of meniscus injury is not performed, than periodical entrapment of the injured part leads to the mechanical destruction of the articular cartilage, that has no vessels and possibilities for regeneration. This can lead to the occurrence of degenerative changes and osteoarthritis development.

**Fig. 6.24. Removal of the internal meniscus lock of the knee joint**

**Fig. 6.25. Arthroscopic picture of the menisci injuries**

**RUPTURE OF THE KNEE JOINT LIGAMENTS**

**Injury of the medial and lateral collateral ligaments (MCL, LCL)**

Rupture of MCL occurs in combines trauma mechanism with extensive shin abduction. Rupture can be complete or partial and has the injury localization: in place of ligament attachment to the femur – more often (Fig. 6.26), or at the place of attachment to the tibia, or at the level of joint space.

Mechanism of LCL rupture is opposite to the MCL rupture in shin adduction.

Clinical picture, diagnostics. Local pain, swelling and hematoma correspond to the area of injury. Positive test of shin valgus deviation in MCL injury, ie external shin deviation is observed (Fig. 6.27).
Shin deviation in partial rupture is less than 10°, opening of the joint is space from the corresponding side is less than 10 mm, in complete – correspondingly more than 10°, 10 mm.

Sonographic investigation of the knee joint is effective, especially in performing of the valgus test and MRI. It is possible to make a diagnosis according to radiographic image only in the case of ligament abruption with part of the cortical layer.

Treatment. Acute (up to 10 days), subacute (up to 3 weeks) partial ruptures are treated conservatively by rigid immobilization of the knee joint – long leg cast in the position of 10–20° bending for 6 weeks, unloading of the leg with crunches with following gradual increase of load on the limb and knee joint immobilization with elastic bandage or orthosis for the following 2 weeks. Exercise therapy, massage, physiotherapeutical procedures are administered in the rehabilitation period.

In acute complete ruptures, especially in younger people, operative treatment is conducted: suture of the ligament or its reinsertion to the attachment area to the bone with the following immobilization with the long leg cast for 6 weeks.

In old injuries of the ligament (more than 3 weeks) frontal instability of the knee joint develops, that impairs the joint function, promotes the development of degenerative processes. Elective reconstructive-reparative operative intervention is indicated. Working capacity recovers in 10–12 weeks.

Injuries of the crucial ligaments. Injury of the anterior crucial ligament (ACL) is observed more often than injuries of the posterior crucial ligament (PCL). Rupture of the PCL is often combined with the injury of the MCL, meniscus, cartilage.

Injuries of the crucial ligaments cause instability of the knee joint.

Clinics, diagnostics. At the moment of trauma patient experiences acute pain, like something "crunched" and moved in the joint, loose function of the joint. In acute period – hemarthrosis.
After subsiding of the traumatic processes in the knee joint, periodical knee instability starts to disturb the patient and uncertainty in physical activities, walking in a rough surface, inability to do sports. Recurrent instabilities are accompanied by synovitis (synovial fluid hyperproduction into the articular cavity). Anteromedial instability occurs in ACL injury, in PCL injury – posterolateral instability. Instability is divided into acute (up to 10 days), subacute (up to 1 month), and chronic (more than 1 month).

Most valuable diagnostic symptom of the crucial ligament rupture is as called drawer test (Fig. 6.28).

Hip muscles should be relaxed, the patient is in the dorsal recumbent position, knee in flexed under the right angle, and the hip joint under the 45°. Doctor fixes patients foot with his hip and grasps the upper third of shin with both hands and tries to move shin towards or backwards. Shin can be easily moved towards in ACL rupture against the hip, and in PCL rupture – backwards.

Modification of the drawer test is also effective, as called Lachman test – when the shin dislocation is determined in 20–30° flexion in the knee joint.

MRI is performed in acute period, when the clinical pattern has no specific signs. USD is not informative – ligaments can not be completely visualized, as bones impede this, because ultrasound waves are completely deflected from them. Only ACL tearing with the bone fragment can be diagnosed at radiograph.

Treatment. Anterior crucial ligament tears off more often at its place of the attachment to the bone. There is no reason to rely on the ligament union to the attachment place as the collagen fibers of the ligament decrease their length immediately after trauma, and the remaining ligament resolves gradually or cicatrize in the elongated state and does not perform its function. So, if the ACL injury is diagnosed in the acute period, limb is immobilized in the 10–20° flexion in the knee joint for 3–4 weeks and the load on the injured limb is limited (walking with crunches). Punction of the knee joint should be performed if there is tensed hemarthrosis or synovitis for fluid evacuation. Exercise therapy, symptomatic conservative and physiotherapeutical treatment, anesthesia for decreasing of the joint tissue reactivity to trauma are administered at the same time. Patient undergoes rehabilitation treatment after the bandage removal.

If patient has complaints of the knee joint instability after the rehabilitation treatment (ie knee joint instability has signs of decompensation), operative treatment is suggested – ACL plastics.

Operative intervention in acute period (up to 7 days) is conducted in athletes. Complete knee stability not only due to the dynamic stabilizers (muscles), but also static stabilizers (ligaments) are necessary for doing sports. Performing of the operative intervention in the subacute period (from 7 days till 1 month) is not advisable, because of the increased posttraumatic reactivity of the articular soft tissues to cicatricial changes remains – arthrofibrosis with the development of stable knee flexion-extension contracture in the postoperational period is considered as unfavourable result of treatment.

Ligament autoplast with tendons of semitendinous and gracilis muscles, middle portion of the popliteal ligament with osseous blocks, and also alloplastic of tendinous allotransplants with popliteal ligament are used for plastic reconstruction of crucial ligaments. Significant advantages has the minimally invasive arthroscopic surgery technique of the crucial ligaments plastics.
Technique features. After joint revision, apertures are made with drill along the natural passing of crucial ligaments. Transplant is conducted through the apertures. It is fixed in the channel and by interferential screws made from biodegradable materials or titan or other intrachannel or extrachannel fixing devices (Fig. 6.29).

Knee joint immobilization and limb unloading in the postoperational period after crucial ligaments plastic can consist from 2 to 6 weeks depending on the operation performing technique and choice of the transplant fixation method. Patient uses functional orthosis, does medical exercise, receive physiotherapeutical

Fig. 6.28. Diagnostics of the anterior crucial ligament injury. A – anterior “drawer” test; B – “Pivot shift” test or Jerk test; C – Lachman test; D – MRI-pattern of the intact (left) and injured (right) anterior crucial ligament

Fig. 6.29. Methods of ACL plastics with autotransplant: A – popliteal ligament; B – tendons of m. semitendinosus, gracelis
treatment during the rehabilitation period. It is possible to return to the sports loads after the ACL recovering only in 5–6 months after the operation, after the PCL recovering – after 1 year.

**SHIN LUXATION**

Shin luxation in the knee joint can be the result of the high-energy trauma (car accident, production, sports trauma, etc.). Trauma mechanism – direct as well as indirect.

**Classification of the shin luxation:**
- anterior (27%);
- posterior (70%);
- medial, lateral, rotation (3%).

**Clinical picture, diagnostics.** Knee deformation, forced leg position, an impossibility of movements in the joint, expressed pain. Knee joint radiograph confirms the diagnosis (Fig. 6.30).

**Treatment:** reduction is performed under the local anesthesia by traction along the limb axis and manipulation with the upper shin third in the direction opposite to the luxation direction.

Condition of the articular ligaments is assessed after reduction by the check of clinical tests. Leg is fixed with the long leg cast in the position of 30° flexion, radiography, MRI control are performed.

**Schenck classification (in Nascher modification) divides the character of articular tissue injury in luxation:**
- Type 1 – lateral collateral ligament + ACL or PCL
- Type 2 – ACL + PCL
- Type 3 – ACL + PCL + 1 lateral collateral ligament + posteromedial (posterolateral) ligamentous complex;
- Type 4 – ACL + PCL + lateral collateral ligaments + posteromedial + posterolateral ligamentous complex;
- Type 5 – fracture of bones, that form the joint + ligaments rupture.

Operative treatment is conducted in the acute period: renovation of the ACL or collateral ligament, long leg cast is placed for 6 weeks. Orthesis is placed on the joint for the following 4 weeks with continuous rehabilitation treatment. If the knee joint instability is determined, the following routine operative treatment (arthroscopy) for the joint stability renovation is offered.

**Fracture of the patella.** Frequency of the patella fractures in the structures of the musculoskeletal system traumas consists from 1.5% to 2%.

**Main function of the patella** – increases for more than 60% the extensor action mechanism of the quadriceps muscle in the knee joint (patella – force lever: of the long arm – muscle, short – patellar ligament).
Fig. 6.30. At radiographs: shin luxation in the knee joint: A – posterior; B – anterior (in lateral and frontal projection)

Fig. 6.31. Types of patellar fractures

Mechanism of the trauma is direct. Character of injury depends on the acting force of the traumatic agent, and dislocation depends on the degree of the patellar ligamentous apparatus injury. Fractures are comminuted in 48 %, in 32 % – simple transverse, in 18,5 % – apical fractures, in 1,5 % – basis fractures (Fig. 6.31).

Clinical picture, diagnostics. Clinical pattern is characterized by: local tenderness, impossibility to lift stretched leg, hemarthrosis and swelling of the articular tissues, retraction of the soft tissues between fragments, which is conditioned by the fragments dislocation; crepitus. Diagnosis is confirmed radiologically (Fig. 6.32).

Treatment. In fractures without dislocation, in hemarthrosis presence, puncture of the joint and limb fixation with the long leg cast or orthosis for 5–7 weeks is performed (Fig. 6.33). Working capacity is renovated in 8–10 weeks.
Injuries of bones and joints of the lower extremity

Operative treatment with fragments metal-fixation is indicated in fractures with dislocation depending on the fracture type: wire, screws, according to Weber (Fig. 6.34).

SHIN BONES FRACTURES

Fractures of the proximal epimetaphysis of the tibia consists from 8.9% to 11% in relation to the shin bones fractures and up to 87% among the bones, that form knee joint.

Fractures of the lateral condyle are observed in this group in 52% to 80% of cases, medial – up to 7%, and multifragmental fractures – in 41% of patients. Part of this fractures sharply increases with the patient’s age – 1% od all fractures types in young and 8% in elderly people.

Fractures of this localization are accompanied by the injury of other knee joint structures in 56% cases. Menisci injuries are diagnosed in 50–85% of patients, collateral ligaments – in 20–83%, anterior crucial ligament – 20–69%, tendons of femoral muscles – up to 47%, ruptures of the articular capsule – up to 75%, fibular nerve – in 3% of cases.

Schatzker classification is used for fractures of such localization characteristics (Fig. 6.35).

**Schatzker I** – injury, that is characterized as the vertical isolated fracture of the lateral condyle with typical dislocation: aside and downwards.

**Schatzker II** – characterized as the vertical isolated fracture with the presence of the part of the lateral condyle compression.
Schatzker III – injury, that is characterized by the articular surface impression with preservation of the cortical layer integrity.

Schatzker IV – injury, that is characterized as vertical isolated fracture of the medial condyle with typical dislocation: medially and downwards.

Schatzker V – injury, that is characterized as the fracture of both tibial condyles, which is the result of the high-energy traumatic influence and is accompanied by the severe injury of the soft tissue.

Schatzker VI – characterized as the fracture of one or both condyles with the diaphysial fracture of the tibia.

Clinical picture, diagnostics. Complaints of the pain in the knee joint area, impossibility of active movements in the joint, impairment of the lower limb function. Deformation of the knee joint, valgus or varus deformation of the limb axis (depending on whether lateral or medial condyle is injured) passive position of the lower limb are determined during clinical investigation. Local tenderness of the proximal tibial epimetaphysis and knee joint, signs of hemarthrosis (positive patella ballottement test), pathologic mobility and fragments crepitus are revealed during palpation. Radiologic investigation besides classic projection is additionally conducted under the 45° angle (three-fourth projection). CT specify the fracture character.

Treatment. Limb is immobilized with long leg cast in fractures without dislocation for the term of 6–8 weeks; full load on the limb is allowed after the union (in 3 months).

Closed single-stage reduction after local anesthesia is performed in the condyles dislocation (Fig. 6.36, 6.37).

Taking into account the fragments instability, conservative method is more often realized by the skeletal traction for the period of 4–6 weeks with following immobilization with the long leg cast.

Taking into account the fracture character and disadvantages of the conservative method, fractures with dislocation or articular surface compression of more than 4 mm are nowadays more often treated surgically, when the fixation method depends on the fracture type according to Schatz-
Injuries of bones and joints of the lower extremity

Significant positive step in treatment of such fractures is introduction of the arthroscopic method, that allows avoiding the arthrotomy conduction, completely visualize structures of the knee joint (menisci, ligaments), perform adequate control over the reduction and unite metalosthesynthesis with operative intervention for this structures injury. It is reasonable to use arthroscopic method in first days or after the 7 days after the trauma, which is due to the reparative reactivity of the articular soft tissues. Minimization of the operative intervention damage leads to the reduction of complications numbers in the post-operative period, promotes fast recovery of the function and movements range and as a consequence, - shortening of the working capacity loss period.

Fractures of the head and neck of the fibula. Isolated fractures of this area are observed rather rare and are more often the accompanying injuries in the tibia fractures. Manifests clinically with local pain, that increases in the tension of the biceps muscle of thigh. Function of the lower limb is preserved. But fibular nerve, external collateral ligament of the knee joint and anterior tibial artery can be damaged in fractures of the upper part of the fibula.

Dyaphysial fractures of the shin bones. Part of this fractures in the structure of the musculoskeletal system traumas consists up to 14 %.
Mechanism of the shin bones fractures can be direct (kick at the shin, that lead to the bumper fractures occurrence) or indirect – rotational moment with foot fixation. Direction of the fragment dislocation depends on the direction of the traumatic agent action, and then the longitudinal dislocation occurs due to the muscles impact. Proximal fragment dislocates towards in the fracture of the diaphysis upper third under the impact of the quadriceps muscle. Open fractures are rather often – tibial crest is covered only by skin and subcutaneous tissue. Area of the insufficient blood supply of the bone is at the level of distal diaphysis third (periosteum is covered with skin, junction of the endosteal vessels).

Isolated fractures of the tibia and fibula and fractures of both bones are defined, and by localization – fractures of the upper, middle and lower third. It is reasonable to use AO/ASIF classification for the fracture specification, which is identical to characteristics in the femoral diaphysis fractures.
Clinical picture, diagnostics. Clinical manifestations of the diaphysial fractures of the shin are typical for the long bones fractures. Complaints of the pain in the area of the shin injury, impairment of the leg supporting ability. Local swelling, hematoma are typical during the examination. Tibia is accessible for palpation, so character of dislocation, pathologic mobility and fragments crepitus can be determined. Radiographic examination in two projections specifies the character, localization of the fracture and type of the fragments dislocation.

Treatment. Conservative treatment is realized by the immobilization in stable (transverse or oblique) fractures without dislocation and after single-stage reduction in the dislocation presence. Skeletal traction is used in unstable fractures for 3–4 weeks with the following external immobilization till the occurrence of union signs.

Intra- and extramedullary methods of MOS, EFD are used in operative treatment (Fig. 6.39, 6.40).

Possible complications of the tibial diaphysis fractures:
- **Slow union** (up to 17%). Autoplastic of the fracture zone with spongious tissue from the iliac wing is used for osteoreparation stimulation.
- **Nonunion.** Localization – lower third of the tibial diaphysis. Stable reosteosynthesis with the fixation method change and osseous autoplastic of the false joint area are performed.
- **Suppuration.** External fixation device is used for treatment (Ilizarov method).
- **Incorrect union.** Segment deformation is liquidated by correcting osteotomy performance with MOS in the corrected position. Raised shoes or limb elongation with operative method according to Ilizarov are used in limb shortening.
- **Compartment syndrome.** Requires fasciotomy, elevated limb position and medicamental decongestant therapy.
- **Refracture.** Requires conducting of the stable reosteosynthesis.
- **Contracture of adjacent joint,** neurodystrophic syndrome of the lower limb (in continuous immobilization of the limb). Requires continuous rehabilitation treatment.

Fractures of the distal epimetaphysis of shin bones

**Fractures of the distal tibial epimetaphysis.** Injuries of this localization are observed in up to 30 % among injuries of the musculoskeletal system and in up to 80 % among the injuries of the ankle joint. These fractures are usually combined with fractures of the fibula or lateral malleolus. Significant place in the structure of the shin bones injuries in the ankle joint area takes the most severe fractures of the distal tibial epimetaphysis, as called "pilon, plafond" fractures. This term was firstly used by Destot in 1911 for the assessment of fractures in this area from the high-energy trauma, when the leading mechanism is the axial load on the limb.

AO/ASIF classification is represented at Fig. 2.19 (See chapter 2).

**Clinics, diagnostics.** Patients complain of the pain, loss of the supporting ability of the leg. Deformation smoothing of the ankle joint contours, depending on the fracture – valgus or varus deviation of the foot are revealed at the examination. Active and passive movements are significantly limited or impossible. Area of the injury, hemarthrosis presence (B, C type fractures) are specified during palpation. These fractures refer to high-energy, that lead to significant trophic impairments of soft tissues on the background of subfascial pressure increase (Fig. 6.41).

Diagnosis is specified with X-ray. It is reasonable to perform CT in B and C types of fractures (Fig. 6.42).

![Fig. 6.41. Trophic impairments of soft tissues](image1)

![Fig. 6.42. Comparative fracture characteristics in radiologic (A) and CT (B) investigations](image2)
Treatment. Conservative treatment is indicated in A and B1 types of fractures without fragments dislocation – limb immobilization is performed, in dislocation presence – skeletal traction for 4–6 weeks with the following immobilization till the union signs occurrence (Fig. 6.43).

Open reduction of fragments is conducted in operative treatment – renovation of the articular surface congruence and fragments fixation depending on the fracture character, using screws and plates, and operation is supplemented with osseous autoplastic by the transplant from the iliac wing in fractures with bone tissue compression (Fig. 6.44, 6.45, 6.46).

Combined osteosynthesis is used in trophic impairments: osteosynthesis of fragments, that directly form the articular surface with screws, and EFD for providing stable fixation in general (Fig. 6.46).

Malleolar fracture. These fractures consist up to 80 % of ankle joint injuries. Isolated fracture of the fibular lateral malleolus occurs more often. Fractures of both malleoli are observed in 20–25 % of cases, and in 5–10 % – combined with fracture of the anterior or posterior margin of the distal tibial epimeta- physis. Indirect trauma mechanism prevails – sprain of an ankle. Trauma mechanism leads to the corresponding injury type (Fig. 6.47, 6.48).

Author’s characteristics of the injuries are widely used in practice for the fracture determining. The following are used more often.

Dupuytren’s fracture – fracture of the medial malleolus and fibula in the lower third with the injury of the distal tibiofibular syndesmosis. It is often accompanied by the external sprain of an ankle (Fig. 6.48).

Maisonneuve Fracture (close to previous one) – difference is in the localization of the fibular fracture – upper or middle third (Fig. 6.49).
Volkmann's fracture – fracture of the medial malleolus, fibula and external part of the tibial epimetaphysis (Fig. 6.50).

The term "trimalleolar fracture" of the shin is often used, which has no anatomical background. Fracture of the anterior or posterior margin of the distal tibial epimetaphysis is considered as "third" malleolus in this case. The following are defined among these fractures: Pott's fracture – fracture of both malleolus and anterior or posterior margins of the distal tibial epimetaphysis; Destot's fracture – fracture of the medial malleolus, lower fibular third and anterior or posterior margins of the distal tibial epimetaphysis (Fig. 6.51, 6.52).

Clinical picture, diagnostics. Clinical pattern in patients with injuries of the ankle joint depends on the traumatic force intensity and character of anatomophysiological injuries.
Patients complain of moderate pain in the area of fracture, impairment of the limb supporting ability in isolated fractures of the lateral or medial malleolus. Smoothening of the articular contours, hematoma presence at the area of the internal or external surface are determined by objective examination. Shin and foot axis is correct. Palpation of the ankle joint increases tenderness in the injured area. Active and passive movements in the joint are possible, but are limited and painful.

Clinical pattern is more expressed in fractures of both malleoli with the foot subluxation or luxation. Patients complaint of the expressed pain, that increase in movements, loss of the supporting ability, expressed joint deformation, signs of hemarthrosis, and also (depending on the subluxation
(luxation) direction) varus and valgus deformation are determined. Additionally in luxation: relative foot shortening or elongation (foot deviation from the shin axis). Injury character is specified during palpation.

Radiologic investigation is conducted in frontal and lateral projections. Limb is located in such way during imaging in the frontal projection, that bimalleolar line of the ankle joint is parallel to the plane of
the film (30° internal foot rotation), that provides the possibility to assess the condition of the distal tibio-fibular syndesmosis.

**Treatment.** Conservative treatment in fractures without dislocation is performed with limb immobilization with the U-like bandage or circular bandage. In fractures with dislocation – closed single-stage reduction is performed after anesthesia with the following fixation with the short leg cast. Skeletal traction is used in significant impairments: opened fracture, severe swelling, trophic and traumatic impairments of the soft tissues integrity – as preoperative preparation.

Operative treatment is realized by the fragments reduction with different metallic constructions (Fig. 6.53).

**Ankle bone fractures**

Consists less than 1% of all the skeletal bones fractures, and up to 15% in relation to the foot bones.

**Features of the ankle bones:**
- forms ankle joint;
- receive all axial loads;
- 3/5 of the bone is covered with cartilage;
- has limited blood supply.

Ankle bone fractures are divided into extraarticular (Fig. 6.54) and intraarticular.

These fractures are observed rather rare. Clinical pattern is characterized by moderate pain, swelling and hematoma in the area of fracture, moderate impairment of the limb function and supporting ability. These injuries are rather often considered as the injuries of the ankle joint ligaments. diagnosis is confirmed with X-ray.

Fractures without dislocation are treated conservatively – limb immobilization with posterior long leg splinting (from tiptoes to the shin upper third), in dislocation presence – osteosynthesis with reduction.

Intraarticular fractures of the ankle bone occur as the result of indirect trauma, under the force of excessive foot extension of the significant amplitude in contact with the bearing area or ground, and rotational forces act in the final phase. Types of intraarticular fractures of the ankle bone are represented in the figure 6.55.

Expressed tenderness in palpation and axial load, significant hemarthrosis in the ankle joint area and foot, segment increase in volume are determined clinically. Foot is in the position of pronation or supination depending on the fragments dislocation.

Standard and additional projections are used during the radiological investigation, CT.

**Treatment.** Conservative treatment is indicated only in type A fractures: limb immobilization with the circular bandage from the tip toes to the lower thigh third. For fragments fixation during the operative treatment screws, Kirschner wire or their combinations are used (Fig. 6.56).
Fig. 6.54. Extraarticular fractures of the ankle bone: A – lateral process; B – medial wall; C – posterior process; D – head; E – block arch

Fig. 6.55. Types of intraarticular fractures of the ankle bone:
A – neck or head fracture without dislocation; B – neck or head fracture with dislocation; C – fracture dislocation and multifragmental fracture

Fig. 6.56. Methods of the bone fragments fixation
Heel bone fractures consist up to 60% of the tarsal bones and 2–4% of all musculoskeletal system fractures. These fractures are rather often combined with injuries of not the only foot, but also the spine. Heel bone fractures are divided into intra- and extraarticular.

**Extraarticular fractures** consist up to 25% of cases. Fractures of the plantar surface of the calcanean tuber and avulsion fractures with the small or large fragment.

Fractures of the plantar surface of the calcanean tuber occur as the result of the insignificant traumatic force impact and are characterized by the mild local tenderness in axial load and palpation, insignificant subcutaneous hemorrhage and swelling. Active and passive movements in the ankle joint can be preserved in the full range (Fig. 6.57).

These fractures are rather are accompanied by the fragments dislocation, so treatment is usually conservative – immobilization with the short leg cast or posterior leg splinting from the tiptoes to the shin upper third.

Avulsion fractures with small or large fragments ("duck beak" type) occur due to the extensive contraction of the triceps muscle of calf (Fig. 6.58).

No removed timely fragments dislocation lead to the soft tissues compression and crushing from the inside and necrosis occurrence (Fig. 6.59).

**Intraarticular fractures** consist up to 75% of injuries in this area. Fractures occur due to the direct high-energy trauma (fall from a height – catatruma – or in the car accident). Classification of the heel bone fractures is represented at the figure 6.60.

**Clinics, diagnostics.** The following is typical for intraarticular fractures: swelling, subcutaneous, submalleolar hemorrhage, tenderness in palpation and sometimes fragments crepitus. Heel is in-

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**Fig. 6.57. Fractures of the plantar surface of calcanean tuber**

**Fig. 6.58. Avulsion fractures of the calcanean tuber with big (A) and small (B) fragment**

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6. Injuries of bones and joints of the lower extremity
Fig. 6.59. Fixation methods in operative treatment

Fig. 6.60. Classification of the heel bone fractures:
A1 – simple avulsion fracture; A2 – simple fracture of the medial process;
B1 – tongue type fracture with injury of the posterior articular facet of the subtalar joint; B2 – tongue type comminuted fracture with injury of the posterior articular facet of subtalar and calcaneocuboid joints;
C1 – simple central depression fracture; C2 – comminuted central depression fracture;
D – multifragmental "explosion" fracture

creased in volume, sharp tenderness in axial loads, usually impossible. Attention is paid to the arch flattening and valgus or varus deviation.

Radiologic investigation specify the diagnosis, but CT diagnostics is needed for complete visualization (Fig. 6.61).

Treatment. Conservative treatment is realized by the following methods:
- compressing bandage with the following earlyfunctional load of the injured leg;
- limb immobilization with the plaster cast;
- triaxial skeletal traction with the following immobilization with the plaster cast (Fig. 6.62).

Operative treatment is realized by the external fixation devices (Fig. 6.63) or metallic constructions use (Fig. 6.64) depending on the fracture.
6. Injuries of bones and joints of the lower extremity

Fig. 6.61. Radiologic investigation and comparative information value of CT (A) and "classic" radiograph (B)

Fig. 6.62. Triaxial skeletal traction system

Fig. 6.63. Treatment of heel bone fractures with external fixation device
Fractures of bones of the middle foot part

**Navicular bone fractures.** Consists 2–2.5% of all foot bones fractures. Isolated fractures occur in the indirect mechanism of injury with forced flexion or rotation of the anterior foot part, that leads to the navicular bone compression between the cuneiform bone and head of talus, and its fragments are pressed out from their bed. In avulsion fracture of the tuberosity – injury occurs as the result of uncoordinated *m. tibialis posterior* contraction. Four types of navicular bone fractures are defined: avulsion fracture of the cortical plate dorsal margin (A); avulsion fracture of the tuberosity (B); fracture of the body (C) (Fig. 6.65).

Clinical signs of the navicular bone fracture are swelling, subcutaneous hemorrhage or hematoma in the middle foot part at its internal side, pain at the area of the navicular bone projection in palpation and axial load at 1–2–3 metatarsal bones. Active pronation, supination, abduction and adduction of the anterior foot part are limited and increase pain significantly.

Radiological investigation of the foot is performed in the anteroposterior and lateral projections. It should be remembered, that fresh fractures of the navicular bone without fragments dislocation are often visualized at radiograms and wrongly considered as the soft tissues injury.

*Treatment.* Posterior leg splinting from the shin upper third to tiptoes is used in fractures without dislocation, in dislocation – operative treatment (Fig. 6.66).

**Cuboid bone fractures** occur in fall from the height or accident as the result of force impact at the anterior foot part in its plantar flexion and anterior foot part abduction. Cuboid bone fractures are represented at the Fig. 6.67.
Clinical picture is characterized by local subcutaneous hematoma, swelling at the internal side of the middle foot part, tenderness in palpation at the cuboid bone projection and in load along the axis of 4 and 5 metatarsal bones. Expressed pain occurs at axial load on the injured foot along its lateral side in the middle part. Radiologic investigation is performed in frontal, lateral and oblique projections in the position of 45° foot pronation.

Treatment. Cuboid bone fractures without fragments dislocation and preservation of the lateral foot arch length are treated conservatively. Task of the operative treatment is to renew length and reconstruct articular surfaces with stable fragments fixation (Fig. 6.68).

Cuneiform bones fractures occur due to the indirect impact along the axis of 1–2–3 metatarsal bones, or direct impact (fall of the heavy object on the foot, run over with the car wheel, etc.).

Clinical signs of fractures of such localization are swelling at the dorsal foot surface in the middle part, hematoma presence, tenderness in palpation and in axial load at 1, 2 and 3 metatarsal bones.

Radiologic investigation is performed in two classic projections, radiograms in oblique projection are done if needed (Fig. 6.69).

Treatment is conservative in most cases – immobilization with posterior leg splinting, in dislocations – operative treatment is performed (Fig. 6.70).

Metatarsal bones fractures consists 2% of all skeletal bones fractures, and 60% in relation to all foot bones fractures. Trauma mechanism can be direct as well as indirect.
Isolated fractures of first and fifth (basal fracture) metatarsal bones, and also multiple diaphysial and subcapital fractures. All metatarsal bones differ from each other by function and require differential approach in treatment. Taking into account functional anatomy of the anterior foot part and differences at the medical tactics, the following should be defined:

- fractures of the first metatarsal bone;
- fractures of the second, third and fourth metatarsal bones;
- fractures of the fifth metatarsal bone.

Fractures of metatarsal bones are also divided: by the amount of fractures bones – in isolated and multiple; by their fragments dislocation degree – into fractures with or without dislocation; by the amount of metatarsal bone fragments – simple, comminuted (with one intermediate fragment) and multifragmental; by joints involvement into the fracture line – into intraarticular and extraarticular; by the degree of the surrounding soft tissues injury – into closed and opened, and also by the fracture line localization along the metatarsal bone – into basal, diaphysial, subcapital and capital fractures.
Clinical signs in metatarsal bones fracture depend on the trauma character, amount of injured bones and degree of the fragments dislocation. Subcutaneous hemorrhage, swelling at the dorsal surface of the injured foot, local tenderness, impairment or loss of the supporting ability usually occur. Positive symptom of the axial load.

Fracture character, degree and direction of fragments dislocation are specified at radiograms done in three projections: anteroposterior, lateral and oblique lateral with foot pronation angle of 45–50° (Fig. 6.71).

Treatment. Fractures of one or two metatarsal bones without dislocation can be treated with posterior leg splinting or circular cleaved plaster cast, that is placed from tiptoes to the shin upper third with well-modeled foot arch for the period of 4–5 weeks, depending in the dislocation degree and patients age. Fractures with fragments dislocation require closed reduction by manual removal of the angular dislocation after the axial traction by the corresponding finger or fingers.

Operative treatment is performed if conservative treatment is ineffective, Methods of fragments fixation depends on the fracture character (Fig. 6.72).

Toes phalanxes fractures consist 1,5 % of all skeletal bones fractures and 30 % of all foot bones fracture. They more often occur due to the direct traumas: at direct strike with the anterior foot part in the direction of longitudinal axis against fixed subject, as the result of the heavy subject fall or run over the anterior foot part with the car wheel. Injuries of the first finger prevail. Taking into account functional anatomy of the anterior foot part and differences in the medical tactics, the following should be defined:

- fractures of the first toe phalanxes;
- fractures of second, third, fourth and fifth toes phalanxes.
Toe phalanxes fractures are divided by the amount of fractured bones – into isolated and multiple, by the fragments dislocation degree – into fractures with or without dislocation; by the amount of phalangeal fragments – simple, comminuted (with one intermediate fragment) and multi-fragmental; by joints involvement into the fracture line – into intraarticular and extraarticular; by the fracture line localization along the metatarsal bone – into basal, diaphysial, and nail-bone tuberosity.

Clinical picture is characterized by tenderness, hematoma, function impairment; positive symptom of the axial load.

Radiologic investigation in phalangeal fractures should be performed in three projections. Anteroposterior, oblique and lateral radiographs of the foot anterior part demonstrate phalangeal fractures appropriately, dislocation direction and degree.

In suspicion of 2–3–4–5 finger injury – oblique and lateral projections are performed in the position of the great toe maximal extension.

Treatment. fractures without dislocation and also with insignificant dislocation are treated conservatively with external immobilization. Closed fragments reduction under the local anesthesia is performed in closed fractures with dislocation, especially in proximal phalanxes, with dorsal dislocation angulation by the traction along the injured toe axis and manual pressure at the top of an angle from the plantar surface, with following X-ray control in two projections. In multiple fractures of phalanxes – fragments fixation is performed by the short posterior leg splinting or circular plaster cast from the tip-toes to the shin upper third for the period of 3 weeks. In isolated fractures – finger is fixed with adhesive bandage to the intact finger (Fig. 6.73).

Operative treatment is performed in unsuccessful closed fragments reduction or opened phalangeal fracture (Fig. 6.74).
TASKS AND TESTS

TASK №1

Patient D, 52 years, was delivered to the admission department with complains of pain in the area of the right leg, inability to support on the limb. Fell at the street 2 hours ago. During examination was wetermined closed transverse fracture of the middle third of the femoral diaphysis with fragments longitudinal dislocation for 7 cm. Which treatment method is indicated to this patient?
A. Open reduction of fragments, osteosynthesis.
B. Skeletal traction.
C. Plaster immobilization.
D. Functional.
E. Transosseal osteosynthesis.

TASK №2

Patient S, 56 years, was delivered to the admission department from the car accident. Open fracture of both shin bones in the middle third was determined during examination. Which treatment method is indicated to the patient?
A. Skeletal traction.
B. Fixation with plaster cast.
C. Open reduction of fragments, internal osteosynthesis.
D. Extrafocal transosseal osteosynthesis.
E. Functional.

TASK №3

Patient R, 38 years. Open fracture of shin bones, wound of 5 cm in diameter, with compound margins and skin defect were determined. Which method of the operative treatment is preferred?
A. Transosseal osteosynthesis with the external fixation device.
B. Intramedullar blocking osteosynthesis.
C. Reduction osteosynthesis with screws.
D. Osteosynthesis with AO plates.
E. Osteosynthesis with Kirschner's pins and screws.

TASK №4

Patient J, 36 years, get into the car accident, loss consciousness for the short period of time; does not remem- ber, what happened. Complains of sharp pain in the right knee joint, only passive movements are possible, very painful. During examination: deformation of the right knee joint contours, limb axis impairment; limb shortening; passive position of the lower limb with external shin rotation; limitation of active and passive movements in the injured knee joint. During palpation– local tenderness of the distal femoral metaepiphysis and knee joint, “patella ballo/tement” sign; pathologic mobility. Make the preliminary diagnosis.
A. Condylar fracture of the femoral bone.
B. Patella dislocation.
C. Condylar fracture of the tibia.
D. Shin dislocation.
E. Hip fracture in the lower third.

TASK №5

Patient C, 60 years, delivered to the traumatology department with complains of the acute pain in the right ankle joint, that occur after the ankle sprain. Objective status: swelling and tenderness of the joint. At radiographs:
longitudinal clear line along the lateral malleolus and transverse– at the medial malleolus. Incongruency of artic- 
ular surfaces take place. What diagnosis corresponds to the radiologic data?
A. Foot dislocation.
B. Bimalleolar fracture of the right ankle joint, foot subluxation.
C. Bimalleolar fracture.
D. Fracture of the medial malleolus, rupture of the tibiofibular syndesmosis, foot subluxation.
E. Fracture of the lateral malleolus, posterior tibial margin, foot subluxation.

**TASK №6**

Patient E, 42 years, was for 10 days at the treatment with the constant skeletal traction because of the closed 
fusiform fracture of the tibia lower third. Fragments reduction was not reached. Which treatment method is indi- 
cated to the patient?
A. Fixative with plaster casts.
B. Osteosynthesis with extramedullar constructions.
C. Continue skeletal traction with fragments reduction.
D. Transosseous osteosynthesis with rods.
E. Functional with the plaster tutor.

**TASK №7**

After the patient's T, 56 years, examination, the diagnosis was made: closed transverse fracture of the femoral 
bone lower third with fragments dislocation. Which treatment method is better to use?
A. Closed intramedullary blocking osteosynthesis.
B. Fixation with plaster cast.
C. Skeletal traction.
D. Transosseous osteosynthesis according to Elizarov.
E. Closed fracture reduction, glue traction.

**TASK №8**

Patient, 65 years, fall in the flat and contused the right side of the body. Get to the bed by herself, lies in the su- 
pine position, right lower limb with the external rotation, there is no visible limb shortening, can sit up in the bed 
with the help of relatives. The most probable preliminary diagnosis?
A. Pelvis and chest contusion.
B. Right hip joint contusion.
C. Impacted fracture of the femoral bone proximal part.
D. Pelvic bones fractures.
E. Impacted fracture of the femoral diaphysis.

**TASK №9**

Patient, 26 years, is working at chemical factory, complained of the pain in the right hip joint at physical loads 
during the last 2 months, does not come for medical help. Unsuccessfully get out from the bus when was going 
to the work (fall down of the right foot), the pain in the right hip joint and supporting ability loss develop after 
this. During examination – external rotation of the right limb, its shortening for more than 3 cm. What is the most 
probable preliminary diagnosis?
A. Pathologic fracture of the femoral bone.
B. Femoral neck fracture.
C. Exacerbation of the lumbosacral osteochondrosis.
D. Acute arterial thrombosis.
E. Infectious arthritis of the right hip joint.
**TASK №10**

During examination of the patient D, 37 years, who sustained earlier the fracture of the femoral bone lower third, the following movements range is determined in the knee joint: extension – 180 °, flexion – 150 °. Which type of movements limitation is in this patient?

A. Rigidity.
B. Fibrous ankylosis.
C. Osseous ankylosis.
D. Contracture.
E. Extraarticular ankylosis.

**TASK №11**

Patient K, 39 years, was admitted to hospital with the closed fracture of the lateral tibial condyle without dislocation. Which treatment method is better to use?

A. Operative (metal osteosynthesis).
B. Fixation with the plaster cast.
C. Skeletal traction.
D. Fixation with elastic bandage.
E. Transosseous osteosynthesis with the external fixation device.

**TASK №12**

Patient B, 52 years, was admitted to hospital with the comminuted fracture of the patella with fragments dislocation less than 2 cm. Which treatment method is better to use?

A. Operative (metal osteosynthesis).
B. Fixation with the plaster cast.
C. Skeletal traction.
D. Fixation with elastic bandage.
E. Transosseous osteosynthesis with the external fixation device.
7.1. DEGENERATIVE-DYSTROPHIC DISEASES OF JOINTS

Degenerative-dystrophic diseases of joints are characterized by the chronic progressive impairment of the articular cartilage, epiphyseal bone structures metabolism with the following involvement of other articular structures into the pathologic process. They are accompanied by the development of koint deformations, incongruency, loss of functional activity, development of the secondary inflammatory process in the joint of different intensity, disability and decreasing of quality of life in such patients.

According to clinical and morphological data of NS Kosinskaia and AG Rohlin, three forms of degenerative-dystrophic lesions of joints are distinguished (Kosinskaia NS, Rohlin AG, 1961), which get their place in group XIII of ICD-10 "Diseases of the musculoskeletal system and connective tissue".

OSTEOARTHRITIS

Osteoarthritis – heterogenic group of diseases with different etiology and similar biological, morphological and clinical manifestations and consequences, in the background of which lies damage of all the articular elements, articular cartilage in the first turn, and also subchondral parts of the bone, synovial membrane, ligaments, capsule, para-articular muscles (Fig. 7.1). Mentioned changes occur gradually as the injury of the articular cartilage during loads exceeds its recovery speed (physiological regeneration).

These diseases compound up to 80% in the general structure of joint pathology in people above 60 years, osteoarthritis leads to the disability of different degree in 10–30% of cases. Growth of the osteoarthritis morbidity is fixed during the last 30–60 years in 5–9 times. Medico-demographic indicators of Europe and USA in-

![Fig. 7.1. Osteoarthritis](image)
dicates the continuation of the population “aging” and increase of the amount of people elder than 60 years; this age group population will increase twice by 2020. Increase of the age-related morbidity of osteoarthritis is predicted, especially in employable age, and also morbidity increase in childhood and adolescence – “osteoarthritis rejuvenation”. All these components predetermine further morbidity growth of this pathology in absolute as well as in relative numbers.

Terminological definitions – osteoarthritis, arthrosis, osteoarthrosis, degenerative arthritis – are currently represented as synonyms in X Internation Classification of Diseases.

Joints of the wrist, first metatarsophalangeal, joints of the cervical and lumbar parts of the spine, knee and hip joints are more often affected by osteoarthritis. By the severity of the musculoskeletal system function impairment, first place takes the hip, knee and ankle joints, and also shoulder joint.

Osteoarthritis treatment is complex and continuous. Presence of often multiple comorbid pathologies in elderly patients requires strict approach in the choice of the effective and safe therapy, based on the reliable evidential data.

Etiology and pathogenesis

Osteoarthritis – one of the most widespread degenerative-dystrophic disease of joints. From 6.4 % to 12 % of world population suffers from it.

This is polyetiological disease, which occurrence and development are connected with a series of genetic, endogenic (hormonal disbalance, immune disturbances, oxidative stress) and exogenic factors (trauma, overload). Most scientists consider that cartilage tissue is initially damaged in OA. Not only the impairment of the cartilage matrix structure and function are observed in the pathogenesis of this disease, but also its metabolism. Main pathologic OA manifestation is the articular cartilage destruction, the main function of which is to adapt joint to the mechanical load and providing of free movements of the articular surfaces.

Cartilage consists of two main elements: intercellular substance (matrix), which consists 98 % of the cartilaginous tissue volume, and cells: chondrocyte and chondroblast (2 %). Important components of the cartilaginous matrix are macromolecules of different types of collagen (mainly type II) and proteoglycans (PG). PG provides unique adaptive qualities of the cartilage. 90 % of cartilage refers to aggrecans. This molecule consists of the protein nucleus with binded chains of chondroitin sulfate (ChS), keratan sulfate (KS) hyaluronic acid (HA).

Typical signs of cartilage destruction in OA is a loss of GAG with matrix – ChS, KS, HA in superficial, intermediate and deep zones. Decrease of the PG molecule is also observed, which lose the ability to going out from the cartilage matrix. PG (changed and small) are able to absorb water, but are not able to keep it. Water excess is absorbed with collagen, which distends and lose fibrous structure, that leads to the cartilage resistance decrease.

Chondrocytes – cells, that regulate the cartilage tissue metabolism, ie synthesis (anabolism) and degradation (catabolism) of the aggrecan and other components of the cartilage matrix. These processes are normally balanced, but impairment of the normal cartilage tissue metabolism is observed in OA towards the prevalence of catabolic processes over the anabolic.

Significant role in the catabolic processes development in OA plays proinflammatory cytokines, especially IL-1. Chondrocytes synthesize proteolytic enzymes under its influence, as called matrix metalloproteinases, that cause the collagen and cartilage PG degradation. Chondrocytes synthesize PG, are not able to aggregate and produce collagen types I, IX, X, which does not form fibers, instead of normal (Fig. 7.2).

Typical chondrocyte feature in OA is cyclooxygenase-2 (COX-2) hypersecretion (enzyme, which induces prostaglandins synthesis, that participate in the inflammation development) and induced form
of nitric oxide synthase, that provides toxic influence on the cartilage and induce chondrocytes apoptosis.

Release of active biologic substances promotes the inflammation maintenance in articular tissues in IA. As the result, further destruction of the synovial layer with the development of reactive synovitis and increased production of proinflammatory cytokines occur. Released PG, products of chondrocytes and collagen breakup, as antigenes can induce antibodies generation with formation of the local inflammatory process.

Vascular genesis of degenerative diseases consists in changes of the subchondral bone blood supply, hypertension, swelling and microfractures development with following remodeling and sclerosis, that changes the conditions of load on the articular cartilage with OA development.

Data about the role of free-radical peroxidase reaction in osteoarthritis pathogenesis showed, that excessive activation of the FRLP is one of the key initial mechanisms in osteoarthritis development. High capability of free radicals to oxidative modification of highest and intracellular proteins, proteins of the cartilage matrix, that is accompanied by tearing of proteoglycans macromolecular bands, is an important direct factor of the cartilage destruction initiation and progressing in osteoarthritis.

Classification

Osteoarthritis is conditionally divided into primary and secondary. Clinical manifestation of osteoarthritis occurs in the load increasing in the joint, that leads to the articular cartilage damage.Usu-
al load causes osteoarthritis symptoms occurrence, when there are pathologic changes of cartilages, bones, synovial membrane, ligaments, muscles, which are conditioned by the certain primary process (diseases). Secondary osteoarthritis does not differ from primary by clinical manifestations, with the exception of the fact, that the certain etiologic factor is a cause of the secondary osteoarthritis. So, information mentioned above allows considering, that in the basis of the primary osteoarthritis lies natural aging, degeneration of the articular cartilage and para-articular tissues – tendons, ligaments, articular capsule, muscles. Age-related degeneration occurs in the connective tissue, which is the basis of all these structures. In the case of secondary osteoarthritis development, an influence of different exogenic and endogenic factors on the articular tissues is combined with involuntary processes, that occurs in them.

The Ukrainian Association of Rheumatologists (UAR) osteoarthritis classification adopted at 2000 is currently used as the main working classification.

Clinical diagnostics

Clinical symptoms in different athologic processes, that take place in the joint, is rather similar – clinical signs do not correspond to certain anatomical changes. Significant difference between the clinical and radiological investigations attract attention: significant radiological changes can be find in the lack of clinical data and vice versa. Primary changes in osteoarthritis occur in the articular cartilage, so symptoms are not expressed at the early disease stages, and is often conditioned only by the inflammatory process presence – reactive synovitis. Main clinical manifestations of osteoarthritis are: pain (Table 7.2), joint deformations, their function impairment – have different intensity degree depending on the process stage. Four-staged radiological classification according to J. H. Kellgren and J. S. Lawrence is more widely used among the orthopedist-traumatologists. The following clinical changes usually correspond to the radiologic changes in the joint.

First stage is characterized by discomfort or insignificant pain presence in the joint during or just after the intensive load. these symptoms disappear quickly after the rest. Tenderness in palpation, limitation of the active and passive movements are absent during clinical examination. Limitations of the movements, that has minimal amplitude can be found in the reactive synovitis presence: extension in the ankle joint, overextension in the knee joint, internal rotation in the hip joint, etc. Functional ability is practically preserved in these patients, disorders occur only in significant physical loads.

In the second stage of the diseases, pain in the joint is characterized by greater duration and intensity, disappears only after long rest. Limitation of active and passive movements, pain in palpation are determined constantly, but patients can do everyday work. Muscular force decrease is determined. Limping can occur sometimes. Flexion (knee joint), adduction (hip joint) contractures are often observed, which have extraarticular character and can be corrected with conservative treatment. Functional capacity is impaired, especially in patients with the significant physical load.

Clinical symptoms in the third stage are conditioned by articular as well as extraarticular lesions. Pain syndrome intensity increases significantly during physical activity and decrease at rest. Morning stiffness is observed in patients. Palpation of the affected joint is painful for the patient. Movements in the joint are limited, crepitus can be observed in movements; contracture, forced limb position occur. Joint function is stably impaired. Working capacity of the patient is limited or lost depending on the character of performed work.

Fourth stage of osteoarthritis is characterized by constant pain syndrome, which intensity increases significantly in physical activities. Expressed morning stiffness, crepitus, atrophy of periarticular muscles are determined. Movements in the joint are significantly limited, and sometimes are char-
characterized only as oscillating. In the big joint of lower limb affection, gait impairment is expressed in this patients, need of additional support occurs (crunches, orthopedic cane). Functional capacity of the joint is significantly reduced or lost. Reactive inflammatory process often occurs at this stage, with moderately or significantly expressed synovitis.

**Radiologic diagnostics**

The most widespread instrumental method of diagnostics is radiography. OA has typical radiologic signs – joint space narrowing, subchondral osteoporosis and osteosclerosis, osteophytes and subchondral cysts formation. J. H. Kellgren and J. S. Lawrence in the 1957 year suggested osteoarthritis classification according to radiologic diseases stages, which is currently used with clinicormorphological supplements and is generally accepted.

It should be mentioned that all radiologic OA signs reflect changes of bone structures, but provide no direct picture of hyaline cartilage, and is only indirect sign of its change. Absence of correlation between the progress of clinical and radiologic osteoarthritis manifestations is reflected in articles of various authors. E. Bagge study showed, that 57 % of patients with clinical OA signs were detected no radiological changes. So, the radiologic method is not sufficiently effective in determining early OA stages.

**Radiologic diagnostics of osteoarthritis is based on the following radiologic signs determination according to J. H. Kellgren and J. S. Lawrence classification (1957), Fig. 7.3:**

- 0 stage – absence of radiologic signs;
- I stage (questionable) – insignificant narrowing of the joint fissure, irregularity of the joint fissure;
- II stage (minimal) – joint fissure narrowing is less than 50 %, its irregularity, areas of subchondral osteosclerosis, single focus of osteoporosis, single osteophytes (marginal osseous overgrowth);

<table>
<thead>
<tr>
<th>PAIN CHARACTER</th>
<th>CLINICAL FEATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nocturnal pain</td>
<td>Connected with venous hyperemia, blood stasis in subchondral bone parts, intraosseal hypertension. Pain intensity decreases in the morning during walking (in affection of lower limb joints)</td>
</tr>
<tr>
<td>Initial pain</td>
<td>Occur at the beginning of walking, then quickly disappears, occurs again in continuous, movements</td>
</tr>
<tr>
<td>Mechanic pain</td>
<td>Occur in loads on the joint, gradually increases to the evening, disappears after the night rest. Pain, that occurs during movements, is often conditioned by the tendobursitis, periartthritis, tendons affection presence. Pain can also be connected with synovial membrane irritation with osteophytes.</td>
</tr>
<tr>
<td>Blocking pain</td>
<td>Occurs in the presence of the articular foreign body – cartilage fragment, that is compressed between articular surfaces</td>
</tr>
<tr>
<td>Reflex pain</td>
<td>Conditioned by the reactive synovitis</td>
</tr>
<tr>
<td>Reflected pain</td>
<td>Is explained by the involvement of the articular capsule in the inflammative process</td>
</tr>
</tbody>
</table>

Table 7.2. Characteristics of the pain syndrome is osteoarthritis
Degenerative-dystrophic diseases of joints and spine

III stage (medium) – joint fissure narrowness of more than 50%, its expressed irregularity, expressed subchondral osteosclerosis, multiple foci of osteoporosis, multiple but small osteophytes, presence of the insignificant epiphysis deformation;

IV stage (expressed) – significant joint fissure narrowness up to its disappearing, large areas of osteosclerosis in loaded areas, diffuse osteoporosis, cystic cavities presence, massive osteophytes and significant epiphysis deformation.

Computed tomography (CT), arthrosonography, magnetic-resonance imaging (MRI) and diagnostic arthroscopy obtain bigger importance in OA diagnostics during last years.

Arthrosonography
Arthrosonography – ultrasound investigation of the joint – allows determining anatomical structures, that are poorly determined during other methods of investigation. This method gives a possibility to determine fluid accumulation in the joint even in the insignificant amount of it. Fluid character can be preliminarily assessed by the echo signal character (serous, hemorrhagic, purulent). Ultrasound investigation also gives a possibility to determine cysts presence, changes of tendons and tendon sheaths, ruptures of ligaments and tendons. This method allows assessing the degree of degenerative changes of the articular cartilage, its thickness, joint fissure parameters, subchondral bone condition (Fig. 7.4).

Magnetic resonance imaging and computed tomography
Magnetic resonance imaging (MRI) is considered as the best noninvasive method of the hyaline articular cartilage investigation. Early MRI-investigations showed relative homogeneity of the unchanged articular hyaline cartilage, then the presence of layers was determined. MRI reliably demonstrates focal

Fig. 7.3. Radiologic pattern of different osteoarthritis stages of the knee joint (A – correspond to I radiologic stage according to J. H. Kellgren & J. S. Lawrence, 1957, B – II stage, C – III stage, D – IV stage)
as well as generalized lesions of the cartilage (Fig. 7.5). MRI allows assessing the water contain in the hyaline cartilage using standard impulse sequences. There is a method with contrast substance use – MR-arthrography. Increasing of methods sensitivity to 93 %, specificity – to 97,6 %, diagnostic value – to 91,5 % are observed after the contrast substance introduction. MRI use for assessment of the articular hyaline cartilage condition is a reliable and perspective method in OA diagnostics, especially at early stages. E. D. Rappeport et al. in the 1996 year suggested to perform MRI before arthroscopy in the investigation algorithm of the patient with osteoarthritis.
Computed tomography (CT) use gives the possibility to assess objectively the articular surfaces interposition and bone structure character of the epiphysis. Joint investigation provides the tridimensional view of the lesion focus, its localization, sizes, extension, connection with other articular elements. Advantage of this method is the possibility of detailed assessment of osseous articular elements structure, that has significance in posttraumatic osteoarthritis, when it is important to determine the bone defects presence, changes of the articular surfaces form, character of the bone structural changes (osteosclerosis, osteonecrosis, osteoporosis, cystic formations, etc.).

**Diagnostic-medical arthroscopy**

Diagnostic arthroscopy – one of the modern widespread method of osteoarthritis diagnostics and treatment, especially at early stages. Arthroscopy allows determining of pathologic lesions or injuries of practically all intraarticular elements and fix the determined changes at the film or digital storage. All intraarticular elements are visualized during investigation – articular cartilage, synovial membrane, intraarticular bodies, menisci, foreign bodies, lipid bodies, etc. Changes in the articular cartilages such as softening, garnetting and erosions are clearly determined in osteoarthritis (Fig. 7.6). Hyperemia and moderate swelling of the synovial membrane are determined, its villous hypertrophy often with areas of fibrous degeneration close to the area of the articular cartilage destruction. Typical changes of the synovial fluid are also determined – it obtains intensive yellow color, turbid, opalescent (contains a large amount of fibrin, remainings of collagen fibrils and fragments of the cartilage matrix). Arthroscopic investigation can be accompanied by the significant lavage of the articular cavity with removing of free small fragments of the degenerative changed articular tissues, part of the hypertrophic synovial villi. Debridement (See p. 270) and articular cartilage smoothening can be conducted if necessary, that allows improving significantly the joint function for the long period of time.

It is possible to sample biologic material (cartilage) during diagnostic-medical arthroscopy – biopsy for the following histomorphologic investigation, that provides the possibility of the final reliable diagnosis verification. Diagnostic arthroscopy is currently considered the "gold standard" in osteoarthritis diagnostics, especially at early stages, as it allows to clearly determine the degree of degenerative changes of the articular cartilage, extension and spread to other articular elements, abnd also helps to choose optimal treatment method for the certain patient.

**Laboratory diagnostics**

To serologic OA markers refer products of PG degradation (keratan sulfate, chondroitin sulfate, glycosaminoglycan (GAG), PG fragments), stromelysin, procollagen type II, osteocalcin, products of synoviocytes (cytokines, proteins), crystals (calcium, apatites, pyrophosphates). Catabolic processes prevail

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*Fig. 7.6. Arthroscopic pattern of the articular cartilage condition in gonarthrosis (A – corresponds to I stage according to J. H. Kellgren & J. S. Lawrence; 1957 B – II stage; C – III stage; D – IV stage)*
in osteoarthritis, macromolecules (predominantly of the articular cartilage matrix) or their fragments get to the synovial fluid, blood and urine, where they can be determined. Special cell enzymes and cytokines, that get to the interstitial fluid in inflammation, can also be metabolic markers of the articular cartilage and synovial membrane.

Physical, cellular and molecular content of the synovial fluid changes in osteoarthritis, that is determined in laboratory investigation. Synovial fluid is transparent or slightly turbid, of a high or medium viscosity, mucin clot is dense. Number of cells in 1 ml of the synovial fluid is from 500 to 5000, neutrophiles compounds less than 50 %, fragments of the cartilaginous tissue can appear.

According to modern data about molecular markers of articular tissues metabolism in synovial fluid and serum. Aggrecan, proteins of the cartilage matrix, metalloproteinases are considered the most objective markers. Also increased levels of keratan sulfate, proteoglycans, protease, C-propeptide, collagen type II, fibronectin, cytokines, hyaluronidase and others can be determined in the synovial fluid.

Hystomorphologic diagnostics

Hystomorphologic method of the biopsy material assessment of the articular cartilage or synovial membrane, that can be obtained during the arthroscopy, gives the possibility of reliable diagnosis, and also specifying its stage. During the biopsy material of synovial membrane investigation the following is determined: covering cells are located in one layer, villi are atrophic, lack of vessels, significant zones of fibrosis are determined, fatty degeneration. Investigation of the cartilage tissue biopsy material gives the possibility to determine the decrease of the perichondrocytic lacunae area in superficial layers, a decrease of the cellular density in deep layers, decrease of the nuclei amount in the medium layers, increase of the calcified cartilage layer thickness. Morphologic signs of osteoarthritis in modern literature are described by V. S. Scott.

Treatment of patients with osteoarthritis

Modern principles of the osteoarthritis treatment is based on staging, continuity and succession. Recommendations on the knee and hip joints osteoarthritis treatment were developed and approved basing on the evidential medicine data of European League Against Rheumatism (EULAR). These recommendations consider four main groups of medical measures in osteoarthritis: non-pharmacologic treatment, pharmacologic treatment, intraarticular treatment and surgical treatment.

I. Non-pharmacologic treatment

Non-pharmacologic treatment provides the following measures: educative programmes for patients to study the basic principles of the osteoarthritis prevention and treatment, excessive weight decrease by the diet correction and creation of the optimal motion regime, development of the individual exercise complex, orthopedic unloading regime, a complex of physiotherapeutical treatment, therapy with vitamins and minerals, phytotherapy.

Exercise therapy is one of the most important methods of rehabilitation and joint function improvement in patients with osteoarthritis.

Exercise therapy in osteoarthritis promotes:

- prevention and removal of periarticular muscles atrophy;
- prevention and removal of the joint instability;
- decreasing of arthralgias intensity, function improvement of the affected joints;
Scheme of osteoarthritis diagnostics:

I. Clinical criteria
- Articular pain, that occurs at the end of the day in the first half of the night.
- Articular pain, that occurs after the mechanical load and decreases during rest.
- Joint deformations due to the marginal outgrowth (osteophytes), increase of the axial joint deformations.
- Limitation of the active and passive movements range in the joint.

II. Instrumental diagnostics:
1. Radiology, main signs:
   - narrowing of the articular fissure;
   - subchondral thickening – zones of subchondral osteosclerosis;
   - marginal osseous overgrowth – osteophytes;
   - subchondral osteoporosis.
   Radiologic stages of osteoarthritis according to J. H. Kellgren and J. S. Lawrence (1957): 0, I, II, III, IV.
2. Arthroscopy – direct visual intraarticular investigation with the possibility of biopsy, Now is considered as the "gold standard" in the osteoarthritis diagnostics.
3. Arthrosography – ultrasound investigation of the joint.
5. MRI: non-invasive, highly informative, without radiation exposure.

III. Laboratory diagnostics
1. Assessment of the physical, biochemical, cellular and molecular condition of the synovial fluid.
2. determining of the biologic molecular markers in the biologic mediums (serum, synovial fluid, etc.).

Purposes of the osteoarthritis treatment are:
- Slowdown of the osteoarthritis progression.
- Decreasing of the pain syndrome intensity.
- Increasing of the functional activity and quality of life of the patients.

There are following treatment methods for performing these tasks in osteoarthritis patients:
- Education of the patient (explaining the basics of this disease) and social support.
- Decreasing of the excessive body weight.
- Orthopedic regime and auxiliary orthopedic devices (insole, stick, crunches and other).
- Exercise therapy, massage and physical activity.
- Physiotherapeutical treatment.
- Sanatorium-and-spa rehabilitation.
- Medications.
- Operative treatment.

- slowdown of the further osteoarthritis progression;
- body weight decrease.

Physiotherapeutical treatment decreases the pain syndrome and synovitis manifestations. Influence of electromagnetic fields of high and superhigh frequencies, ultrasound therapy and phonophoresis of antiinflammatory and other drugs, short-wave diathermy in synovitis absence, electrophoresis, laser therapy, balneotherapy (radon, hydrosulfuric, sodium chloride, turpentine, iodide-bromine), hydrotherapy (multiple procedures) are used for reaching the mentioned above effects.
II. Pharmacological treatment

The main purpose of pharmacological (medicamentous) treatment of osteoarthritis are the correction of the intraarticular lesions, pain syndrome decrease, improvement of intraosseous and regional blood flow, metabolism stimulation throughout the organism in general and in the articular cartilage in particular, treatment of accompanying pathology. Correction of the intraarticular lesions is in the protective action on the articular cartilage, normalization of the biosynthetic processes in chondrocytes, catabolic processes inhibition in bone and cartilage tissues, normalization of the synovial fluid secretion in synoviocytes and synovitis depression. The task of the pain syndrome intensity decreasing is aimed at the overcoming of the inflammatory process in the joint and normalization of the periarticular muscles tone. Metabolic processes stimulation in the organism consists in the metabolism correction, improvement of the bone tissue quality, vitamin supplements and mineral metabolism correction, psychotropic therapy.

Antiosteoarthritis drugs. Broadening and deepening of conception about the disease nature and scene mechanisms of its development lead to the revision of the application point and assessment of the pathogenetic importance of most drugs, that are used in OA therapy.

The classification of antiosteoarthritis drugs, that include two classes of drugs, according to their pharmacologic action is currently accepted:

I. Symptoms modifying antiosteoarthritis drugs – SMOADs):
- Symptomatic drugs of fast action (to them refer non-steroid anti-inflammatory drugs (NSAIDs, paracetamol, opioid analgesics, glucocorticoids).
- SYSADOA – symptomatic slow acting drugs for osteoarthritis (chondroitin sulfate, glucosamine sulfate, hyaluronic acid, nonsaponifying compounds of avocado/soya, diacerein).

II. Structure modifying or disease modifying antiosteoarthritis drugs – DMOADs).

It should be mentioned that practically all drugs, that are used for osteoarthritis treatment (non-steroid anti-inflammatory drugs, analgesics, glucocorticoids, hyaluronic acid, glucosamine and chondroitin sulfate) have symptomatic (symptom-modifying) effect, that is characterized by the different onset of action. As to the pathogenetic action (structure-modifying or disease-modifying), there is no 100 % for any of the pharmacologic drugs. But the fact, that all mentioned above symptom-modifying drugs have the influence on some links of the osteoarthritis pathogenesis, is undoubtful. It is impossible to take the effect of these drugs only to the symptomatic action. The possibility of SYSADOA (symptomatic slow acting drugs for osteoarthritis) group drugs to influence positively the metabolism of the articular cartilage in osteoarthritis was shown in series of experimental and clinical studies. So drugs of this group (chondroitin sulfate, hyaluronic acid and others) are currently called as chondromodifying or such, that structurally modifies the cartilage. It was also demonstrated the possibility of pharmacological correction of the articular cartilage reparation in its injuries and posttraumatic osteoarthritis with these drugs use.

So, symptom-modifying drugs can provide the pathogenetic action and vice versa, pharmacologic drugs of pathogenetic action can have the symptomatic effect.

Non-steroid anti-inflammatory drugs (NSAIDs) has wide practical use in medicine. Around one hundred of NSAIDs of different classes are currently developed and produced. Development of new, more safe and effective drugs of this groups continues. The main mechanism of NSAIDs action – inhibition of prostaglandins (PG) biosynthesis, that are formed from the arachidonic acid, by the cyclooxygenase (COG) activity inhibition.

There is NSAIDs classification according to the character of their influence of the articular cartilage metabolism, suggested by J. T. Dingle and M. Parker in the 1997 year, which was then specified and supplemented (Table. 7.5).
Depending on the action duration, NSAIDs are divided into the short-acting, medium-acting and long-acting.

I. Short-acting NSAIDs has the half-period from 2 to 8 hours. To them refer: ibuprofen, ketoprofen, indometacin, fenoprofen, diclofenac, fenamates, tolmetin.

II. Medium-acting NSAIDs are characterized by the half-period from 10 to 20 hours. Representatives of this group are naproxen, diflunisal, sulindac.

III. Long-acting NSAIDs has 24 and more half-period. To these drugs refer oxicams (piroxicam, meloxicam, lornoxicam), phenylbutazone.

**Steroid anti-inflammatory drugs**

Systemic use of glucocorticoids is not indicated in osteoarthritis, and periarticular and intraarticular injections of prolonged glucocorticoid forms exclusively according to indications and with strict maintenance of injection rules. This provides significant but temporary symptomatic effect. Glucocorticoids action feature is that they are able to rather freely get through the plasmatic cell membranes unlikely the most hormones. The leading path of the steroid hormones influence on cellular processes – influence on the gene expression with inhibition of prostaglandins and leukotrienes synthesis, that play significant role in the inflammatory process development. So, leading mechanism of corticosteroid action is inhibition of the cyclooxygenase and lipoxygenase ways of the arachidonic acid metabolism.

Injections of glucocorticoids are not recommended to perform more often than 3–4 times a year, and the interval between the injections in the same joint should be more than 3 months. Main indications for glucocorticoids use in osteoarthritis – persistent synovitis on the background of the conservative treatment, and also persistent inflammation of periarticular tissues (tendovaginitis, bursitis, etc.).

**Glucocorticoid injections are contraindicated** in infectious arthritis of different etiology, infection of skin and subcutaneous fat tissue or muscles in the area of injection, sepsis, hemorrhosis in patients with hemophilia or traumas, in intraarticular fractures. Absolute contraindication to the glucocorticoid use is the Cushing’s syndrome or disease. These drugs should be administered with caution in patients with arterial hypertension, peptic ulcer disease of the stomach and duodenum, diabetes mellitus, predisposition to the clot formation, cachexia. In persistent pain syndrome and synovitis absence, that does not pass after conservative treatment, intraarticular injection of glucocorticoids is contraindicated. Glucocorticoids injection into tendons is contraindicated. According to H. J. Kreder et al. (1994) data, negative influence of intraarticular glucocorticoid injections in animals was increased by their physical activity. After glucocorticoid drugs injection it is necessary to provide rest to the joint for 1–2 days, that promotes more expressive and long effect.

**Symptomatic slow acting drugs for osteoarthritis (SYSADOA).** As was mentioned above, drugs from SYSADOA groups is currently named as chondromodifying, structurally modifying the cartilage, diseases-modifying, chondroprotectors. To these drugs in the first turn refer the structural analogs of the cartilaginous tissue: chondroitin sulfate, glucosamin sulfate, hyaluronic acid drugs, diacerein, nonsaponifying compounds of avocado and soya, complex drugs (alflutos), combined drugs.

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**Table 7.5. Classification of some NSAIDs action on the articular cartilage metabolism**

<table>
<thead>
<tr>
<th>Inhibits glucosaminoglycans biosynthesis and articular cartilage metabolism</th>
<th>Acetylsaliclyc acid</th>
<th>Indometacin</th>
<th>Ibuprofen</th>
<th>Fenoprofen</th>
<th>Phenylbutazone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meloxicam</td>
<td>Piroxicam</td>
<td>Diklofenak</td>
<td>Sulindac</td>
<td>Celexocib</td>
<td></td>
</tr>
<tr>
<td>Do not influence the glucosaminoglycans biosynthesis and articular cartilage metabolism</td>
<td>Benoxaprofen</td>
<td>Tiaprofenic acid</td>
<td>Paracetamol</td>
<td>Nimesulide (10 mcg/ml)</td>
<td></td>
</tr>
<tr>
<td>Stimulate glucosaminoglycans biosynthesis and articular cartilage metabolism</td>
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<td>---</td>
</tr>
</tbody>
</table>
Practically in all conducted studies, drugs of SYSADOA group showed efficacy and safety in osteoarthritis treatment.

Glycosamine (GA) – amino sugar, that is the component of practically all human tissues, including cartilage. It was established, that it compounds GAG, that forms the matrix of all connective tissues. GA is a substrate for proteoglycans biosynthesis of the articular cartilage and also their components. It was established, that the primary biological role of the glucosamine is directly conditioned by its ability to stimulate the glucosaminoglycane biosynthesis and hyaluronic acid, which are necessary for the proteoglycans formation.

Chondroitin sulfate (ChS) together with keratan sulfate (KS), dermatan sulfate (DS), heparan sulfate and heparin refer to the group of compounds, that has common name – sulphated glucosaminoglycane (GAG). ChS in formed from the glucosamin in the organism. It compounds the aggrecan – macromolecule, that creates the microenviornment for the chondrocytes functioning in the articular cartilage, influence their metabolism in such a way. An important value of ChS is it ability to influence the proliferation and metabolism of chondrocytes.

**Hyaluronic acid (HA)** – natural polysaccharide, that is present in many tissues of the organism. OA is accompanied by changes of the cartilage metabolism. One of the consequences of this processes is the synthesis impairment, and also changes of HA properties, natural cartilage component, that determines viscous-elastic properties of the synovial fluid, which are lost in osteoarthritis, as depends on the HA molecular weight and concentration. Anti-inflammative effect of glucocorticoids is connected with their ability to interact with specific cell receptors (chondrocytes, synoviocytes), such as CD-44, RHAMM, I-CAM. HA inhibits the enzyme activity, that destroys articular cartilage. Analgesic effect of HAs is connected with their lubricating properties, as well as with the possible direct influence on the nerve endings of the synovial membrane. Exogenous HA inhibits synthesis of endogenous HA. Multiple clinical studies showed the high efficacy of HA in OA.

**Anti-oxidant drugs** inhibits processes of lipids peroxidation, prevent and decrease the free radicals formation and inhibits cartilage destruction due to this.

**Drugs for microcirculation improvement** are used in a complex treatment of osteoarthritis during the remission stage for decreasing the venous congestion, improvement of hemocirculation in the synovial layer and subchondral areas, trophics optimization of the articular cartilage, other articular and extraarticular structures. The following medications are currently used for this purpose: kurtantil, trenal, nicotinic acid, detralex. cyclo-3-fort and others.

**Metabolic therapy** is directed at the metabolic processes improvement in the articular cartilage, periarticular tissues and in the organism in general, To them referdrugs, that influence the bone tissue metabolism (osteotropic drugs); metabolism and functional condition of the muscular tissue (drugs, that normalize muscular tone), energetic state of tissues and organs, anabolism and catabolism activity. To this groups also refer the drugs for enzyme-therapy, vitamin therapy, macro- and microelements.

**III. Intraarticular treatment**

Local peri- and intraarticular injection of drugs in osteoarthritis is directed in the first turn at the inhibition of the local inflammative process intensity, and also prevention of degeneration-destructive process in the joint. Reaching of this purpose is realized by the intra- and periarticular drugs injection, action of which is directed at the cellular membranes stabilizing, synthesis inhibition and activity of a series of proteolytic and biological active substances, that promotes the cartilage destruction, hemocirculation improvement, activity inhibition of the free-radical lipid peroxidation; immunologic correction, etc.
Among drugs, that are more often used for periarticular and intraarticular injection is osteoarthritis, the following should be mentioned:

- local analgesics (novocaine, lidocaine, bupivacaine, etc.);
- glucocorticoids (Diprospan, Flosteron, Depo-medrol, etc.);
- Protease inhibitors (Contrycal, GordoX, Trasilol);
- chondroprotectors (complex drugs: Alflutop, hyaluronic acid drugs: Hyalual-arthro, Sinocrom, Syngyal, etc.);
- synovial fluid substitute (Polyvinylpirrolidon, Noltrex, Synvix, etc.);
- antihomotoxic therapy drugs (Traumel C, Cell Т, Discus compositum, etc.);
- antioxidant drugs (Orgotein).

It should be mentioned, that method of local intra- and periarticular injection of pharmacological agents in osteoarthritis is used in complex with systemic pharmacological, non-pharmacological and operative treatment.

IV. Operative treatment

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 prosthetic 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. 7.7). At the articular fissure projection (knee, shoulder, ankle, elbow, and other joints) several, usually two-three, small sections (punctures) are performed.
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 cm, 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 osteoarthritis 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.

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 characterized 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 inflammatrve processes, with chondromatosis in particular. In chronic recurrent 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 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. 7.8). 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
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good, 77% assessed the treatment effect as constantly positive. Technique of the arthroscopy performance with abrasive chondroplasty provides for the damaged cartilage parts removal and careful polishing of defect margins.

Microfracturing – microfractures, forage of the articular cartilage defect bottom performance (Fig. 7.9). 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 postoperative period.

Osteoarticular autografting (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. 7.10). 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).

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.

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.

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 osteoar-
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Arthritis 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 performed 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 to 12°.

For good postoperative 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 endoprostheses have long exploitation period and can serve during 15–20 years, in some endoprostheses 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 endoprostheses (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 endoprostheses fixation: cemented and uncemented. In the first case, joint components are fixed to bones with polymethylmethacrylate (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 pa-
tient 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. 7.11).

**Fig. 7.11. Construction of the hip, knee and shoulder joints endoprosthesis**
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.

Some 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.

**Indications for endoprosthetic joint replacement:**
- severe forms of degenerative-dystrophic and inflammatory 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 irreversibly from the organism. Endoprosthesis is implanted at its place after this (Fig. 7.12).

**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;

*Fig. 7.12. Patient A., 1964 dob. X-rays of the affected hip joint before (A) and after (B) the endoprosthetic replacement*
● 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 crunches for up to 3 months in uncemented joint fixation. It is recommended to limit lifting of significant weight, running, 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 destructed 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. 7.13). 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.

**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
Degenerative-dystrophic diseases of joints and spine 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 III, 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.

Fig. 7.13. Patient M., 1947 year of birth. Radiographs of the affected knee joint before (A,B) and after (C, D) endoprosthetic replacement
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. 7.14).

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 endoprosthetic replacement. Postoperational wounds heal in this period and patient is discharged home. Till the discharge patient should walk confidently with crunches.

Patient continues to do exercises, which he/she was educated by the doctor or physical therapist, ev-ery day at home. Most of the patient also continue to intake anticoagulants, because the risk of throm-\textit{bosis} 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 endoprostheses fixation and in 2–2.5 months after the uncemented. General terms of rehabilita-\textit{tion} 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 con-trainindicated 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. 7.15).

AVASCULAR NECROSIS

Avascular necrosis (avascular necrosis, according to ICD-10) – form of the degenerative-dystrophic affection of joints, when the subchondral bones tissue is initially affected with the avascular necrosis focus formation with the following involvement into the degenerative-dystrophic process of all joint elements – articular cartilage, synovial membrane, capsule, periarticular muscles and others (See pic. 7.16.)

Avascular necrosis of the femoral head, that is the consequence of the blood flow impairment and bone marrow elements necrosis in the femoral head. Disease usually develops in the background of corticosteroids use, joint trauma, alcohol abuse, pancreatitis, sickle-cell anemia, ionizing radiation, etc. In absence of the clear reason, the diagnosis of idiopathic femoral head avascular necrosis is made,
but the number of such diagnosis recently decrease due to the widening of medicine diagnostic capabilities. Radiologic diagnostics allows to mainly diagnose late stages of the disease in femoral head fragmentation or deformation. Orthopedic prognosis is unfavorable in most of the cases – deforming osteoarthrosis of the hip joint, when endoprosthesis replacement, arthrodesis or correction osteotomies are often used as methods of choice in surgical treatment. Early diagnostics is possible only using CT (computed tomography) and magnetic resonance imaging (MRI) of the hip joint and gives hope for favourable consequences of the diseases with using of conservative or surgical treatment.

**Pathogenesis**

Two points of view are widely represented in the literature: traumatic and vascular. It is known, that avascular necrosis of the bone tissue can be caused by different reasons: impairment of the arteries integrity by their compression or rotation, embolism, continuous arterial spasm, venous stasis and other mechanical impacts. AVN of the femoral head due to the trauma (luxation, metaphyseal zone fracture) or surgical intervention are studied completely, and its occurrence mechanism is conditioned by the arterial and venous blood flow area impairment.

Issue of the pathogenesis of the as called non-traumatic avascular necrosis of the femoral head. Gracianskiy VP in the 1955 year has shown, that due to the microtrauma, joint overload and other unfavorable factors, processes of the "overstrain" occurs in the bone tissue. Impulses from the focus go to the cerebral cortex and cause corresponding return signals, that provoke the vascular spasm and blood and lymph congestion, metabolism, impairment, accumulation of the catabolic products in the bone. These lead to changes of physicochemical and structural-dynamic properties of the bone, leads to slow destruction of the bone trabeculs, further complication of the local blood flow and progress progressing. This theory of the "chronic microtrauma" is currently supported by many scientists.

Welfling J. in 1967 made a conclusion, that all femoral head necrosis have the vascular genesis, occur due to the arterial embolism. Impairments of the venous circulation in the affected femoral diaphysis in patients with avascular necrosis allowed some authors (Shumada IV., 1990; Ayrоlles Chr., 1962) to suggest, that the initial change is the venous insufficiency with following process transmitting to the arterial system.

Blood flow impairment manifests with the increased intraosseous pressure, enhancement of the ischemic disorders. According to Arlet J. and Float opinion, that one of the reasons of the femoral head avascular necrosis is an intraosseous pressure increase in the proximal femoral end.

Experimental studies, compared to the histologic investigation of the operation material (Stecula VI, Moroz NF, 1988), showed, that osteonecrosis foci are formed in 3–5 days in the blood flow impairment in the epiphyseal area, that are replaced with osteogenic tissue during the revascularization process and during the differentiation process are transformed into the normal bone tissue. In unfavorable conditions (joint overload), perifocal necrosis area develops at the border of the osteonecrosis focus. and then on the background of secondary circulation disorders the perifocal osteosclerosis zone is formed. Bone trabecules are without osteocytes during this period, space between them is filled by protein masses, osteonecrosis focus is limited by the fibrous tissue.
Common cause, that unites all non-traumatic cases of osteonecrosis – osteopenia. Fractures occur in the anterosuperior part of the femoral head, where the most part of pressure is applied to, due to the "weariness" of the osteopenic trabecules. Accumulation of the fractured trabecules more probably can lead to the arterial blood flow closure and cause bone necrosis.

Osteoporosis combination, mechanical pressure, frequent use of the osteo- and chondropathic medications, and also inflammation lead to the subchondral trabecular fracture and further destructive and degenerative processes in the hip joint. Expressed movement function impairment is observed in all patients, caused by the pain syndrome, movements limitation in the joint, muscular hypertrophy and their function. impairment. Laboratory investigation in patient indicates the capillary blood flow impairment, intraosseous pressure increase, hypercoagulation syndrome, and also vegetotrophic regulation in these patients.

**AVN of the femoral head**

The following are defined according to etiology:

I. Primary
- idiopathic

II. Secondary:
- neuroendocrine;
- posttraumatic;
- postarthritic;
- dysmetabolic;
- other.

Choose of the treatment method in AVN o the femoral head depends in the first turn on the diseases stage on the moment of the diagnosis formulation.

Different classifications are currently suggested by the orthopedist-traumatologists, in which different stages are defined. Reinber SA, 1964, and Ritz IA, 1981, developed 5-stage classification. Mankin H. J., 1992, define 6 stages. Serre H. and Simon L. define only three stages of the process, Korzh et al adhere to the same classification (1982).

Most acknowledged classification among the Ukrainian specialists is Kulish MI, Filipenko VA classification (1986), where 4 clinico-radiologic stages of the AVN of the femoral head are defined (Fig. 7.17–1):

- 1 stage – initial (radiologic lighting, sequestration). It is clinically the stage of the initial manifestations, where non-intensive pain syndrome can be observed, that occur during loads. The only limitation of the internal rotation is defined. Impairment of the femoral head bone structure like the osteosclerosis and osteoporosis foci can defined.
- 2 stage – stage of the impressive fracture (impression fracture and demarcation of the avascular necrosis focus). Transition into the second stage is accompanied by the intensive pain occurrence due to the capital impression fracture. Then pain becomes less intensive and its intensity increase during activities. External and internal rotations, abduction are significantly limited. Radiologic signs: articular space widening; femoral head – irregular contours due to the necrotic focus impression in the anterosuperior part, which is more loaded, necrotic focus is clearly differentiated due to the increased radiologic density; osteolysis and reactive sclerosis zones are located around it.
- 3 stage – necrotic focus punching in the articular area with the secondary osteoarthritis development, or the stage of secondary osteoarthritis. Pain is intensive, constant, its intensity decrease during rest. Movements are limited in all three dimensions, adduction-flexion contrac-
Avascular necrosis of the femoral head is started to be compared to Perthes’ disease in children and the same term was suggested with the clinical experience accumulation. But many investigators had indicated further, that the disease course in children and adolescents is milder, than in adults due to the better blood supply and high reparative capacity, which ends with the bone tissue recovery, often even with the preservation of the femoral head form, which is usually not observed in adults. Friedkin VI and Logunova IG notice features of its manifestation in adults during the radiologic pattern investigation of the AVN of the femoral head (typical localization of the necrotic focus in the superior external segment of the femoral head). This issue was in the programme at the international meeting of orthopedist and traumatologists in Paris (1966). Issues of etiology, pathogenesis and treatment of avascular necrosis were discussed. Most of the investigators had definitely supported the vascular diseases genesis (Bosch S., Bickee W., Merle D.). It was accentuated, that factors, which can promote the diseases development can be: trauma, including – repeated microtrauma; articular dysplasia, continuous drugs intake, in the first turn – corticosteroids and cytostatics. Some authors connect the increase of patients with the disease to the wide use of the steroid drugs. Alcohol abuse has a big value in the AVN of the femoral head development.

Disease is more often observed in men (8:1) of young and middle age (more then 2/3 of all cases) and consists 1.5–2 % of all orthopedic pathology. 15 thousand cases of AVN of the femoral head are discovered in the USA each year. According to IETC data (Moscow, Russia, 2010 year), AVN of the femoral head is determined in 2.3 % of patients and is a cause of continuous progressing disability in 7 % of orthopedic patients with the lower limbs function impairment. Bilateral affection according to data of different authors is observed in 50 % of cases. The most common cause of the non-traumatic AVN of the femoral head is GC-therapy and alcohol abuse. Ohzono K. et al. (1991) observed 87 patients (115 hip joints), where the cause of the avascular necrosis were: GC-therapy (69 patients), alcohol (18), idiopathic affection (25).

Treatment

AVN of the femoral head treatment should be complex and differentiated depending on the process stages and clinical manifestations, prognosis depends on the early diseases diagnostics, osteo-
Fig. 7.17–1. Clinico-radiological stages of the avascular necrosis of the femoral head

Fig. 7.17–2. AVN of the femoral head, 1 stage:
A – Radiograph according to Launstein; B – MRI: frontal plane; C – MRI: horizontal plane

7. Degenerative-dystrophic diseases of joints and spine
necrosis spread and proper treatment tactics. Possibility of the bilateral hip joints affection should be taken into account in more than 50 % of patients.

In spite of success of the surgical treatment: transtrochanteric rotak (flexion-antivalgus) osteotomy, which prevents the femoral head collapse in 95 % of cases; subchondral autoplastics of the femoral head, endoprosthetic replacement, and sometimes arthrodesis – see in osteoarthritis treatment section). AVN of the femoral head is the problem of the out-patient orthopedy. Disease duration (from 1.5 to 2 years) require a lot of patience from doctor and patient and performance of the necessary medical rehabilitation complex adjusted for the process stage and orthopedic situation. Complete recovery of the joint usually does not occur. But rather acceptable disease outcome can be reached in most of the cases: prevention of the collateral joint affection, decrease of destructive processes in the femoral head and secondary coxarthrosis; false hip positioning in the position of flexion, adduction or extensive rotation; minimal movement range limitation in the hip joint; good functional condition of muscles and mildly expressed pain syndrome.

Orthopedic regime. Special importance has the adherence to the orthopedic regime. According to the university biomechanical laboratory at the Berlin orthopedic hospital, and also according to IETC (Russia, Moscow), the regime of the maximal joint unloading is not reasonable and not justified (crunches) for the continuous period of time and adherence to the bed rest at the initial period of the disease. Studies that were conducted in the IETC biomechanical laboratory, proved, that walking with crunches for more than 2–3 months leads to the progressive hypotrophy and function impairment of the main muscular groups, persistent pain syndrome and vegetotrophic impairments formation, impairment of the motor stereotype. These complicates orthopedic status of patients and lead to severe impairment of the lower limbs function, that in its turn complicate the AVN of the femoral head course, provokes pathologic process development in the collateral joint, causes problems in adjacent joints and spine. Patient’s walking should not be limited, it is enough to exclude inertial loads on the joint (running, jumping, lifting weight); orthopedic stick should be used only during first 3–4 weeks after the pain syndrome onset and during walking on the long distances. In the opposite, dosed walking (15–20 minutes) in the medium pace, climbing the stairs, riding the exercise bicycle, swimming facilitates course and reduce term of the first disease stages. Measures directed at the excessive body weight reduce are also necessary.

There are interesting studies, that were conducted in the university biomechanical laboratory at the Berlin orthopedic hospital in patients after the bilateral endoprosthetic replacement of hip joints using the telemetric probe built-in in the prosthesis neck. Loads on the joint, force moments and temperature were studied during 18 months after the endoprosthetic replacement in different walking modes. In walking with impairement locomotion, stumbling, loads increased in 46 times. Additional support does not solve the problem of the joint unloading. Support with 2 crunches reliably unload the joint during first 2–3 weeks (25–60 %), in 1 month unloading effect decreases to 10–15 %.

Walking up/down the stairs. According to the Bergmann et al., 1995 data, walking up the stairs with support in the handrail unloads the joint significantly more than walking with support on crunches. Big load was determined during walking down the stairs. Stumbling leads to the significantly bigger load on the joint (720–870 %), then in other studied activities.

N.B. Medical rehabilitation complex in the AVN of the femoral head includes:

- adherence to the optimal orthopedic regime and exercise therapy;
- drugs;
- decompression forage and prolonged intraosseousblockades;
- intraarticular injection therapy;
- gait correction, ie using the multi-channel electrostimulation;
- electrostimulation;
- physiotherapy (EHF-therapy, laser therapy, magnet therapy).
The most optimal load on the joint is on the exercise bicycle: medium loads on the joint are always lower than 60% of the normal load, when the combined muscular force was not lower than 80% of the normal value (during walking). Carrying weight of 10% of the body weight in one hand leads to the load increase in the collateral joint by 22% (in decreasing on the same side by 3%), and with equal weight in both hands – by 8.8%.

Besides this, temperature change in the joint was studied. Articular temperature starts to grow up in walking for more than 15 minutes, and in 45 minutes articular temperature reaches 45 °C.

Important valus is given to exercise therapy for the flexion and abductive femoral muscles, prelum and spinal extensors strengthening. Electrostimulation method is widely used, including multi-channel ESM during walking for muscles strengthening and walking stereotype recovery.

Medicamentous treatment. Vascular drugs use is pathogenetically grounded at the initial disease stages for the ischemic changes reducing in the femoral head, normalization of the blood rheological properties.

Decompression of the metacarpal area. Is undoubtedly pathogenetically grounded and rather effective method for early decompression of the femoral metaepiphyseal area. Elimination of the increased intraosseous pressure can “break” ischemic cycle of the diseases. Succes of this method use varies from 40 to 90% (Hopson CN, 1998). According to Bluemke D. A., Petri M., Zerhouni E. A. (1995) data, femoral head collapse was prevented in 25% of patients. There are many methods of influence on the bone issue – from osteotomy to cryodestruction of the spongious substance. IETC actually recommends low-traumatic and available in the out-patient condition method of metaepiphysial zone forage with the bone decompression and blockades conducting. Unlike the blockades, suggested by Poliakov VA (1975), autoblood is used as prolongator, adding 2% novocaine solution and vascular drugs in it (curantyl). in some cases (in patients with diabetes mellitus and non-clostridial cellulitis, and also in patients who sustained infection – gonorrhea, chlamidiosis, etc), use of the intravenous antibiotics is appropriate.

Pain syndrome elimination at the initial stages of the AVN of the femoral head is an important issue in patient’s treatment, allows to influence on multiple cause-effect mechanisms of the disease. The most effective method of the pain elimination is the iliopsoas muscle blockade, which performance in combination with other medical measures allows to eliminate or decrease manifestations of the pain syndrome to minimal.

Physiotherapeutical treatment. EHF-therapy, laser therapy, magnet therapy, pelotherapy and balneotherapy are widely used in patients with AVN of the femoral head.

CYSTIC RESTRUCTURING OF THE ARTICULAR BONES

Cystic restructuring – form of the degenerative-dystrophic articular lesions, when the subchondral bone tissue is initially affected by the formation of multiple or singular cysts in it, their merging, burst into the articular cavity and secondary osteoarthritis development with the following involvement into the degenerative-dystrophic process of all articular elements (articular cartilage, synovial membrane, capsule, periarticular muscles, etc.).

This pathology is observed significantly rarer than osteoarthritis and avascular necrosis. Degenerative-dystrophic changes with the cystic restructuring of the articular bone differ from osteoarthritis with the clarification presence in the articular bone ends. In the primary form, they are more often found in the small bones of the hand and are consequences of the continuous, permanent microtrauma. But the predisposition to such changes occurrence usually exists.
**Clinical picture**

Pain intensity increases gradually, slowly, it increase during movements and after loads. But then in pathologic fractures with the burst of the cystic formations into the articular cavity, intraarticular hemorrhages, degenerative articular lesions, secondary osteoarthritis can occur. Normal or slightly reduced height of the radiological articular space, slightly visible marginal bone outgrowth and expressed cystic restructuring of the bones are determined and the X-ray film. Cysts are more often multiple, small, rarer – solitary and large. Areas of the cystic restructuring have not distinct borders during formation. Formed cystic formations have clear contours due to the sclerotic end-plates. In lasting physical load (overload) fracture of the cystic formation walls can occur, that is clearly observed at computed tomography. Described changes are primary manifestations, that are typical for the vibration disease, decompression disease, permanent microtrauma and overload, and also for some other professional diseases.

Secondary cystic restructuring is often observed as a consequence of the primary diseases: dysplastic and other types of osteoarthritis, after sustained arthritis, after endocrine diseases, in systemic metabolism impairment (dismetabolic), etc.

In the background of the cystic restructuring occurrence mechanics, lies impairment of hemo circulation in certain epiphysis part in the subchondral bone tissue, that leads to it hypoxia, dystrophy and lysis of the local subchondral part with cyst formation.

The following clinico-radiological changes are determined during the clinical investigation depending on the pathologic process stage:

- clinical symptoms are practically absent in the first stage, patients notice insignificant discomfort after the continuous physical load in the area of the affected joint. Overextension limitation in the joint is observed sometimes. Clarification with irregular contours is determined at X-ray, often with regular form – onset of the cyst formation;
- pain syndrome intensity and discomfort in the joint increase in the second stage, sometimes gait impairment, limping, insignificant movements limitations in the joint occur. Cyst is of the irregular form, but clearly limited at X-ray. Then cyst enlargement occur, sometimes its restructuring and its wall fracture is visible till it burst into the joint; articular surfaces and space are not changed;
- third stage is characterized by the presence of constant pain syndrome in the area of the affected joint, pain irradiation into the adjacent parts of the musculoskeletal system, movements range decrease, occurrence and increase of contractures, muscular hypotrophy. Then, with the development and progressing of secondary osteoarthritis, intensity of these symptoms increase. Flattening of the articular surface at the limited area is observed at X-ray (due to the bone wall punching), its structure is heterogenous due to the restructuring and reactive changes around the cyst, marginal bone outgrowth occur. As the consequence, deformation increases and secondary osteoarthritis deformans progresses.

Following radiologic stages of the cystic restructuring of the articular bones are defined (Fig. 7.18):

- I stage – occurrence of singular subchondral cysts – round form clarification in the epiphyseal bone area;
- II stage – widening, generalization of certain cysts;
- III stage – cysts burst into the articular cavity, articular surfaces deformation, secondary osteoarthritis deformans development.
Treatment of the cystic restructuring of articular bones

Treatment depends on the pathologic process form (primary or secondary), and also the stage of course. Taking into account the similarity of this form of the degenerative-dystrophic articular lesion with avascular necrosis, which is characterized by the primary affection of the subchondral bone tissue and more often has vascular disorders in its genesis, treatment of these forms is similar. In early stages, it is directed at the unloading if the affected joint and use of drugs and surgical methods for the blood circulation improvement, decrease of the inflammatory process if it is present, pain syndrome decrease, osteotropic and chondroprotective drugs. At the final stages, when drugs are usually ineffective, endoprosthesis replacement of the affected joint is used, and in case of impossibility or contraindications presence – arthrodesis. General principles of the non-medicamentous, medicamentous and surgical treatment (forage, correction osteotomy, endoprosthesis replacement, arthrodesis) stated in detail in previous sections.

7.2. DEGENERATIVE-DYSTROPHIC DISEASES OF THE SPINE

OSTEOCHONDROSIS

Osteochondrosis – disease of the spine, in the background of which lies the primary degenerative-dystrophic process in the intervertebral disk (IVD), with the following development of reactive and compensatory changes in intervertebral joints and ligamentous apparatus, and then in the bodies of adjacent vertebrae, and as the result total affection of all elements of the vertebral motor segment.

People after 45 years nowadays limit their activity due to the constant low-back and neck pain. Prevalence of the chronic low-back pain consists 26–32 % of the adult population. Among diseases with the working capacity loss in the adult population, more than 50 % consist diseases of the peripheral nervous system.

Etiology. According to modern conceptions, osteochondrosis refers to the polyetiologial group of diseases. It is chronic systemic affection of the connective (cartilage) tissue, that develops on the background of its existing congenital or acquired functional (predominantly metabolic) insufficiency.
The most spread are involutional and microtraumatic theories of the osteochondrosis development. According to the involutional theory, aging and intervertebral discs involution are the diseases background. Microtraumatic theory assumes, that trauma of the spine can have etiological, as well as the provocative character in the diseases development. In osteochondrosis development importance is attached to the hereditary predisposed biochemical, hormonal, neuromuscular and immunologic disorders, and also spine development anomalies, which can impact the clinical course of the diseases. Certain role is given to the exogenic factors, supercooling in particular, which influence can provoke autoimmune disorders or reflex arterial spasm development, that supply nervous root and vertebral segments.

**Biomechanics and physiology** of vertebral-motor segment (VMS). The spinal column consists of vertebrae connected by IVD, massive ligamentous apparatus and paired zygapophysial joints. IVD together with adjacent vertebrae forms structural-functional unit – vertebral-motor segment (Fig. 7.19).

Leading role in the VMS and spine in general plays IVD, which perform the following functions: vertebral bodies connection, vertebral bodies protection in overloads and trauma (amortization).

IVD consists of the nucleus pulposus, which is located in the center, and fibrous ring, that surrounds nucleus pulposus. Nucleus pulposus – ellipsoid avascular formation, that consists of the intercellular substance. Proteins, mucopolysaccharides (glucosaminoglycans), hyaluronic acid and water compound the intercellular matrix. Depolymerization of the polysaccharides occur with age, nucleus loses its elasticity.

Fibrous ring consists of very dense connective-tissue interlacing plates, which are located around the nucleus pulposus. The fibrous ring incorporates vertebral bodies and IVD into the whole.

 Movements of the spine are performed in the following planes: flexion and extension – in the sagittal, lateral body inclination – in the frontal, rotation – around the spine axis.

**Osteochondrosis pathogenesis**, depending on the process prevalence in the segment and segment function impairment, stable and unstable form of the diseases are defined.

**Staging of the dystrophic-degenerative changes in the IVD** is important in the pathogenesis of osteochondrosis clinical manifestations. Three stages of osteochondrosis are defined (Hvysiuk NI, Prodan AI):

- stage of the intra-disk dislocation of the nucleus pulposus within the undamaged fibrous ring;
● protrusion of the nucleus pulposus in absence of the fibrous ring ruptures – disk protrusion (more often towards the posterior longitudinal ligament, where the fibrous ring structure is thinner);
● stage of the nucleus pulposus prolapse through the destructed fibrous ring – hernia (a disk hernia).

Spine osteochondrosis development starts with the nucleus pulposus degeneration – polysaccharides depolymerization. Nucleus dehydrates and loses fibrous structure, elasticity and breaks up into separate fragments. Fibrous ring becomes fragile, radial ruptures and delamination occur at different distances. If the nucleus elasticity was preserved in some degree, weakened fibrous ring can not resist the nucleus tendency to widening during the axial load. Nuclear fragments penetrate through the fibrous ring fissure, stretch and stick out its external layers. Fibrous ring protrusion can be ventral, into the spongy substance of the vertebral body, through the hyaline membrane ruptures, forming Schmorl’s nodules or hernia, and also towards the spinal canal, causing compression of the neurovascular formations. Mentioned structural changes are typical for the stable osteochondrosis form (Fig. 7.20).

Process can spread through several ways in the final stage: substitution of the degenerative changed IVD elements with the connective tissue and fibrous ankylosis formation and immobilization of the vertebral-motor segment; involuntary reduction and autolysis of the IVD tissues that fall out into the spinal canal; cicatricial-commissural process formation in the spinal canal around the IVD fragment; the diffuse affection of the fibrous ring and instability occurrence in the VMS (unstable form of osteochondrosis). Spinal instability – is a clinicoradiological syndrome of osteochondrosis, which manifests with the functional inability of the spine, especially during static-dynamic loads, and is characterized by excessive pathologic mobility in the horizontal plane with the following dislocation of one vertebra according to another, that leads to its resistance decrease.

Three stages of instability are defined (Hvysiuk NI, Prodan AI):

I stage – diskogenic, when pathologic process is diffusely spread only in disk tissues and pathologic mobility of the vertebra only in horizontal plane is observed;

II stage – disko-arthrogenic, when zygapophysial joint of the spine, ligaments and muscles are also involved in the pathologic process besides the disk;

III stage – disk-arthro-osteogenic, when all mentioned above structures and vertebral arc are affected with its resorption, anterior dislocation of the vertebra – degenerative spondylolisthesis.

Clinical symptoms of osteochondrosis usually manifest, when the pathologic process affects posterior parts of the fibrous ring and posterior longitudinal ligament, that are well supplied with the meningeal nerve endings, that consist from sympathetic and somatic fibers. Pain syndrome is especially expressed in a disk hernia, that cause compression of the nerve roots and (rare) spinal cord. Diskogenic (hernial) compression causes changes in the root. Three stages of changes in the root are defined: irritation (are characterized by paresthesia and pain), compression (sensitivity impairments

Fig. 7.20. Stages of degenerative-dystrophic changes in intervertebral disks:
A – initial disk degeneration;
B – protrusion (prolapse) of the disk;
C – disk hernia formation (disk sequestration)
Vascular impairments in osteochondrosis occur due to the vasomotor innervation impairment and rarer due to the mechanical compression of the vessels. Visceral disorders are also conditioned by the irritation or drop-out of the viscerofant or visceroeff erent fibers. Presence of a big amount of sympathetic fibers in roots (especially thoracic) can be a reason of visceral pain or dyskinesia.

Mechanical stability of the VMS and all spine recover with years due to the marginal outgrowth (osteophytes), disk and capsule fibrosis, facet joint ankylosis, ligaments thickening. These changes finish the "degenerative cascade" in the spine and sometimes lead to the spontaneous decline of pain. But in the same time they can cause the spinal canal stenosis. Besides, osteophytes, that are directed towards the spinal canal can injure roots and cause persistent pain syndrome and neurologic disorders.

Clinical picture and diagnostics of osteochondrosis. Formation of the osteochondrosis clinical manifestation depends on the process localization, disease form (stable or unstable) and process stage, and also from the nervous, immune, endocrine, cardiovascular and muscular systems condition.

Clinical manifestations of the spinal osteochondrosis are multiform: from severe low-back pain in acute hernia of the dystrophic-changed disk to the discomfort feeling. Provocative factors of the low-back pain are more often muscular overstrain, weight lifting and awkward movement, continuous uncomfortable position, overcooling, straining effort, etc. Vertebral (connected with the impairment of one or two VMS functioning) and the extravertebral (connected with pathologic outfl ow from the affected vertebral segment) manifestations (syndromes) are defined.

Extravertebral manifestations occur due to the pathologic outflow from the affected vertebral part, that spread to the corresponding sclerotomes to certain body parts. These syndromes obtain names according to localization: cranialgia, toracoalgia, brachialgia, ischialgia, cruralgia, calcaneo-, achil-, coccygodynia (pain in the area tailbone). Painful feelings can also irradiate across the wide vegetative net to the visceral sphere (heart, lungs, pleura, liver, pancreas, intestine) – visceral symptoms. Pain syndromes, that occur in the compression of roots, cauda equina and other parts of the peripheral nervous system, consist a special group. All mentioned types of "irradiated" and reflected pains form the variety of extravertebral neurovascular, musculotonic, neurodystrophic, vertebro-visceral and neural syndromes.

Vertebral manifestations of osteochondrosis:
- change of the spinal configuration (lordosis smoothening or increase, kyphosis, scoliosis, kyphor lordoscoliosis);
- spinal mobility impairment (mobility limitation due to the miofixation or pseudospondylolistesis);
- local pain and tenderness in active and passive movements. These symptoms are conditioned by the recurrent (meningeal) nerve receptors irritation;
- feeling of the "spine fatigue" and discomfort in the back – sign of the VMS absorbing function loss, decrease of the spine ability to resist usual loads;
- paravertebral back an neck muscles spasm, tenderness during palpation at the paravertebral soft tissues, and also tenderness of the spinous process, interspinous ligaments, facet joints area, sacroiliac junctions.

Extravertebral vertebrogenic syndromes of spinal osteochondrosis

Neurologic manifestations of spinal osteochondrosis are considered as vertebrogenic:

1. Reflex syndromes – main their reasons are fissures and ruptures of the fibrous ring fibers, that manifest clinically with tension and dystrophic changes of various muscles and fascias, that is called miofascial syndromes. In reflex syndrome pain is distinguished by the diffuse spreading, has
sclerotomic character, its intensity increase in weather changes, is accompanied by distressing pain-
ful paresthesiae, limbs cooling, formication. Dystrophic changes of joints and ligaments and multiple
vegetovascular disorders also compose the reflex syndromes group. They manifest with the vascular
 spasms of limbs and heart. The last is called cardialgia and their differential diagnosis with vascular
 heart diseases often cause significant complications.

**Reflex syndrome** is divided into three big groups: musculo-tonic, neurodystrophic and vegeto-
vascular.

**Musculo-tonic syndrome** of spinal osteochondrosis manifests with the tension of different para-
vertebral muscular groups.

**Neurodystrophic syndrome** is represented by the noninflammatory affection of the joints – peri-
arthritis and their combination with vegetative disorders of limbs, dystrophic changes in muscles and
ligaments. Dystrophic changes in muscles at the place of their adjunction of the bone are determined
by the tendons induration, tenderness and are called with the term “neuroosteofibrosis”.

**Vegetovascular syndrome** manifests with vascular and vegetative disorders in arms and legs.

2. **Radicular syndrome** – diskogenic (vertebrogenic) affection of the spinal roots/ Affection of the
root is conditioned by not only its mechanical compression, but also inflammation, swelling and demy-
elination. Immunologic processes have the certain role in their development. Changes in sensitivity, re-
flex sphere (reflex decrease or absence) or motor (paresis, paralysis) are typical for diskogenic radiculitis.
Main reason of diskogenic radiculitis is usually the rupture of the fibrous ring and secondary compres-
sion of the spinal root with the disk hernia. Pain in radicular syndrome has nagging, burning, stabbing,
sharp character, is accompanied by the feeling of numbness, formication, electric current passing. Pain
increases in bendings, mild physical activity, cough, irradiate to the one or both legs. Affection of the
motor root leads to the muscular contracture occurrence, and in more severe cases – to muscular hy-
pertrophy.

3. **Radiculo-vascular syndrome** (radiculoischemia, myeloischemia – is determined by the acute
occurrence of motor and sensitive disorders of radicular type with the muscular paresis and paralysis
occurrence at the upper and lower limbs on the background of the pain syndrome disappearing.

Osteochondrosis of the cervical and cervico-thoracic parts of the spine

**Cervicalgia** – cervical pain in osteochondrosis – can be instant or like attacks (lightning pain). Pain
in attacks can be very intensive, boring, aching, but is always sensed deeply in the neck. It is accompa-
nied by the cervical muscles tension, stiffness, its intensity increase in attempts to turn over in the bed.

**Cervicocranialgia** – characterized by the pain in the cervico-occipital area with irradiation (more
often unilateral) to the parietal, temporal, fronto-orbital and auricular area. Pain is of throbbing, dart-
ing, aching and burning character, that occurs and increases at head movements.

**Cervicobrachialgia** – cervical vertebrogenic syndromes in the area of the arm and muscles of
the anterior chest wall. They are conditioned by the reflex dystrophic changes in muscles of the
proximal part of the upper limb, shoulder girdle and chest, and also tendo-periarticular tissues of
the shoulder and elbow joints. Local manifestations – tenderness and muscular tension indura-
tion presence in them, nodules – are often accompanied by the tenderness in the area of muscular
tendons adjunction to the bone prominences (coracoid process of scapula, external epicondyle of
shoulder, etc.).

Osteochondrosis of the cervical and thoracic spine are often accompanied by the cardialgic syn-
drome (pain in the area of the heart, sternum or beside sternum of noncoronary genesis can be continu-
ous, aching, stabbing), which should be distinguished stenocardia or myocardial infarction.
Vertebral artery syndrome which includes the complex of the cerebral vegetative and vascular symptoms, that are conditioned by the sympathetic plexus of the vertebral artery irritation, its wall deformation and lumen narrowing (Fig. 7.21).

Vertebral artery syndrome manifest with pain, paresthesia in the cervico-occipital area with irradiation to the anterior part of the head, crown, temple, dizziness, that are accompanied by nausea, vomiting, stuffiness or noise in the ears, photopsy.

Osteochondrosis of the lumbar part of the spine

Clinical pattern of the stable forms of osteochondrosis.

I stage: intradiscal dislocation of the nucleus pulposus – diskogenic. Manifests with pain like lumbago, lumbodynia or lumb-ischialgia.

Lumbago – acute, like darting, lumbar pain. Occurs in the weight lifting, awkward movement, cough, sneezing. Movements in the lumbar part of the spine are sharply limited or absent.

Lumbodynia – subacute or chronic lumbar pain. Occurs gradually after physical activity, continuous stay in the inconvenient posture, cooling, catarrhal diseases, etc. Pain has an aching character and its intensity increases in change of the body position, continuous sitting or during walking. Smoothing of the lumbar lordosis, movements limitation, mild tenderness in paravertebral points in the lumbar area are observed.

Lumboischialgia – lowback pain with irradiation to one or both legs of sclerotomic character. The following forms of lumb-ischialgia are defined.

Reflux-tonic – muscular tension, changes of the vertebral configuration, sharp movements limitation in the lumbar area prevail.

Vegetovascular – combination of pain with the feeling of leg numbness, especially foot, feeling of “afflux”, heat or chill in it. Unpleasant painful feelings occur in the transition from horizontal into the standing position.

Neurodystrophic – pain has burning character and usually increase during the night. trophic impairments, feet hyperkeratosis, sometimes ulcer are observed during the physical examination.

II stage: disk protrusion; depending on the affected segment localisation, degree and place of the affection, diseases can manifest with several syndromes, where the lumb-ischialgia is a common symptom. Unlike the lumb-ischialgia in the I stage of the disease, pain at the protrusion irradiate to the corresponding dermatome, or combination of the sclerotomic and dermatomic irradiation are observed.

Pain differs with duration, persistence, its intensity increase in loads on the spine, movements. Pain intensity decreases at rest, but not disappear completely. In patients with disks protrusions, reflex myotonic disorders are observed in practically all patients and are more expressed than in the I diseases stage. Lumbar lordosis is smoothed, paravertebral muscles are tensed, movements in the lumbar part of the spine are sharply limited. Sensitivity disorders manifest with hypesthesia, paresthesia, numbness, formication. Reflex, muscular force decrease or absence, muscular hypertrophy are observed.

III stage: disk hernia manifest with reflex pain and compressive radicular syndrome.
Pain syndrome at lumb-ischialgia is more often occurs after the trauma or weight lifting, sometimes on the background of preceding moderate lumbodynia. Pain reaches bigger intensity only in the first 1–2 weeks, then its intensity decreases. Lumbodynia is mildly expressed initially and sometimes disappears completely till the visit of the doctor. Only ischialgia is preserved, which is characterized by the combination of the dermatonic and sclerotomic irradiation as well as in the II stage. Tension symptoms (Lasègues symptom, Wasserman crisscross symptom). Miotonic reactions are sharply expressed: paravertebral muscles hypertone, kyphosis increase or lumbar lordosis smoothing, scoliosis. Forced antalgic postures (patient lies on the side with affected leg flexed in the knee and hip joints) and sharp limitation of all or some movements in the lumbar part of the spine (movements in the sagittal plane and bending towards the affected side are more often absent) add to the clinical pattern of this stage of the disease. Radicular syndromes are observed in all patients with III stage of stable osteochondrosis form of the lumbar part of the spine. Patient has sensitivity disorders in the innervation area of the 1–2 roots.

Clinical picture of the instable forms of osteochondrosis. Clinical picture in instable forms of osteochondrosis of the lumbar part of the spine is characterized by the typical syndrome of instability and reflex myotonic syndrome in relatively rare expressed neurologic symptoms.

Three stages of instability of the lumbar osteochondrosis are defined depending on the affection of one or other structures of the vertebral motor segment.

Diskogenic instability (1 stage) – manifests mainly with lumbodynia, that pass in dynamic loads to lumb-ischialgia. Pain is more intensive in the morning at the beginning of the diseases; during the day due to the coordinated increase of the muscular activity and relative spine stabilization, but increases up to the evening, with the muscles fatigue. With increase of the disk destruction and protrusion, pain become so severe, that hamper the ability to be in a vertical position even for the short time. Reflex syndrome prevails, that manifest with movements limitation in the lumbar part of the spine. In segmentar block, abrupt sharp lowback pain and movements absence are observed. Muscles are sharply tensed. Due to the swelling development radicular disorders can occur in several days.

Diskoarthrogenic instability (2 stage) – characterized by the expressed dependance of the painful feelings from the statico-dynamic loads on the spine. Not only pain intensity depends on the statico-dynamic load, but also paresthesiae, rare – antalgic scoliosis. These symptoms manifest during walking and movements, significantly decrease or disappear in the recumbent position or spine unloading. Pain is localized in the lumbar part, usually irradiates at both lower limbs. Together with the expressed reflex syndrome (lordosis smoothening, spinal muscles tension, movements limitation in the lumbar part of the spine) radicular disorders are determined in part of the patients. Cause of the radicular disorders is more often fragments of the ruptured disk, that dislocate into the spinal canal. Expressiveness of neurologic disorders depends on their size – up to the gross function impairment of the lower limbs and small pelvis organs. Unlike the disk hernia, radicular disorders of such genesis are usually constant and do not regress.

Degenerative spondylolisthesis (3 stage) – manifests clinically with lumb-ischialgia and instability syndrome, that reflects dependance of the clinical symptoms from the statico-dynamic load on the spine. Reflex disorders are observed rarely in patients with degenerative spondylolisthesis. Sharp tension of spinal muscles, movements limitation of the lumbar part of the spine, radicular disorders are rarely observed. More often they manifest with hypesthesia in the area of 1–2 roots innervation, reflex asymmetry.

Instrumental diagnostics. X-ray investigation specifies localization of the pathologic process and character of the function-structural changes in VMS. Plain and functional (in the position of maximal flexion and extension in the lateral projection) X-ray without contrast are performed. Mobility limitations (spine instability) in the VMS is determined at the functional spondylogramms in the lateral projection at maximal flexion and extension at the standing position. Vertebrae dislocation in the horizontal plane in maximal flexion and extension usually consists around 2 mm. Increase of the dislocation
distance indicates the VMS instability or vertebra dislocation – spondylolisthesis. To radiologic signs of osteochondrosis refer: decrease of the intervertebral space height, subchondral sclerosis – configuration impairment and thickening of the endplate with the impression areas presence – Schmorl’s nodule, marginal osseous outgrowth, arthrosis (of intervertebral joints, uncovertebral, vertebrocostal) (Fig. 7.22).

Radiography with subarachnoid space contrasting (myelography) (Fig. 7.23) or epidural space (epidurography), magnetic resonance imaging (Fig. 7.24 and 7.25) or spiral computed tomography are performed according to indications.

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**Fig. 7.22.** X-ray (A – anteroposterior, B – lateral projection) of the lumbosacral part of the spine. Decrease of the intervertebral space height of L₁–L₂, L₃–L₄, L₄–S₁; subchondral sclerosis, marginal osseous outgrowths, intervertebral joints arthrosis, spondylolisthesis of L₃ vertebra

**Fig. 7.23.** X-ray: anteroposterior (A) and lateral (B) projection of the lumbosacral part of the spine with the subarachnoid space contrasting (myelography). Defect of the spinal canal filling at the level of L₄–L₅ intervertebral disk, that indicates intervertebral disk hernia

**Fig. 7.24.** Magnetic resonance imaging (A – lateral and B – axial projections) of the lumbosacral part of the spine. L₄–L₅ intervertebral disk hernia
Treatment. Treatment of spinal osteochondrosis should be directed at all links of the pathogenesis, should be conducted adjusted for the lesion localization, stage and form of the diseases, functional condition of the organism and separate systems. Such effect usually provides complex use of different methods (drugs, exercise therapy, massage, traction, manual therapy, etc.) depending on indications. Plan of the medico-rehabilitation interventions is made individually for every patient adjusting for the prevailing pathologic syndromes.

1. Pain syndrome – the following is used: analgesics, neuroleptics and sedatives, counter-attracting therapy, infiltration therapy, diadynamic therapy, UVI, anesthetics electrophoresis, spine immobilization.

2. Orthopedic disorders (VMS instability, functional block, stenosis manifestation) – spine immobilization and traction, exercise therapy, decompressive-stabilizing operative interventions.

3. Microcirculation disorders at the spine tissues and at the periphery (swelling, ischemia, hypoxia) – antiedematous, spasmytic drugs (nicotinic acid, nicospan), ganglioblockers (gangleron, pachycarpinum, etc.), infiltrative therapy, ultrasound, segmental massage, reflex therapy, local heat.

4. Musculo-tonic disorders – heating procedures, massage, infiltrative therapy are conducted, sedatives and muscle relaxant, ultrasound, reflex therapy, autogenic relaxation are recommended.

5. Neurodystrophic syndrome (neuroosteofibrosis) – segmental nerve-point massage, hormone and enzyme therapy, biostimulators and resorptive drugs.

6. Nervous conduction disorders – cholinesterase inhibitors, vitamin therapy, massage, exercise therapy, anabolic hormones, ADP, biostimulators, resorptive drugs are administered.

7. Dyshemic disorders of the cerebral, spinal and peripheral blood circulation – bed rest in the acute period, immobilization of the affected part of the spine, spasmytic, hypotensive, cardiotonic, antiedematous drugs, neuroleptics and sedatives, antihistaminic drugs, decompression of the affected vessel.

8. Reactive cicatrical-commissural changes in the epidural tissue, nerves and spinal cord tunic – hormone and enzyme therapy are conducted (injection into epidural tissue, intramuscular, subcutaneously, using phonophoresis), resorptive drugs, biostimulators, surgical section of the commissures.

Operative interventions is indicated in:
- acute compression of the cauda equina, that cause the lower paraparesis and pelvic organs disorders;
- root compression, that causes progressing paresis;
- severe disabling pain syndrome, persistent after conservative treatment.

Surgical interventions in the spinal osteochondrosis are divided into:
- decompression – elimination of factors, that compress neurovascular formations of the spinal canal (diskectomy, facetectomy, laminectomy, etc.);
- stabilizing (spondylodesis) – directed at stabilization of the affected VMS – anterior, posterior and anteroposterior spondylodesis;
**DEFORMING SPONDYLOSIS AND SPONDYLOARTHROSIS**

**Spondylosis** is characterized by the primary affection of the vertebral bodies with the following affection of the posterior supporting complex (facet joints and ligaments) with the occurrence and slow progression of degenerative changes in the IVD.

This pathology is more often observed in the elderly age. Among the spondylosis causes the following are defined: spinal injury of different genesis, continuous sitting work (continuous static load), posture impairment, osteochondrosis. Overcooling or excessive physical activity are often provocative factors. Process can be isolated or can have diffuse character.

**Pathogenesis.** The main sign of spondylosis – massive osteophytes formation in the area of vertebral bodies apophyses. Due to the degenerative-dystrophic changes, hyaline cartilage loses its fibrous structure and is replaced with the connective tissue, which decreases its ability to resist loads and traumas. Fibrous ring is also involved in the pathologic process, that is accompanied by tear of its fibers in the place of adjunction to the bone margins (apophysis) of the adjacent vertebrae (in front, aside, and back). Tissue, which loses strength and traumatizes the anterior or posterior longitudinal ligaments, of the peripheral disk part dislocate at the place of fibrous ring tear. Anterior longitudinal ligament delaminates from the adjunction place at the vertebral body limb, and then from the vertebral body. Anterior longitudinal ligament is a periosteum for the vertebral body. It reacts to constant trauma and irritation with the formation of the marginal osseous outgrowth at the anterior or lateral surfaces of one or two adjacent vertebrae. Typical feature of these ossification is their symmetry – direction towards each other. They often merge together forming a block of 2 or several adjacent vertebrae at the anterior or lateral surface. Depending on the main osteophytes localization, spondylosis is divided into ventral and dorsal (last can cause the spinal canal stenosis). Cervical (most common), thoracic and lumbar spondylosis are defined. Morphologic changes in the spine are confirmed by additional methods of investigation (Fig. 7.26).

**Clinical picture of spondylosis**

Cervical spondylosis manifests with cervical pain and pain in the shoulder girdle, circulation disorders in the verteobasilar system (dizziness, noise in the ears, visual disorders, blood pressure changes). When the process is localized in the thoracic or lumbar part of the spine, patient complains of pain, that spread to the chest, buttocks and hips and is accompanied by movements limitation, stiffness, discomfort. Tender areas are determined at palpation along the spine with irradiation to the chest, abdominal wall, pelvic wings, buttocks and hips. Dorsal osteophytes can cause the spinal canal stenosis and radicular canals of the spinal cord with their irritation, rarer – roots compression, compression-ischemic myelopathy in process localization at the cervical and thoracic parts of the spine. In patients with lumbar spondylosis, neurologic disorders can manifest with syndromes of radicular or caudal intermittent claudication (false intermittent claudication symptom).
Spondylarthrosis

*Spondylarthrosis* (facet joints athrosis, facet syndrome) – degenerative affection of the true synovial joints of the spine. Costovertebral (rib head and costotransversal) joints are also included in this group. Spondylarthrosis is often combined with spondylosis and osteochondrosis of the spine. Osteochondrosis development is accompanied by the hyaline covering cartilage destruction, subchondral sclerosis, marginal osteophytes formation, articular processes hyperplasia, dystrophic changes of the articular capsule with its weakening.

**Spondylarthrosis classification (Radchenko VA, Prodan AI):**

I. Dystrophic-destructive:
- dislocation (in osteochondrosis, scoliosis, hyperlordosis, osteochondropathy, posttraumatic);
- dysplastic;
- dyshormonal.

II. Inflammatory-destructive.

**Clinical picture of spondylarthrosis**

In cervical spondyloarthrosis patients complain of the cervical pain, that can irradiate to the shoulder girdle, interscapular area, upper limb, occipital area. Osteocartilaginous outgrowth from the joints can also lead to the intervertebral foramens narrowing and irritation of the spinal cervical roots (radicular syndrome), impress into the vertebral artery canal and cause the vertebral artery syndrome development.

Thoracic and lumbar spondyloarthrosis manifest clinically with bilateral pain, which is usually located in the paravertebral area, not at the midline, unlike the diskogenic pain. Pain often irradiates to the chest, sacroiliac junction, buttocks, hip, the more distal pain spread to the foot is possible. It usually has intermittent character and increase in continuous standing and extension, decrease in anterior flexion, sitting and walking, and also in dorsal recumbent position. Hyperplastic changes in the facet joints can lead to the spinal canal stenosis and canals of the spinal nerve roots, that manifests clinically with different neurologic disorders depending on the level of affection.

Additional methods of investigation in spondylosis and spondylarthrosis include: X-ray of the spine (narrowing of the intraarticular spaces, subchondral sclerosis, deformation and hypertrophy of the articular facets are observed), MRI and spiral computed tomography of the spine, in suspicion of the vertebral artery syndrome – Doppler investigation of the head and neck arteries, MRI-angiography (Fig. 7.27).

**Treatment of spondylosis and spondylarthrosis**

Spondylosis and spondylarthrosis treatment should be complex and pathogenetic.

In expressed pain syndrome treatment should be directed at the pain and inflammation elimination. These can be reached by the following medicamentous agents: antiinflammatory
drugs, in expressed muscular spasm – muscular relaxants of the central action, local use of the anti-inflammatory ointments, plasters. Blockades of the facet joints are effective in persistent pains under the X-ray or CT-fluoroscopy control – blockade of the joint or nerve, that innervates (supply with nerve endings) the corresponding joint is performed. Local anesthetics, for example lidocaine, and suspension of glucocorticoids, that has good antiinflammatory features, are used for the blockade. Blockade is not only medical, but also diagnostic procedure: if the positive effect was obtained the doctor can state, that changes in the blocked joints were responsible for the pain syndrome development in this patient. Epidural injection of local anesthetics and glucocorticoids are used in the spinal canal stenosis, that have good analgesic and antiinflammatory effect. Massage, physiotherapeutical procedures (electrophoresis with novocaine at the affected area, diadynamic currents, ultrasound at the spine area), exercise therapy for the muscular corset strengthening of the spine, pelvic position correction, lumbar lordosis decrease are included in the treatment complex. If the conservative treatment is not effective, operative treatment is indicated. They are divided into decompression (neurovascular formations of the spinal canal decompression), stabilizing (anterior and posterior spondylodesis) and decompression-stabilizing (Fig. 7.28).

After the in-patient treatment patients require rehabilitation measures, that include sanatorium-and-spa treatment, exercise therapy, massage, rational organization of the working regime.

SPONDYLOLISTHESIS

Spondylolisthesis – diseases, that is characterized by the dislocation of the upper vertebra in relation to the lower (Fig. 7.29).

Spondylolisthesis etiology remains insufficiently studied, impairment of the vertebropelvic balance, pars interarticularis pathology, etc., are considered as one of the spondylolisthesis development factors.

Classification. Depending on the leading etiological factor, that causes spondylolisthesis, the following are defined:

- isthmic (spondylyotic) – characterized by the isthmus pathology presence – pars interarticularis, which is divided into:

N.B. Intervertebral joints arthrosis is a cause of the lowback pain in 20% of cases, and spondyloarthrosis is an often cause of the chronic lowback pain in elderly people (older than 65 years).

Spindylarthrosis can occur:

- as the result of the posterior VMS parts over-load (for example, due to the statics impairment, especially in elderly people);
- in diffuse osteoarthritis, that affects joints of limbs and spine
- due to the degeneration and decrease of the disk height, interrelation of the articular processes, that leads to changes, joint subluxation and articular capsule pinching, articular tissues inflammation.
● lysis of pars interarticularis;
● elongation of pars interarticularis;
● fracture of pars interarticularis.
● dysplastic or congenital;
● degenerative;
● traumatic;
● pathologic (generalized or local pathologic process in the bone tissue, tumor, spondylitis).

Depending on the upper vertebra dislocation direction the following are defined: anterolysthesis – towards, retrolysthesis – backwards, laterolysthesis – aside. Four degrees of the vertebrae dislocation relative to each other according to Meerding’s classification:

I degree – dislocation for ¼ of the vertebral body;
II degree – dislocation for ½ of the vertebral body;
III degree – dislocation for ¾ of the vertebral body;
IV degree – dislocation for the entire vertebral body length or spondyloptosis (7.30).

Also depending on the pathologic mobility presence between the vertebrae, stable and unstable forms of spondylolisthesis. This has an important value for the surgical intervention choice (to perform or not stabilizing interventions).

**Clinical picture.** Patients with the III–IV degree dislocation have typical telescopic body during the examination. Due to the center of gravity dislocation and vertebropelvic balance impairment, these patients have a gait like a "rope-walker". Palpation along the spinous processes determines retraction – stairs symptom. Patients have horizontal positioning in the sacral area.

Clinical picture of spondylolisthesis consists of two parts – back pain and neurologic disorders, that are conditioned by the compression of different nervous structures. There are many theories of the back pain occurrence. Pain syndrome in case of spondylolisthesis is conditioned by pathologic changes in the intervertebral disk, intervertebral joints and secondary – paravertebral muscles and ligaments.

Back pain has mechanical character, increase in physical activities, body bending. Also, complaints of posture and gait disorders occur.

Nervous structures compression (roots, spinal cord) occur in the spinal canal narrowing, due to the vertebrae dislocation relative to each other, pathologic outgrowth in pars interarticularis, sacral roots tension in the vertebrae slippage. Tension symptoms (Lasegue's symptom, reverse Lasegue's symptom or Wasermann's symptom) will be observed in case of nervous roots compression, decrease or absence of tendon reflexes, pain in the area of the corresponding dermatome, hypo- and anesthesia in the innervation area of the corresponding dermatome). "Intermittent neurogenic claudication syndrome" occurs in the cauda equina compression. Myelopathy occurs in the spinal cord compression. Disorders of the pelvic organs function can be observed.
Additional investigation includes X-ray (anteroposterior projection, lateral projection or functional tests, oblique projection), MRI, CT.

Isthmic spondylolisthesis – characterized by the pathology of *pars interarticularis*. It is characterized by the symptom of "Scottish dog" at oblique radiographs ($\varphi \frac{3}{4}$). This symptom can be observed in 5–20% of healthy people. Cause compression of the spinal cord in the III–IV degree of the vertebrae dislocation.

Dysplastic spondylolisthesis is characterized by the dysplasia of the posterior supporting complex, which manifest with the impairment of space orientation (position in the frontal plane) of the articular processes, that form as called osseous uncus, which is formed by the upper articular processes of the subjacent vertebra and lower articular processes of the overlying vertebra. The more frontally articular processes are located, the stronger is adhesion between the joints. This type of spondylolisthesis is the most complicated for the progressing prediction.

Degenerative spondylolisthesis develops as the result of continuous intersegmental instability; isthmus pathology is absent in this case. It is observed in 6% of men and 9% of women and is characterized by the asymptomatic course.

Traumatic spondylolisthesis occurs as the result of *pars interarticularis* or posterior supporting complex fractures, which form as called osseous uncus. It is characterized by the sharp pain in the area of fracture, and neurologic disorders in presence of the nervous structures compression.

**Treatment.** Conservative and operative treatment of spondylolisthesis are defined. Conservative treatment in spondylolisthesis is indicated in the pain syndrome presence in the lumbar part of the spine. Conservative treatment includes NSAIDs intake, therapy with corsets (Boston corset) with immobilization purpose, blockades. In continuous pain syndrome (more than 3–6 months), that does not react on conservative therapy, the issue of operation should be decided.

Conservative treatment is also indicated in 1, 2 degree according to Meerding's without neurologic deficit, in stable forms of spondylolisthesis.

Spondylolisthesis progressing is an important issue for the treatment method choice.

Operative treatment is indicated in cases of neurologic deficit increasing: radiculopathies, radiculomyelopathies, myelopathies and neurogenic intermittent claudication. Main purposes of the operative treatment are the elimination of the nervous structures compression, renovation of the sagittal balance and stabilization. Stabilizing operations are directed at conditions for spondyloptosis creation. Stabilization is performed with transpedicular fixatros, interbody cages, plates, that are placed on the ventral surface of vertebral bodies. Vertebra removing can be performed in case of spondyloptosis. An important problem of operative treatment is the necessity and reduction degree of the vertebra. Reduction can not be reached in some cases without the neurologic deficit increase.

**Dysplastic spondylolisthesis**

In degenerative spondylolisthesis with nervous roots and spinal canal content compression and progressing signs, decompression interventions (laminectomy, hemilaminectomy, spinal root canal decompression) and decompression-stabilizing interventions are performed.

Operative treatment is used for the traumatic spondylolisthesis, which consists in the nervous structures decompression and stabilization (using transpedicular fixation, cages, etc.), for creating the spondyloptosis conditions.
SPINAL STENOSIS

Spinal stenosis – decrease of the spinal canal lumen in relation to its content with specific clinical manifestations. Stenosis – structural, functional and clinical term. So, the following definition of the spinal stenosis can be given – disease, that is characterized by the expressed inconformity between the spinal canal size and its content, functions decompensation, loss of the protective functions reserve and occurrence of the specific neurologic disorders of the spinal cord elements and nervous roots (Prodan AI). Stenosis was described for the first time by Swedish neurosurgeon H. Verbiest.

Classification

Congenital and acquired stenosis are define by etiology (Verbiest). Congenital stenosis is observed rarely. Then Nelson modify and expand the stenosis classification.

According to etiology:

1. Congenital:
   - idiopathic (is formed as the result of genetically determined impairment of the vertebral bone elements development in the postnatal period);
   - chondrodystrophic.
2. Acquired:
   - degenerative (central stenosis, lateral stenosis, degenerative spondylolisthesis);
   - combined (combination of the congenital and degenerative stenosis elements);
   - spondylolisthetic;
   - iatrogenic (postlaminectomic, after dorsal and ventral spondylodesis).

In the institute named after Sitenko MI, stenosis is divided into dysplastic, degenerative and combined. Dysplastic stenosis can be connected with congenital (genetically determined) dysplasia, as well as with the acquired in the postnatal period and connected with the vertebral morphogenesis impairment until the growth end. Degenerative stenosis occurs on the background of degenerative changes of the spinal canal. In their turn, each of these stenoses are divided into 3 types: dislocation, hyperplastic, combined. Depending on localization each of these types is divided into the central, lateral and foraminal.

Stenoses are defined depending on localization in modern classifications: central, lateral, foraminal. The term of “dynamic stenosis” is defined, which is characterized by spinal canal stenosis during movements (extension).

The following mechanisms are defined in the stenosis pathogenesis:

- mechanisms of the spinal canal remodeling, which lead to the spinal canal lumen narrowing;
- mechanisms of the nervous structures compression (spinal cord, nervous roots) and vascular structures compression, that cause the ischemia of nervous elements.

Degenerative changes in the IVD (height decrease), antelisethesis, retrolisthesis or laterolisthesis, facet joints hypertrophy, ossification of the flaval ligament, osteophytes from the facet joints cause the spinal canal lumen narrowing, that results in the nervous structures compression. Even in relatively wide spinal canal, significant ossification of the facet joints can cause the lateral recesses stenosis. Compression of primary central or lateral part of the spinal canal occurs depending on the hypertrophy or degeneration of different VMS structures. Flaval ligament, posterior longitudinal ligament (Forestier disease), lower facet joints hypertrophy and ossification causes primarily central stenosis; hypertrophy of upper facet joints – primarily lateral stenosis. So, spondyloarthrosis is more often accompanied by the lateral stenosis.

7. Degenerative-dystrophic diseases of joints and spine
Clinical picture. Stenosis manifestations are mainly neurologic. Depending on the stenosis level different symptoms occur. Stenosis more often occur at the lumbar level (in decreasing order L₄–L₅, L₃–L₄, rarer L₃–L₄ and even more rare L₅–S₁), but also stenosis can occur at the cervical part. Morbidity is higher among elderly people.

Stenosis in the cervical part of the spine is characterized by the myelopathy and/or radiculopathy syndromes with corresponding neurologic symptoms, depending on the compression of spinal and/or nervous roots.

"Anthropoid" posture attracts attention during the examination. It is characterized by the lumbar lordosis smoothening – compensatory increase of the spinal canal lumen in flexion at the lumbar part.

Main clinical symptom – "neurogenic intermittent claudication" – progressive fatigue and sensitivity disorders (along the dermatome) in legs during walking, that occurs in the insufficient blood supply of certain root with intermittent impairment of the nervous impulse passing. Neurogenic intermittent claudication should be mandatory differentiated with intermittent claudication, that occur in vascular diseases – circulatory insufficiency of the lower limbs. Pulsation intensity decrease at the distal part of the limb, sensitivity decrease according to the peripheral type ("socks symptom"), normalization of the blood circulation occur during rest at US-investigation, etc. Patients say, that legs become feeble. Patient is asked to specify distance, that he can manage until the fatigue in the lower limbs occurs. Distance decreasing during observation indicates the progressing.

Depending on the level of compression and decompensation degree, different sensitive and motor disorders will occur, that accompany compression radicular syndromes. One, two or more roots can be compressed. Symptoms can be unilateral or bilateral.

Cauda equina compression can cause the pelvic organs function disorders.

Reflexes, sensitivity, muscular force can be preserved at rest during neurologic examination. Then the "march test" is performed with provocative purpose – patient is asked to walk on-side.

Diagnostics. MRI, CT, X-ray, different methods of spinal canal contrasting (myelography) are used in diagnostics.

Narrowing of the anteroposterior sizes of the spinal canal, articular processes hypertrophy, osteophytes, possible manifestations of spondylolisthesis can be determined at radiographs. Use of the contrasting is possible (myelography).

Narrowing of the anteroposterior sizes, articular processes orientation impairment, lateral canal narrowing manifest with "trefoil" symptom, can be determined at CT-scans.

Compression of nervous structures is determined at MRI. "Sand glass", "washboard" symptoms are typical.

Stenosis is diagnosed, when typical clinical data is present. MRI, CT, X-ray specify only the spinal canal narrowing degree.

Electroneuromyography use is possible in addition.

Differential diagnosis is performed with vascular disorders of the lower limbs (peripheral artery disease with legs affection, obliterating endarteritis), IVD hernia, juxtafacet cysts, arachnoiditis, spinal cord tumors, diabetic neuropathy.

Treatment is divided into conservative and operative.

Conservative treatment is conducted with orthopedic braces (that decrease lumbar lordosis), NSAIDs, antiedematous therapy. Epidural blockades with glucocorticoids, epidural adhesiolysis are used.

Operative treatment is conducted in the effect absence or disease progressing. Operative treatment consists in decompression (laminectomy, hemilaminectomy, partial facetectomy, different laminoplastics) and decompression-stabilizing operations (stabilization with transpedicular fixators, cages, combined methods) operations. Decompression-stabilizing operations on the cer-
vical part of the spine can be conducted from the anterior or posterior approaches, that depends on the compression presence with anterior or posterior structures. Expected results – neurologic symptoms regress. But this result, due to the cicatricial changes in the perineural membranes, liquor dynamics impairments, can not be reached. In case of myelopathy and sclerosis focus formation at the MRI, neurologic symptoms do not regress completely, the main purpose of the operation – decrease myelopathy progressing.

**TASKS AND TESTS**

**TASK №1**

Patient V, 39 years, complain of the low back pain. Examination: lumbar lordosis is increased, weakness and paraesthesia in lower limbs. Shift of the $L_5$ vertebra towards for the 75% of body (spondylolisthesis) is observed at X-ray. Chose the treatment method.

A. NSAIDs injections.  
B. Surgical treatment.  
C. Physiofunctional treatment.  
D. Lumbar part of the spine fixation with brace.  
E. In-bed traction.

**TASK №2**

Patient B, 43 years, complain of the low back pain, that occur after physical loads. Pain irradiation into the right leg down to the I toe occurs during last months. Physical examination: lumbar lordosis is decreased, moderate atrophy of the right leg muscles, hypesthesia at the area of I toe, positive tension symptoms. At X-ray of the lumbar part of the spine – space between vertebral bodies is narrowed at the level of $L_4-L_5$. Make the preliminary diagnosis.

A. Spinal tumor.  
B. Spinal stenosis.  
C. Intervertebral disk hernia of $L_4-L_5$.  
D. Lumbago.  
E. Pathologic fracture of lumbar vertebrae.

**TASK №3**

Patient D, 48 years, complain of the pain, paresthesia in the cervico-occipital are with irradiation to the temple, dizziness, accompanied by nausea, vomiting, stuffiness and noise in ears, photopsy. At X-ray of the cervical part of the spine the following is determined: signs of osteochondrosis, spondyloarthrosis; osseo-cartilaginous outgrowths from the joints protrude into the vertebral artery canal. Make the preliminary diagnosis.

A. Contusion of the cervical part of the spine.  
B. Migraine.  
C. Intervertebral disk hernia at the cervical level.  
D. Vertebral artery syndrome.  
E. Rotational subluxation of the I cervical vertebra.
TASK №4

Patient A, 73 years, complain of the bilateral pain in the lumbar part of the spine, which is localized in the paravertebral area, irradiates into buttocks, thigh and further to the foot. Pain has intermittent character, increases in continuous standing and extension, decrease in anterior bending, sitting and walking, and also in the supine position. At the X-ray of the lumbar part of the spine – osteochondrosis sign, hyperplastic changes in facet joints. Make preliminary diagnosis.

A. Spondylolisthesis of the lumbar vertebra.
B. Instability of the lumbar part of the spine.
C. Lumbar spondyloarthrosis.
D. Intervertebral disk hernia at the lumbar level.
E. Tumor of the lumbar part of the spine.

TASK №5

60-years man suffer from the osteoarthritis of the II degree of the right knee joint with the expressed pain syndrome. Moderate varus deformation of the knee joint are determined clinically and radiologically. Which treatment tactics is pathogenetically grounded in this patient?

A. Tutor wearing on the knee joint.
B. Intraarticular injection of chondroprotectors.
C. Antiinflammatory treatment with non-steroid drugs.
D. Intraarticular injection of glucocorticoids.
E. Operative treatment.

TASK №6

Boy, 10 years. During 3 months complains of the pain in the area of the left hip joint; joint function is limited. At radiograph in the area of the femoral head there is 1–1.5 cm focus with increased density and epiphysis flattening. Articular space is wider, articular cavity is not changed. Name the most probable diagnosis.

A. Rheumatoid arthritis.
B. Tuberculous arthritis.
C. Osteoarthritis.
D. Strumpell’s disease.
E. Avascular necrosis of the femoral head.

TASK №7

Patient complain of the pain in the right hip joint, which intensity increase during movements. Is ill for several years. Denies trauma, not treated. During investigation – pain, movements limitations. X-ray – articular space narrowing, osteophytes, deformation of the femoral head. Diagnosis:

A. Right-sided coxarthrosis.
B. Rheumatoid arthritis.
C. Lumbar radiculitis.
D. Lumbosacral radiculitis.
E. Tumor of the hip upper third

TASK №8

Patient complain of the pain in the cervical part of the spine, numbness in the right forearm. Com plains increase in physical loads. Tension of cervical muscles, forced position during pain, movements limitation are observed during examination. Narrowing of the C5–C6 intervertebral space during plan X-ray is determined; dislocation of the C5 vertebra towards consists 0.4 c, at the functional radiograph. Indicate the patient’s diagnosis.

A. Spondylosis deformans of the cervical part of the spine.
B. Disk hernia of C5–C6 vertebrae with vertebra instability at the same level.
C. Expressed instability at the level of C5–C6 vertebrae.
D. Myositis.
E. Disk hernia of C5–C6 vertebrae.
**TASK №9**

Patient M, 42 years. The following clinical diagnosis was made: right-sided L₅–S₁ intervertebral disk hernia with S₁ root compression. MRI: dislocation of the L₅–S₁ intervertebral disk hernia, burst of liquor signal at this level. Which type of the operative treatment is indicated to the patient, if conservative therapy will be ineffective?

A. Endoscopic transosseous removal of the disk hernia.
B. Interlaminectomy, disk hernia removal.

**TASK №10**

Patient complain of the pain in the thoracic part of the spine, that increase in movements, weakness, weight loss. Is ill for 3 months. Pain has aching character. The following is determined during examination: tenderness at the level of Th₉–Th₁₀ vertebrae, slight leukocytosis in blood. At the radiograph: small destruction focus in the Th₁₀ body, that is adjacent to the intervertebral disk. What is the diagnosis?

A. Tumor.
B. Schmorl's hernia.
C. Spondylitis.
D. Spondylosis deformans.
E. Disk hernia.

**TEST**

11. What leads to the coxarthrosis development?

A. Excess weight
B. Hip joint dysplasia.
C. Professional sports.
D. Diabetes mellitus.
E. Irrational nutrients.

12. Movements limitation in the joints in all planes (rocking motion) is:

A. Joint contracture.
B. Stiffness.
C. Bone ankylosis.
D. Rigidity.
E. Joint block.

13. Constant aching nocturnal pain in osteoarthritis is conditioned by:

A. Reactive synovitis.
B. Venous stasis in the subchondral bone tissue.
C. Reflex muscles spasm.
D. Neurodystropic syndrome.
E. Compression microangiopathies.

14. Exacerbation of the pain syndrome and joint function decreasing in osteoarthritis can be caused by physio-procedures:

A. Magnet therapy.
B. Amplipulse therapy.
C. Electrophoresis with drugs.
D. General baths (hydrosulfuric, radon, etc.).
E. Paraffin-ozocerite applications on the joint.

7. Degenerative-dystrophic diseases of joints and spine
15. In clinical pattern of the osteoarthritis the following is not observed:
   A. Pain.
   B. Crepitus during movements.
   C. Changes of the joint form (deformation).
   D. Gradual movements limitation in the joint.
   E. Increase of the local temperature (joint).

16. Destructive changes in the superficial area of the cartilage at the early disease stage can be determined by:
   A. X-ray
   B. US
   C. Arthroscopy
   D. MRI
   E. Scintigraphy with technetium (99mTc)

17. In which variant all stages of osteochondrosis are mentioned?
   A. Round and flat back, kyphotic, scoliotic and lordotic postures.
   B. Osteochondrosis, spondylisis, spondyloarthrosis.
   C. Spondyloysis, spondylolisthisis, pseudospondylolisthisis.
   D. Rachitic kyphosis, congenital kyphosis.
   E. Intradiskal nucleus dislocation, protrusion, disk hernia.

18. Degenerative-dystrophic disease of the spine with primary affection of the intervertebral disk is:
   A. Osteochondrosis.
   B. Spondylolisthesis.
   C. Spondyloarthritis.
   D. Spondylolysis.
   E. Spondylosis.

19. Degenerative-dystrophic disease of the intervertebral joints is:
   A. Osteochondrosis.
   B. Spondylolisthesis.
   C. Spondyloarthritis.
   D. Spondylolysis.
   E. Spondylosis.

20. Degenerative-dystrophic disease of the spine, that is characterized by osseous outgrowth at the are of the ligamentous apparatus detachment from the vertebral body is:
   A. Osteochondrosis.
   B. Spondylolisthesis.
   C. Spondyloarthritis.
   D. Spondylolysis.
   E. Spondylosis.
8.1. CONGENITAL DEFECTS AND DEFORMATIONS OF THE MUSCULOSKELETAL SYSTEM

CONGENITAL MYOGENIC TORTICOLLIS

Congenital myogenic torticollis is known from the ancient times. Suetonius, Horatius described it as the caput obstipum, cervix obstipa.

Etiopathogenesis. Congenital myogenic torticollis occurs as the result of the sternocleidomastoid muscle dysplasia and takes the seconds place among the congenital defects in children reaching 5–12 %.

There are views, that the cause of the congenital torticollis are forced child’s head position in the uterus with neck entanglement with the umbilical cord, trauma during delivery, inflammatory and dystrophic processes in the muscle (interstitial myositis, ischemia, etc.). Presence of the fusiform swelling in the muscle is considered as hemorrhage, that occurs during the passing of the head through the maternal passages, due to ruptures, extensive distension of the dysplastic muscle.

Clinical manifestations of the muscular torticollis depend on the child age and diseases form. Mild, moderate and severe degrees of torticollis are defined clinically. Mild degree and sometimes moderate are usually not diagnosed by non-specialists. Children are admitted to the hospital, when changes of the facial skeleton occur. Moderate and severe degrees of myogenic torticollis are not complicated in diagnostics (Fig. 8.1).

Typical symptoms of myogenic torticollis are child’s head bending towards the affected muscle and chin rotation in the opposite side to the head bending. Attempts to bring head into the straight position have no success due to the significant tension of the sternocleidomastoid muscle. Fusiform thickening is visual-
ized and palpable at the level of the middle third of the muscle, which is not matted with the surrounding tissues, located in the muscle belly. All symptoms progress with the child growth, the elasticity of the sternocleidomastoid muscle decreases. Asymmetry of the half of the facial skeleton and skull starts to manifest after the 1st year at the affected side. Face asymmetry starts to be clearly manifested in the absence of adequate treatment (Fig. 8.2). Shoulder girdle and scapulae are asymmetric at the affected side, they are located slightly higher than on the affected side, than at the opposite. Neck seems to be shorter at the side of head bending. Sternocleidomastoid muscle is hypotrophic in comparison with one on the health side except the middle third, where the fusiform dense thickening is palpated.

Shoulder girdle and scapulae asymmetry is conditioned by the trapezius and anterior scalene muscle contracture. Cervical and upper thoracic scoliosis on the side of torticollis develope in older children.

Face asymmetry at the affected side is clearly determined during the examination of the child due to the narrow orbit and flattened superciliary arch, which are located lower. Upper and lower jaws are also underdeveloped and flattened. Auricle is located closer to the shoulder girdle on the side of torticollis than on the healthy side.

So, the task for doctors is to diagnose it in the maternity hospital and adequate treatment of the child in the age under 1 year for the prevention of facial skeleton and skull deformations occurrence.

**Differential diagnosis.** Congenital myogenic torticollis should be differentiated with the congenital additional cuneiform vertebrae of the cervical part of the spine. In the congenital additional cuneiform vertebrae head is bent aside, but the chin rotation is absent. Besides, this in the attempt to set the head in the correct position the impediment is felt and sternocleidomastoid muscle remains relaxed and do not stretch. Congenital myogenic torticollis is also differentiated with spastic torticollis, which is observed in children with cerebral palsy. If cerebral palsy has the typical clinical pattern, then there is no diagnostics mistakes. Mistakes are possible in the subclinical form of cerebral palsy. Careful examination of the child prevents the incorrect diagnosis. Differential diagnosis is also conducted with the myogenic torticollis due to the polyo. Palsy or paresis of the sternocleidomastoid muscle and also other muscles occur in such cases. In congenital torticollis muscle is not paralyzed, palsies of limbs are absent. It is also differentiated with the dermatogenic torticollis after the burns, trauma. Desmogenic torticollis occurs as the result of inflammative processes in the area of the neck (phlegmon, lymphadenitis). Reflex torticollis occurs in inflammative processes of the middle ear, that requires careful history collection and patients examination.

**Klippel-Feil syndrome** – congenital defect of cervical vertebrae, in some cases is characterized by the fact, that atlas and axis – first and second (axial) cervical vertebrae – are concreted with the lower vertebrae, which are usually not more than four. Their arches are not concreted. Synostosis of the atlas of the occipital bone Atlas synostosis with occipital bone is determined in other cases, and several or all cervical vertebrae are concreted with each other with the presence of additional cuneiform vertebrae or cervical ribs (Fig. 8.3). There is a short neck in these children. Limit of the hairy part of the head is so low, that hair pass to the scapulas. Head is bent towards and aside, chin touches the sternum, expressed face and skull asymmetry. Movements in the cervical part of the spine are ab-
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sent. Paresis, palsies, sensitivity disorders at the upper limbs occur. All mentioned symptoms are absent in congenital myogenic torticollis.

Differential diagnosis should be conducted with cervical ribs, which clinically manifests with swelling in the supraclavicular area and neurovascular disorders at one hand in unilateral cervical ribs and both hands in bilateral ribs (cooling, skin color changes, sensitivity disorders, pulse loss, paresis and even palsies) (Fig. 8.4). Shoulder sare located lower in bilateral cervical ribs. Impression occurs, that shoulders are the prolongation of the neck. Head is bent aside, ie expressed torticollis is observed and scoliosis in the cervicothoracic part of the spine. Complete history, inspection and examination of the patient excludes the diagnostic mistake.

Differential diagnosis is also conducted with the webbed neck (Turner’s syndrome). It is a congenital defect, that manifests clinically with unilateral or bilateral wing-shaped cutaneous folds at the lateral surfaces of the neck. Webbed neck can be combined with other congenital defects (dysplasia, hip luxation, syndactyly, flexion contractions of fingers, etc.). During the examination of a newborn, cutaneous folds are stretched at the one or both lateral surfaces of the neck from the mastoid process to the middle of the shoulder girdle. Child’s face is stiff, reminds sphinx, auricles are deformed, the neck seems short. With no doubt, these symptoms are absent in congenital myogenic torticollis.

Differential diagnosis should be performed with Grisel’s disease or Grisel’s torticollis (Fig. 8.5). Precursor of its occurrence is always the inflammation of the nasopharynx, tonsils with the high body temperature. Inflammation transits to the atlanto-axial joint, that leads to the occurrence of the atlas subluxation. After the inflammatory process intensity decrease, the contracture of the paravertebral muscles occurs, that attach to the anterior atlas or skull. Grisel’s disease is more often observed in girls at the age of 6–11 years with the asthenic constitution, with the developed lymphatic system, through which the infection spreads. Head is bent aside with the rotation to the opposite side, sternocleidomastoid muscle is tensed, indurated. Protruding spinous process of the C2 cervical vertebra is palpated. Protrusion that corresponds to the atlas is determined during the pharynx examination, that dislocated towards and upwards. This protrusion changes in size during head rotations. Flexion, extension and
bending of the head towards the torticollis side are free, head bending to the collateral side is not only significantly limited, but also causes pain. Head rotations are limited, painful and occur at the level of lower cervical vertebrae. X-ray should be performed through the mouth, that allows atlas subluxation diagnosing with rotation around the vertical axis.

**Treatment** is started after the diagnosis. It is explained to the mother, that child should lie in the bed on the side of torticollis, so the pillow can push the head to the opposite side. Bed should also be located in such a way, that light, toys will be located at the opposite to torticollis side; so child would not constantly turn head, distensing the dysplastic sternocleidomastoid muscle (Fig. 8.6).

For holding the head in the correct position and constant correction cotton swabs are used initially, which are placed under the side of head bending, and later (on the 3rd-4th week of life) – Schanz collar, which is placed after redressment (Fig. 8.7).

Redressment is performed for the head position correction and distension of the dysplastic sternocleidomastoid muscle (Fig. 8.8). This is a forced manual liquidation of the deformation. Redressment is performed 3–5 times a day for 10–15 minutes. Mother is taught the redressment method before the discharge from the maternity hospital. During this procedure child is placed on the table in supine position, hands are placed along the trunk and assistant or mother hold them. Doctor gradually without spurs with increasing force tries to place the head in the correct position, rotation the chin towards the torticollis. Sternocleidomastoid muscle is maximally distended in such a position. Head should not be flexed towards during the redressment. Head is fixed in maximal corrected position after the redressment with cotton pillows, which are fastened with the bandage. After the final skin formation and strengthening at the age of 2.5–3 months, paraffin applications are applied before the redressment session to the sternocleidomastoid muscle, that increases its elasticity and improves microcirculation.

Head is still fixed with the Schanz collar in 1.5–2-month babies after the redressment (Fig. 8.7). Treatment is conducted with gradual distension of the sternocleidomastoid muscle, so the child with congenital torticollis will be cured till the 1-year age, that is usually reached in the mild and moderate forms. Exercise therapy, electrophoresis with lidase, potassium iodide, heating procedures are usually used in the complex of conservative treatment.

As to the severe forms of torticollis, complete correction using the conservative therapy usually can not be reached in most
Congenital deformations of the spine, bones and joints. Scoliosis of the patients, so the operative treatment is used at the age of 10–12 months according to the Zacepin method. Operative treatment is conducted in earlier age if there is no positive dynamics after using the conservative treatment, because the facial skeleton asymmetry occurrence is an irreversible process. Operation is performed under the narcosis. Child lies in the supine position, assistant adduct the head maximally, so one or both legs of sternocleidomastoid muscles are sharply tensed. Above the clavicle, parallel to the tensed muscular legs, skin and soft tissue section of 3–4 cm is made, clavicle and sternal legs are separated, protectors are stepwise put under the legs and they are cut. Then the posterior wall of the tendons sheath is carefully cut (in order not to damage the jugular veins). Second skin and soft tissues section around 3 cm in length is made over the mastoid process, along the sternocleodimastoid muscle. Muscle onset is separated and cut transversely. Head is placed in the position of hypercorrection. Both wounds are sutured layer by layer. Aseptic bandages and Schanz collar are applied. Head should be in the position of hypercorrection. Thoracocranial plaster cast is applied at the age of 8–9 years. Exercise therapy is started from the 3rd week. Correcting Schanz collar is applied after each session of the exercise therapy for 3 months, till the force, working capacity and endurance of muscles recovery in stable head position.

**CONGENITAL MYOGENIC CLUBFOOT**

Congenital myogenic clubfoot is one of the most widespread congenital defects according to Frumina AE and Zacepin TS and consists 0.5–2 % of cases for 1000 deliveries (Fig. 8.9). It occurs more often in boys and it is bilateral in 60 %, and in 10 % is combined with other congenital defects: torticollis, hip joints dysplasia, syndactyly, cleft lip and palate, etc.

Congenital clubfoot is a polyetiologic disease, which is caused by endo- and exogenic factors, heredity. Bom’s GS points of view deserves attention, according to which during the anlage of organs and systems in the embryo under the influence of exo- and endogenic factors on the 3–4th week the end segment (ie foot) of the lower limb does not reach the complete rotation in the sag-

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Fig. 8.9. Congenital myogenic clubfoot

Clinical manifestations. Right after the birth, the incorrect position of one foot or two feet draw attention. They are located in the position of plantar flexion (equinus), foot rotation in such a way, that plantar surface is turned inside (supinatio) with adduction of the anterior foot part (adductio) (Fig. 8.9). These three symptoms – equinus, supinatio and adductio – are pathognomonic symptoms of the congenital myogenic clubfoot. Three degrees of it are defined according to the deformation severity: mild, moderate and severe.

In the I degree moderate plantar flexion (equinus) and internal rotation (supinatio) with foot anterior part adduction (adductio) are observed. Internal part of the foot due to its concavity seems slightly shorter, and external, convex – longer. Also due to the foot internal rotation and adduction of the foot anterior part its margin is located higher than external. Heel is moderately pulled up and supined. All deformation elements are easily removed in attempts of correction.

In the II degree of the club foot, equinus, supinatio and its anterior part adduction more expressed and rigid. Foot is rotated in such a way, that the plantar surface is practically completely turned backward. Heel is pulled up significantly and anterior part is in the rigid adduction. Plantar flexion of the foot is at the angle of 45–50°. Contour of the lateral malleolus is prominent, and internal is smooth. It is impossible to passively remove foot deformation completely. Long conservative treatment is necessary.

Third degree of the clubfoot is characterized by the severe rigid deformation of the foot. It is rotated inside in such a way, that plantar surface is completely turned backward. Adduction of the anterior part almost reaches the right angle, so the deep groove is formed at the flexion altitude (Adams groove) (Fig. 8.10).

At the back surface the margin of the talus head protrudes under the skin. Medial malleolus is submerged deep into the soft tissues, and contour of the lateral malleolus protrude under the skin. Foot seems shorter, calcaneus contours are smooth, the heel is significantly pulled up.
At X-ray talus is slightly flattened, its anterior part and calcaneus are slightly bent towards plantar surface, and calcaneus itself has an external curve, due to which it seems shorter (Fig. 8.11). Navicular bone has a form of a wedge, a tip of which is directed towards the plantar surface. Fifth metatarsal bone is thick, I - thin, atrophic. All metatarsal bones are turned almost under the right angle and rotated inside in such a way, that I metatarsal bone is located on the top and all others are located under it.

In children, whose bones have not formed yet, and only foci of ossification are visible, clubfoot is determined by the relation of the talus and calcaneus axis.

If the line is conducted at the anteroposterior image of the foot through the foci of ossification of the talus and calcaneus, then they are not fit into the general plantar axis of the foot and form the angle between each other that is less than 45°. At significant degrees of the clubfoot, foci of ossification lay over each other at the X-ray images, talus and calcaneus are often located parallel to each other, long axis of the talus passes parallel to the I metatarsal bone.

In the lateral projection, the projection of the talus and calcaneus axis are practically parallel.

**Differential diagnosis**

Congenital clubfoot should be differentiated with the arthrogryposis, amniotic strangulations, spastic clubfoot.

Arthrogryposis – congenital disease of the musculoskeletal system and its components. For arthrogryposis the following are typical: anomalies of bones, muscles, joints, multiple defects and contractures, the stiffness of dysplastic or deformed joints, an absence of certain muscular groups or their dysplasia, which are never observed in congenital clubfoot.

Amniotic strangulations can be multiple at different limb segments and single at one or both shins, so that clubfoot occurs, that is similar to congenital. But there are no anomalies at shins in congenital clubfoot, and there is visible deep circular strangulation of the soft tissue at the middle or between middle and lower third of the shin.

Muscular tone is not impaired in congenital clubfoot, and muscular hypertone is determined in children’s spastic palsy. Doctor passively push foot from the incorrect position, that is impossible in the mild form of the congenital clubfoot.

Radiologic investigation in children under 1 year allows determining the late occurrence of the ossification foci of the foot bones or their smaller size with the impairment of bones form and topography. Metatarsus varus angle increase (if the line is conducted along the long axis of the I and V
metatarsal bones at the anteroposterior X-ray projection, which is normally equal to 25–28°, and in clubfoot – 45–50°).

Talus index angle decreases. If the line is conducted at the lateral X-ray projection along the I metatarsal bone axis, and second – along the calcaneus, the angle of 145–155° is normally formed at the place of their intersection. At clubfoot it decreases depending on the deformation degree increase, reaching sometimes 80–90°. Fragmentation of the ossification focus of the cuboid bone is often observed. With child growth and in the absence of treatment, foot form deformation increases, especially of the talus with the impairment of their interrelation and formation of the articular surfaces; neurotrophic changes and osteoporosis occur.

**Treatment.** Three periods are conditionally defined in the treatment of congenital clubfoot: before 1-year age, after 1-year age and anti-relapse treatment.

First period is started from the diagnosis formulation, but not earlier than the umbilical wound healing. Conservative treatment is usually used in this period. Redressment, exercise therapy, heating procedures are performed. Tools for the foot fixation in the corrected position are used after the conducted procedures and redressment. During first 2–2.5 months, massage and plaster casts are not used, because the babies skin is not formed yet, so there is a significant risk of its damage, infection (pyodermatitis, sepsis). Plaster casts are not used, because after the plaster solidification its temperature increase up to the 60°, that can lead to burns and occurrence of the significant wound surface.

Treatment is started with redressment – forced liquidation of the deformation and foot fixation with flannel bandages according to Fink – Ettingen method. Removal of the main deformation elements during the redressment is performed in the strict order: each smooth motion should gradually remove foot supination and adduction of the anterior part, plantar flexion (equinus) is removed while holding the foot in the position of reached correction. Supination and adduction of the anterior foot part should be removed first of all, and equinus in the last turn. This is conditioned by the fact, that the talus should be congruently positioned to the “fork” of the ankle joint (that is reached by the supinatio and adductio removal), and only after this the dorsal flexion in the ankle joint becomes possible, removing the equinus. Redressment session lasts mot less than 5–10 minutes, after which the foot is fixed in the position of reached correction. Soft bandage after the redressment is changed for the correcting plaster casts like a short leg cast.

Short leg casts are changed each 7–9 days, complex of the conservative measure is conducted between this changes: exercise therapy, massage, redressment, heating water procedures, paraffin applications, etc. If there is a positive dynamics after the redressment performance, then treatment is continued till reaching the deformation hypercorrection.

Method of I. Ponseti currently obtained the biggest popularity in many countries in the treatment of congenital clubfoot. According to I. Ponseti method, duration of the foot deformation correction with plaster casts consists from 3 to 6 weeks, and in the foot fixation with plaster casts after the achillotomy (3–4 weeks) does not exceed 2 months.

Adherence to the treatment protocol of the I. Ponseti method:
- feet preserve their mobility;
- expressed muscular atrophy is absent;
- full movements range in the ankle joint and feet joints is preserved;
- percent of successful results reach 95 %.

Main treatment principles according to the I. Ponseti method (Fig. 8.12)

I. Ponseti suggested thenew technique of plastering, taking into account the ligaments elasticity, which contains a big amount of collagen, and also softness of the newborn's tendons:
1. Plastering starts from the 2-weeks age with the high foot arch correction (an increase of the longitudinal arch angle magnitude). Then simultaneously varus of the posterior foot part and middle part inversion (plantar flexion, adduction and supination) are corrected, as tarsal joints are tightly connected and can be corrected only in the complex. Foot is rotated around the talus head. Supination (varus) and adduction (foot adduction in the anterior part) are usually corrected after 5–6 plastering.

2. Treatment duration usually consists 6–8 weeks – till the liquidation of all the deformation elements, then it is directed at the maintenance of the correct foot position and relapse prevention.

3. Practically complete deformation correction is usually reached.

4. At the age of 1 year, if the equinus foot position is preserved, complete tenotomy of the Achilles tendon is recommended at last stage of the plastering. Further complete Achilles tendon regeneration is proved in this case.

5. There is no need for complicated operative interventions.

6. Manipulations can be performed with the parent’s presence, that allows to provide peace to the child and reach the sufficient foot correction.

All deformation elements should be completely removed before the start of child's walking, ie before 1 year of life in average. In cases, when conservative treatment does not correct the deformation completely, operative treatment is indicated. Operation on the soft tissues is performed according to the Zacepin method, which principle consists in the elongation of the dysplastic muscles tendons. If necessary operation is performed with ligamento- and capsulotomy of the ankle joint for the complete removal of all deformation elements and providing the hypercorrection position to the foot. All complex of the conservative treatment is performed in the postoperative period, which is directed at the microcirculation improvement in tissues of the shin and foot, development and growth of dysplastic muscles, foot fixation in the correct position and prevention of the deformation relapse. Operative treatment in children of the older age, which were not timely operated, is complemented with correctional wedge resection and osteotomy along the transverse tarsal joint with the arch formation.

Significant place in treatment after the operative intervention is given to the relapse prevention. Orthopedic rehabilitation, orthopedic splints, special shoes are widely used, which patient uses for at least 3 months after the operation, and as a rule – till the growth end. It should be remembered about the predisposition to the deformation relapse after the operative treatment. So, efforts of exercise therapy in the postoperation therapy are directed at the muscles shins force, working capacity and endurance recovery, at the continuous correctional orthopedic boots, splints, orthopedic shoes.
DEVELOPMENTAL DYSPLASIA OF THE HIP JOINT

Dysplasia of the hip joint – impairment of the growth and development of all elements of the hip joints, in particular – bones, that form the hip joint, capsulo-ligamentous apparatus, vessels and nerves. This separate defect is observed in 16 cases for 1000 newborn. Dysplasia is more often observed in girls (7:1) and in most cases is unilateral.

**Etiology.** There are many points of view concerning the occurrence of the hip joint dysplasia, but the attention is drawn more by the theory of primary fetus anlage and development delay of the hip joint with normal anlage. Cases of hip joint dysplasia combination with other congenital defects is a confirmation of the primary anlage impairment. As to the second point of view, their supporters consider unfavorable influence of exo- and endogenic factors on the fetus as the main cause. Investigation of the industrially polluted territories, where the percent of dysplasia is higher, is a confirmation of this theory. So, these two theories provide the basis for the disclosure of the etiology of developmental dysplasia of the hip joint.

Hypoplasia of the acetabulum is typical for the hip joint dysplasia: it is shallow, flat, elongated, with different degree of the roof skewness (more than 30°). As a rule, ossification foci of the femoral head and its developmental delay occur in hip joint dysplasia. Physiological torsion of the proximal part of the femoral bone is impaired: excessive (more than 10°) rotation (deviation) of the femoral head and neck towards occurs – antetorsion, or rarer backward – retroversion with the increase of the cervico-diaphysial angle.

Muscles, capsule and ligaments dysplasia are always present in the developmental dysplasia of the hip joint. So, hip joint dysplasia – underdevelopment of all elements of the hip joint. Feature of the dysplasia, in the opposite to the subluxation or luxation, is that the femoral head is always centered in the acetabulum. At the modern level of medicine obstetricians, midwives, health visitors should pass corresponding education about the developmental defects, especially dysplasia, congenital hip joint dislocation, torticollis and clubfoot.

**Clinical manifestations.** During the examination of the child, doctor pays attention to the presence of additional skin folds or their asymmetry at the medial surface of the hip upper third, which is conditioned by the muscles underdevelopment on the side of the affected joint (Fig. 8.13).

During the passive movements check in the hip joint, doctors bends child’s legs in the hip and knee joints up to the right angle and then starts to slowly abduct them and feels that the abduction becomes limited from one side (in unilateral dysplasia), or notes the limitation of the both hips abduction (in bilateral dysplasia). This is conditioned by the underdeveloped capsuloligamentous apparatus of the dysplastic hip joint. Hip abduction of less than 70° on the side of dysplasia has clinical value in this case.

![Fig. 8.13. Additional skin folds and skin folds asymmetry at the medial surface of the hip upper third](image-url)
So, three main clinical symptoms are the most typical for the hip joint dysplasia: additional folds presence at the middle surface of the hip upper third and/or their asymmetry and limitation of the hip abduction less than 70°. These are not the pathognomonic or absolute symptoms, but relative, which indicate the presence if disorders in the hip joint, and can sometimes be observed in healthy children. If these symptoms are determined child should be additionally examined.

Ultrasound – modern noninvasive, safe and high-effective method of diagnostics, which allows determining signs of hip joint dysplasia and congenital hip dislocation even in newborns. In many countries of the world the US is used as the mandatory screening method for the hip joint dysplasia determining.

X-ray. Ultrasound of the hip joints is used for the diagnosis specification till the 3-months age. But the most objective method of the investigation, which should be obligatory performed in the suspicion of congenital hip joint dysplasia or dislocation presence is X-ray, which is performed after the 3-months age, when the ossification focus of the femoral head epiphysis normally occur (Fig. 8.14). The most widespread system of the obtained assessment is a quantitative assessment of the radiographs according to the Hielgenreiner scheme, where angles, distances, line and arches are determined (Fig. 8.15).

Following radiologic symptoms are typical for the developmental dysplasia of the hip joint:

- excessive skewness of the acetabular roof, which is determined by the alpha acetabular angle, which normally varies from 27 to 30 degrees; it is also flat and shallow;
- late occurrence of the ossification foci on the femoral head epiphysis (later than 3–3,5 months), their absence or hypoplasia;
- femoral head is centered.

**Hielgenreiner scheme** (Fig. 8.15). At the plan radiograph of the pelvis and hip joints, the horizontal line is conducted through the Y cartilages (Keller and Hielgenreiner lines). The second line – tangent – is drawn from the margin of the acetabular roof parallel to the last and is connected with the Keller line. Acetabular angle is formed between them, which should normally be less than 30°. Then the segment d is drawn along the horizontal Hielgenreiner line from the acetabulum center to the internal margin of the ossification focus. This segment normally consists 1–1.5 cm. An increase of the segment lengths indicates the head lateroposition. The next line is drawn from the top of the roof as a perpendicular to the Keller line and is continued to the hip – Perkin line. This perpendicular divides acetabulum into 4 sectors. Ossification focus of the femoral head should always be in the inferior internal sector. Also, perpendicular is drawn from the
Keller line to the ossification focus of the femoral head. Length of this perpendicular normally consists 1–1.5 cm. This index indicates the absence of the head dislocation upwards (proximally). Also, Shenton line indicates the absence of the intraarticular dislocation of the proximal end of the femoral bone, which without a gap passes to the upper medial contour of the obturator foramen. Calve line or arch – line, which is like the Shenton line, normally without a gap and smoothly passes from the external contour of the femoral head to the iliac wing.

**Treatment.** Conservative treatment is started, when the developmental dysplasia of the hip joint is determined in the maternity hospital: wide diapering is initially used, and from the 2–3–weeks till 3-months age orthopedic pants are used. Also, parents are taught to perform abduction exercise of the hip before diapering. Radiologic control is mandatory performed after the 3 months of life and if the dysplasia presence is confirmed, the Pavlik harness is applied (Fig. 8.16A).

Their advantages are that they provide free access for the child’s hygiene, allows active movements with legs with fixed hip and knee joints under the right angle with gradual achievement of the complete hip abduction. Depending on the dysplasia Pavlik harness are applied fo the term fo 3–6 months. At the age of 6–7 months abduction device is usually used for keeping legs in the flexed and abducted position. It allows to fixate hip joints in the needed medical position more reliably and inflexibly (Fig. 8.16B). Criteria of harness or abduction device removal is a complete recovery of the acetabular roof, which angle at the Hielgenreiner scheme should be less than 30°.

**Why hip abduction is a medical intervention?**

First of all, in the hip abduction under the angle of 90°, the femoral head is centered and excessive pressure on the acetabular roof is removed, contact between the articular surfaces of the femoral head and acetabulum is maximal, that allow the hip joint elements to form normally.

Secondly, constant irritation of the articular capsule and muscles functioning during active movements improve microcirculation, that positively influence the process of further development of the acetabulum.

The goal of the developmental dysplasia treatment is to provide optimal conditions for the further development of the acetabular roof before the 1-year age, ie the time, when the child will normally start to walk. Normal biomechanical parameters should be recovered in the joint.

**CONGENITAL HIP DISLOCATION**

Congenital hip dislocation is one of the often congenital defects of the musculoskeletal system. Causes of the congenital hip dislocation occurrence are endogenic, as well as exogenic factors, hormonal disorders, toxicoses, B₂ vitamin deficit, metabolic disorders, heredity. All they can condition anlage defects of the articular elements and delay of their development during the antenatal period.
Joint dysplasia always takes place in the congenital dislocation, particularly: acetabular hypoplasia, small sizes of the femoral head, late occurrence of the ossification focus, excessive rotation of the proximal part of the femoral head (antetorsion), and also dysplastic changes of the neuromuscular apparatus of the hip joint.

So, congenital hip dislocation is characterized by the hip joint dysplasia (impaired development of all its elements) and discongruency of the articular surfaces of the femoral head and acetabulum of different degree, up to the complete escape of the femoral head from the acetabulum.

Femoral head without impediments dislocates aside and upwards through the shallow, flattened acetabulum, which is elongated and has underdeveloped superoposterior margin, that condition excessive roof skewness (acetabulum reminds triangle). Acetabulum flattening also increases due to the cartilage layer thickening of the bottom and "fat pillow" development at the bottom. With the gluteus muscles development, flexed leg position of the fetus promotes femoral head dislocation upwards, and in such position, the physiologic pressure of muscles is applied to the medial surface of the head, which leads to its deformation. Capsule is constantly overextended, sometimes has a form of a sand glass, round ligament is hypoplastic or even absent, muscles are hypoplastic on the side of dislocation.

Clinical manifestations. Congenital hip dislocation should be diagnosed in the maternity house, which determined the necessity of knowledge of this pathology by obstetricians, pediatricians, midwives. It is necessary for children to be examined by orthopedists in questionable cases. Because early diagnosis – guarantee of the successful treatment.

During the child’s examination attention is paid to the presence of additional folds on the medial hips surface lower than the inguinal ligaments, their asymmetry, depth; and on the posterior pelvis surface – on the location of gluteal folds, which are asymmetrical in the congenital hip dislocation. After the examination doctor bends the child’s legs in the hip and knee joints up to the right angle and smoothly without spurts abduct hips, which is significantly limited in the congenital hip dislocation and consists less than 70° (Fig. 8.17B). In the opposite to the physiological muscles rigidity, abduction limitation in newborns with the congenital hip dislocation is constant and does not disappear with the child’s development. Relative limb shortening is determined on the side of dislocation during clinical examination. It is clearly visible, that the knee on the side of dislocation is located lower than on the opposite side, when legs are bent in the hip and knee joints (Fig. 8.17A).

Absolute or reliable symptoms in congenital hip dislocation are the symptoms of reduction-dislocation (click sign) or Ortolani – Marks sign (Fig. 8.18).

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Fig. 8.17. A – knee is located below another one on the side of the congenital hip dislocation (relative limb shortening on the side of dislocation); B – hip abduction limitation on the side of dislocation less than 70°
Significant external rotation, patella lateroposition up to 90° are observed in high dislocations. Ortolani – Marks sign is a consequence of femoral head reduction into the acetabulum, and during adduction it dislocates again with the typical click.

Sign of dislocation and reduction (click sign) is durable only in preterm children, and disappear quickly in normally developed children (during several days), which is conditioned by the gluteal and adductor muscles tone development. Also, the hip abduction limitation increases with time. To relative symptoms of the congenital hip dislocation also refer the Dupuytren’s symptom or piston sign (when child is placed in the supine position and pressure is applied to the extended leg along the axis, then it dislocated upwards), positive Chassaignac symptom – extensive external rotational movements are always determined on the side of dislocation.

Congenital hip dislocation can be reliably diagnosed only in the presence of the absolute symptom (reduction-dislocation symptom). Only suspicion of dislocation occurs in other cases, which is specified with radiologic or ultrasound investigation.

Children with the congenital hip dislocation start to walk later. Child sways from one side to another in bilateral dislocations – goose gait, in unilateral – wandering lameness and relative limb shortening. Tip of the greater trochanter is above the Nelaton’s line (conditional line, that connects the anterior superior pelvic spine and ischial tuberosity), Brian’s triangle form is impaired, and Schemaker’s line (line, that pass through the anterior superior pelvic spine and the tip of the greater trochanter) passes lower than the umbo.

In children after the 1-year age, with starting of walking and ability to stand, positive Trendelenburg’s sign (Fig. 8.19). Normally, if the child stands one leg, with another leg flexed in the hip and knee joint up to the 90° angle, then no trunk deviations occur, gluteal folds are at the same lev-
el. When the child with the dislocated hip joint is standing and tries to bend the healthy leg in the hip and knee joint under the 90° angle, he/she immediately starts to bend to the side of dislocation, so the femoral head can set against the iliac wing. At this time, healthy part of the pelvis become distorted, moves downwards, gluteal folds become asymmetrical, on the side of the dislocation they are lower than on the opposite side. These are conditioned not only by the muscle hypotrophy, but the principle – in the femoral head proximal dislocation along the iliac wing, places of the onset and adjunction of the gluteus muscles gets closer. They lose their physiological tone and are not able to stabilize the hip joint (so instability in the Trendelenburg posture occurs). It should be remembered, that Trendelenburg symptom is always positive in congenital and acquired coxa vara.

Radiologic investigation. If the diagnosis specification is necessary at the age of 2 weeks to 3 months then ultrasound investigation of the hip joint is performed. After 3 months, the radiologic investigation is mandatory performed for the determining of the treatment dynamics and diagnosis specification (Fig. 8.20).

X-ray of the pelvis and hip joints is performed in the supine position with extended lower limbs without the pelvis rotation or skewness. Radiographs are assessed according to the Hielgenreiner scheme (Fig. 8.21).

Acetabular angle in luxations exceeds 30–40° (it should normally be less than 30°). Location of the tip of the hip proximal end (epiphysis) above the Hielgenreiner line is typical for luxations. Shenton’s line and Calve arch are ruptured.

Early radiologic symptoms of the congenital hip dislocation were described in the year by bologna orthopedist P. Putti; the last entered the literature as the Putti triad.

Three main symptoms are typical for it:
- excessive skewness of the acetabular roof, is determined by the acetabular angle alpha, which does not normally exceed 30 degrees;
- late occurrence of the ossification foci at the femoral epiphysis (later than 3–3.5 months), their absence or hypoplasia;
- decentered femoral head – lateral and upward dislocation (lateroposition) of the proximal end of the femoral head in relation to the acetabulum is determined.

5 dislocation degrees come from the data of the radiologic investigation:
1 degree – femoral head is at the level of acetabulum with its expressed lateroposition;
II degree – femoral head is located above the Keller's line, but does not go beyond the acetabular roof – subluxation;
III degree – head is located above the upper roof margin;
IV degree – head is shadowed by the iliac wing;
V degree – head is located on the iliac wing.

**Differential diagnosis.** Congenital hip dislocation should be differentiated with the congenital femoral shortening. Anatomical shortening, but not relative as in the congenital hip dislocation, is typical for it. Also, negative Ortolani's test takes place. Limitation of the hip abduction, skin folds asymmetry, impairment of the Brian's triangle and Schemaker's line are absent.

Second congenital defect, which the congenital hip dislocation should be differentiated with, is congenital coxa vara. Limitation of the hip abduction, location of the greater trochanter tip over the Nelaton's line are typical for the last one. Relative limb shortening takes place in the unilateral coxa vara, but Ortolani's, Dupuytren's symptoms, folds asymmetry are absent.

In older children with bilateral coxa vara, as well as in the congenital hip dislocation, typical goose gait takes place. It is diagnosed after the radiologic investigation.

It should be remembered, that muscles hypertone is determined in newborns in first days of life with the hip abduction limitation, that can direct onto the congenital dysplasia of hip dislocation. Careful examination indicates the absence of relative and absolute signs of dislocation, that can prevent diagnostic mistakes. Also, hypertone disappear and hip abduction become normal with the baby's development, and in the dysplasia and dislocation hypertone is preserved.

Deformation of the proximal end of the femoral head occurs as the result of Legg-Calve-Perthes, epiphysiolysis of the femoral head disease, which has typical medical history and course of the diseases. Wandering lameness, Dupuytren's and Chassaignac symptoms are absent in such patients.

Radiologic investigation allows to perform carefully the differential diagnosis and make a diagnosis.

**Treatment**

**Following stages are defined in the treatment of congenital hip dislocation:**
1. Treatment of children in first 3 months of life.
2. Treatment of children from 3 months to 1 year.
3. Treatment of children from 1 to 3 years.
4. Operative treatment of children at the age from 3 to 5 years.
5. Operative treatment of adolescents and adults.

It should remembered, that reduction of dislocation should be performed first in the presence of the congenital hip dislocation (reach centering of the femoral head), and then to fix the hip joint in the position of reduction and treatment (90° bending in the hip and knee joints and 90° hip abduction).

Treatment of children under 1 year. When the hip joint dysplasia or congenital hip dislocation are determined, wide diapering is administered, and after the umbilical wound healing – shirt-harness. Medical exercises for legs during the diapering of the child are performed, which are directed at the elimination of adduction contracture of hips. Frejka pillow, orthopedic pants are administered after the 2-months age, so the degree of hip abduction should gradually increase. X-ray control is performed after the 3-months age to be convinced in the pathology presence in the hip joint. Then the Pavlik harness are put on, which are worn will the complete normalization of the acetabular roof development (till 9–10 months).
Abductional device and splints of different modifications are used besides the Pavlik harness. Fixation in the harness is usually changed to fixation with abduction device at the 6–7 months age.

Treatment duration depends on the acetabulum dysplasia degree, roof skewness, time of the treatment onset. Medium treatment duration of hip luxations and subluxations consists not less than 6–9 months, subluxations – 5–6 months.

After the harness, splints or devices removal children keep legs in the position of abduction and flexion, which gradually passes during 2–3 weeks and legs take the physiological position. Massage, exercise therapy, heating procedures, water procedures, magnet, electrophoresis with calcium chloride, ADP, etc., compounds the complex of the conservative interventions, which are directed at the development stimulation of all hip joint elements. It is advised to the parents not to let their children walk till the 1-year age.

The classic treatment method of the congenital hip joint dysplasia after the 1 year of life is A. Lorence method, which was suggested in the 1894 year. This method considers single-stage closed manual reduction, which is conducted under narcosis. Then body cast in the Lorence-1 position is applied: hip is flexed under the 90° angle with it complete abduction and flexed knee joint under the 90° angle. Closed reduction is performed initially on the side of the bigger femoral head dislocation in bilateral dislocation, and then reduction of dislocation is performed on the contralateral side and the body cast is applied for the term of 6–9 months. X-ray control is mandatory performed after the plaster cast application. Several X-ray controls are performed during the treatment period. Child stays in the bed for 3–4 weeks after the plaster cast removal for the gradual elimination of the hip abduction, fixed position of knee joints with the recovery of the movements range.

But it should be remembered, that the often complication in the A Lorence method use is head traumatization with the development of severe epiphysitis. So the A Codevilla method becomes the method of choice – continuous glue traction of legs in the vertical position with gradual abduction at the special metallic arch, that is built-in in the bed (Fig. 8.22).

Hips are abducted for 1 cm each day till. Self-reduction of the head often occurs at the complete hip abduction. If the reduction of the head is not reached, then the doctor places his/her fingers on the greater trochanter, and place other on the iliac wing and push the femoral head bottom-up, which passes the acetabulum margin and is reducted into it. This method is more sparing. Epiphysites can occur during it, but significantly rarer.

After the traction removal leg is fixed by the abduction splints, device for the gradual transition of the leg into the treatment position. Massage, exercise therapy, vitamins with micronutrients are administered. Radiologic control over the hip joint condition solves the issue of the possibility of the immobilization removal and hip joint activation. The following compound the treatment complex: unloading, balneotherapy, electrophoresis, calcium and phosphorus supplements, vitamins (videin-3), ATP, sanatorium and spa treatment.

Coxa plana is the complication of the dystrophic process with the following progressing osteoarthrosis deformans.

According to the professor IB Kucenko data, treatment of the congenital hip dislocation with functional method provides stable satisfactory results in 70–80 % of cases. The main causes of the unsatisfactory consequences are the avascular necrosis (8–9,5 %), unreducible dislocation due to the capsule strangulations and relapses of dislocation. Operative treatment is necessary for 10–13 % of patients.

If conservative methods are ineffective, surgical method becomes the method of choice, which used not earlier than from the 3–5-years age, when it is possible to make a contact with the child for the performance of the postoperative rehabilitation.

To radical surgical interventions refer all methods and modifications of the congenital hip dislocation elimination, and also arthrodesis and endoprosthetic replacement of the hip joint in the adult patients.
Correctional operations – operations, when deviations of the proximal end of the femoral bone from normal, limb lengthening, transposition of the muscles adjunction, greater trochanter are removed (Fig. 8.23). Correctional operations can be performed separately or together with radical operations on the joint. Correctional osteotomies of the pelvis allow forming the acetabular roof. Osteotomies of the proximal end of the femoral bone are directed at the recovery of anatomical parameters and centering of the femoral head in the acetabulum. These interventions are performed separately, as well as in the complex.

Conservative treatment of adolescents and adults is ineffective. Method of choice is surgical. Complicated reconstructive-renovative operations are performed, which are directed at the recovery of anatomical biomechanical interrelations in the joint with the preservation of its functions.

If there is satisfactory interrelation of the articular surfaces and the femoral head form, then the acetabular roof is formed by the reconstruction according to the Korzh, Toms, Kenig and Pembert methods, pelvic osteotomies according to the Solter, Hiari methods. If there is an excessive antetorsion, then the detorsional subtrochanteric osteotomy of the femoral bone is performed, which allows not only to radically remove antetorsion, but also to recover the neck-shaft angle, by removing the wedge from the proximal bone fragment.

Treatment of the congenital hip dislocations in adolescents and adults is a problem not only by the complicacy of the surgical intervention, but also by the recovery of the hip joint function. So the main purpose – early determining of the dislocation and treatment initiation from the first weeks after birth. Early operative treatment in the unreducible dislocations provides the possibility to obtain significantly better close and remote results.

8.2. POSTURE AND ITS IMPAIRMENTS

Posture – orthostatic position of the human body in the space, when the physiological curves of the spine are preserved with the symmetrical head, trunk, upper and lower limbs position.

The spine in newborns have no physiological curves. Their formation occurs with the child’s growth according to the functional needs. As soon as the child starts to lift head actively and hold it (at the age of 2–3 months), increasing of the cervical muscles mass and force occur, cervical lor-
Congenital deformations of the spine, bones and joints. Scoliosis is formed – anterior curve of the cervical part in the sagittal plane. Child starts to sit at the 5–6 months of life, muscles of the back start to work, the thoracic kyphosis is formed – posterior curve of the spine in the sagittal plane. At the 11–12th months of life the child starts to walk, and the lumbar lordosis is formed at this time – the spine anterior curve in the lumbar part in the sagittal plane. Formation of the physiological curves of the spine occurs till the 7-year age. Terms "kyphosis", "lordosis", "scoliosis" were suggested by Galen.

So, correct postures is formed in the normal physiologic growth of the child with the timely elimination of the unfavorable factors, which include underdevelopment or weakness of the muscular system, functional and forced pelvis skew, limbs shortening, continuous incorrect body position, which is conditioned by the inappropriate furniture (low chair and desk), habit to sit or stand incorrectly.

Pathologic posture, such as round-shouldered back, kyphosis, lordosis, is determined in 18.2% of children, and scoliotic posture – in 8.2%.

The most widespread impairments of posture are: round-shouldered (stooping) back, kyphotic, scoliotic, lordotic posture and flat back (Fig. 8.24).

Physiologic curves of the spine have moderate a smooth transition in the normal posture and vertical axis passes along the line from the middle of the parietal area behind the line, that connects to angles of the lower jaw, and conditionally conducted through both hip joints. During the frontal examination of the child, head is located straight, shoulder girdle is symmetric, earlaps are at the same level, lateral trunk deviations are absent, anterior pelvic spines are at the same level, lower limbs are perpendicular to the floor if there is a complete extension in the hip and knee joints. Feet are parallel and slightly deviated aside. During the examination from behind head is located straight, shoulder
girdles are symmetric, scapulas does not come off the thorax, waist triangles are similar, rhombus of Michaelis is regular, pelvis without the skew, bent towards up to 42–48°, gluteal folds are symmetric, lower limbs are perpendicular to the floor, feet are at the same level.

Posture impairments are conditioned by the spine deviations in the sagittal or frontal planes towards the increase (intensification) or decrease (flattening) of physiological curves.

**Stooping back.** Even increase of the physiological kyphotic curve in the thoracic part is typical for the stooping back. Shallow curve of the thoracic part becomes bigger than physiological.

Besides the expressive increase of the physiologic kyphosis in the thoracic part, increase of the lumbar lordosis and pelvis bending are typical. Such child stands with the bent towards trunk and shoulders brought closer, which form the pectoral muscles shortening. Thorax is hollow, abdomen protrudes. Scapulas are located symmetrically, but their lower angles come off the thorax. Spinal processes of the thoracic part of the spine protrude along the axial line without deviation in the anterior trunk bending. Movements range of the spine is not limited. Lumbar lordosis is compensatory increased.

Kyphotic posture differs of the stooping back with the more limited curve of the spine with its top at the VII thoracic vertebra, with the compensatory increase of the lumbar lordosis, increased anterior pelvis bending.

At the radiographs in the lateral projection, thoracic part of the spine has the general posterior bend, and in kyphosis – local narrowing of the intervertebral space in the anterior part, especially on the top of the curve.

So, in the stooping back, kyphotic posture, anterior part of vertebrae and their growth zones are constantly overloaded by the static-muscular pressure, while the posterior parts of the spine and their growth zones are in the unloaded condition. Such static-biomechanical conditions condition the asymmetrical growth of the thoracic vertebrae: anterior parts have the growth delay under the constant pressure, and posterior develop normally, which lead to the formation of wedge-formed vertebrae. Scheuermann’s disease or juvenile kyphosis – precondition of early osteochondrosis, spondylitis deformans with secondary radiculites, ischialgia development, that leads to the decrease of the functional capacity of the spine in the young and mature age.

**Flat back.** Significant decrease or complete absence of physiological curves of the spine without the pelvis anterior bending are typical for the flat back.

The following is observed during the examination from behind: head is straightly positioned, shoulder girdles are at the same level, back is straight, flat, trunk is thin and seems elongated. Scapulas are located at the same level, prominent, lower angles slightly come off the thorax. Spinal muscles are insufficiently developed, hypotrophic. Rhombus of Michaelis has the regular form, gluteal folds are at the same level. Maximal flexion in the lumbar part of the spine is limited (patients can not touch the floor).

Spinal axis has no deviations in the frontal plane. Flat back is typical for the asthenic constitution and is the most often among the posture impairments.

Static loads along the spinal axis due to the absence of physiological curves always fall on the same disk part, that lead to the constant overload with the development of progressing degenerative-dystrophic changes, which condition the occurrence of early osteochondrosis, spondylitis deformans, spondyloarthritits.

**Lordotic posture.** Excessively deep lumbar lordosis is typical for it. During the examination of the patient from one side (profile) excessively deep lumbar lordosis with the pelvis bending towards in the sagittal plane draw attention. Thoracic kyphosis become more sloping, abdomen protrudes towards. During the examination from behind, the head is positioned straightly, shoulder girdles are symmetric, at the same level, scapulas are also at the same level, their lower angles come off the
Congenital deformations of the spine, bones and joints. Scoliosis.

Scoliosis – is fixed congenital or acquired frontal torsional deformation of the spine. Congenital and acquired scoliosis are defined. To congenital refer scoliosis, that occurs on the background of the developmental anomalies of the spine and disks. To acquired scoliosis refer: neurogenic, myopathic, rachitic, static and idiopathic. Different anomalies of the spine development become the cause of congenital scoliosis: vertebral fusion, additional wedge-form vertebrae, costal fusion, deviations in the arches development, processes fusion, which condition the asymmetric spine growth. Feature of the congenital scoliosis is that its development and progressing corresponds to the period of child's growth, deformation occurs at the more limited area, and contracurvature has the more shallow arch.

Dysplastic scoliosis occurs on the background of the lumbosacral part of the spine underdevelopment, unilateral sacralization or lumbarization. Dysplastic scoliosis manifest in children after the 8–10–year age and progress quickly as they correspond to the following growth leaps. The main arch of the curvature corresponds to the lumbar part of the spine.

Acquired scoliosis are divided by the etiological principle to:
- neurogenic, that occur after the sustained polio, in spastic cerebral palsies, syringomyelia;
- myopathic – in myopathies;
- rachitic scoliosis. Skeletal system suffers in rickets, osteoporosis, deformation of lower limbs with biomechanical impairment of statics and dynamics, muscles-antagonist dysfunction with their weakening occur, kyphosis, lordosis of the spine increase with the growth impairment of the vertebral body apophysis due to the non-physiological load, forced position, especially during sitting. All unfavorable conditions lead to scoliosis or kyphoscoliosis occurrence, which manifests on the 3–4th year of life;
- static scoliosis occurs in diseases of joints and bones of lower limbs, when the pelvis skew, limbs shortening occur (congenital hip luxations, subluxations, unilateral coxa vara, contractions, fractures malunion);

So, people with lordotic posture – a risk group of spondylolisthesis occurrence, so they should be orientated on the choice of job, that is not connected to the continuous standing, weight lifting or rough labor.

Scoliotic posture. Scoliotic posture is characterized by the lateral deviation of the spine in one of the parts only in the frontal plane. Scoliotic posture manifests clinically with the lateral deviation of the spine in the lower thoracic or lumbar part of the spine, asymmetric position of the shoulder girdles, on the concave side the shoulder girdle is located lower, convexity - lifted. Scapulas are located asymmetrically, lower angles are not located at the same level, body triangle on the concave side is bigger, than on the convexity side. Pelvis is not skew. During the frontal examination the shoulder girdles asymmetry and irregular nipples position, body triangles asymmetry are determined. Scoliotic posture is usually corrected in the "stock-still" position, and all its symptoms disappear.
idiopathic scoliosis is most widespread, consists about 85% of all scoliosis. There are many theories of its occurrence: neuromuscular insufficiency, static-dynamic impairment of the spinal function, neotrophic changes in the skeletal and neuromuscular systems during child’s growth, excessive loads, that condition impairment of the enchondral bone formation of vertebrae with their deformations development. The following forms of the idiopathic scoliosis are defined depending on the child’s age: infantile (from birth till 3 years), juvenile (from 3 to 10 years), adolescent (from 10 to 17 years).

Infantile scoliosis consists up to 1% of all scoliosis, more often occurs in boys and is more often left-sided. 85% of infantile scoliosis regresses spontaneously, so 15% – progresses, that can lead to the neurologic complications.

Juvenile idiopathic scoliosis consists about 15% of scoliosis, occurs at the age from 3 to 10 years, more often in girls, more often right-sided thoracic.

Adolescent scoliosis is determined in the age after 10 years. Significant part of the surgical activity (80–85%) is connected with the idiopathic adolescent scoliosis. Disease is more often observed in girls (girls/boys relation is 9:1).

According to the IV Fischenko data, etiology and pathogenesis of the scoliotic disease consists in the intervertebral disk dysplasia on the top of the main deformation curvature. Impairment of the connective tissue metabolism leads to the fibrous ring loosening, conditions early migration of the nucleus pulposus aside. Then the nucleus pulposus stably fixes at the concave side of the deformation and become a reason of the rotational mobility of the vertebral segment at the level of disk dysplasia. Dislocated nucleus pulposus participates in the development of structural changes of the osseous elements of vertebrae (wedge form and torsion) during the growth process.

Irregular loads on the growth zones of vertebral bodies occur in such conditions, that leads to the growth asymmetry. So, the nucleus pulposus migration aside is an initial mechanism in the structural elements formation of the spinal deformation.

Occurrence of the main curvature conditions formation of the compensatory contracurvature or pelvis skew. All these lead to the structural and functional changes in paravertebral muscles as at the concave, as well as at the convex sides.

VD Chaklin defines 4 degrees of scoliotic disease. To the I degree refer scoliosis with the angle of deformation up to 10°, to II – up to 25°, to III – up to 50° and IV – above 50°.

Following clinical manifestations are typical for the I degree of scoliosis (Fig. 8.25). During the examination from behind asymmetrical position of the shoulder girdles and scapulas are determined. Lower angle of the scapula on the convex side is located above the lower angle of the other scapula. If the spinous processes are marked with brilliant green, then the degree of their deviation at the level of spine curvature is clearly visible. Expressed asymmetry of the body triangles is determined (it is smaller on the convex side, and bigger on the concave side). Spinal muscles are hypotrophic. Muscular roller occurs in the lumbar part during the trunk bending. There is no pelvis skew. Asymmetry of the shoulder girdle, nipples and coast arches are determined during the frontal examination.

It is impossible to remove the deformation passively (head traction or horizontal positioning of the patient) as well as actively. For the II degree, expressed S-like deformation of the spine is typical with the costal humpback formation. During the patient’s examination from the behind attention is paid to the significant asymmetry of shoulder girdles, body triangles, scapulas. Scapula at the convex side, especially its lower angle comes off the thorax. The costal humpback is expressively prominent in the anterior body bending. Compensatory arch decreases during the head traction, but the main curve of the spine does not change. Rhombus of Michaelis and pelvis are skewed, relative limb shortening on the side of skew. At radiographs wedge-formed vertebrae are observed on the top of the curve in the frontal view, primary arch angle is within 20–25°.
Congenital deformations of the spine, bones and joints. Scoliosis

For the III degree fixed S-like deformation of the spine, trunk shortening are typical. Thorax is significantly deformed. Humpback is formed at the convex side towards the main deformation. Shoulder girdle and body triangles asymmetry increase, the trunk deviates from the vertical axis of the spine. Neck is shortened, head is bent towards. Maximal amplitude of movements in shoulder joints is limited. Scapula is located on the concave side, lower than another side and closer to spinous processes, its lower angle is prominent under the skin and is does not adjoin to the thorax. On the convex side scapula remote from the spinous processes, vertebral margin and lower angle significantly come off the thorax, that reminds winged scapula (scapula alata). Significant skewness of the pelvis and rhombus of Michaelis, relative limb shortening from the side of convexed thorax are determined.

Primary either secondary arches do not change during the head traction, that indicates the stable deformation presence. The plane of the shoulder girdles does not correspond to the pelvis plane. Deformation of the main curve at X-ray consists 30–50°, vertebrae are wedge-formed, intervertebral spaces are deformed: narrowed at the concave side, dilated on the concave side.

Fourth degree is characterized by the severe S-like deformation of the spine, thorax with big acute hump, trunk shortening, which is deviated towards the main arch. Scoliosis is fixed, significant skewness and deformation of the pelvis. relative shortening of the lower limb on the side of pelvis skewness. Limitation of the spine movements, back and spinal muscles hypotrophy.

At the radiograph: wedge-form deformation of vertebrae, angle of the spine curvature is above 60°, expressed spondylosis deformans, spondyloarthitis. Intervertebral spaces are asymmetrically narrowed: significant narrowness at the concave side, and extension on the convex side.

So, severe anatomical changes not only of the spine, thorax, but also pelvis and lower limbs occur. Also, progressing anatomo-functional impairments condition an increase of pathologic changes in thoracic organs, poor general condition of the patient. On the basis of these, scoliosis is considered not only as the diseases of the spine, but as the scoliotic disease of the organism.

As the vertebrae torsion progresses, gradual torsion of the thorax occur, one part of which become hollow, and another become convex.

Anatomo-functional disorders of the chest organs occur due to such deformation: first of all, occurs an increase of intrapulmonary pressure due to the lungs compression on the concave side and compensatory extension on the convex side with emphysema development. These become the cause of the intravascular pressure in the pulmonary circulation, that condition overload of the right heart chambers, which muscle is weaker than on the left side.
Hypertrophy develops first in the right chambers myocardium, which on the background of hypoxia leads progressively to the myocardiodystrophy occurrence with decreased functional capacity of right chambers. External respiration deficit occurs and chronic hypoxia develops. Intrapulmonary pressure increase leads to the right heart chambers hypertrophy increase, and heart axis deviation – impairment of the blood outflow from the heart, that increase the load on the left heart chambers, where hypertrophy develops. Due to the external respiration insufficiency development, despite the compensatory involvement of the diaphragm into the respiration, organism functions in the conditions of constant hypoxia, which cause not only the fast fatigue, activity decrease, sleepiness in the patient, but also leads to the development of progressing myocardiodystrophy, pulmonary heart disease (cor pulmonale or cor bovinus), which functional capacity decrease, especially at addition of intercurrent diseases. Decompensation, heart and pulmonary insufficiency develops in the young age, which leads to the fatal outcome.

Clinical manifestations of pulmonary hypertension: accent of the II tone over the pulmonary artery, incomplete right bundle branch block (His bundle): P-pulmonale, negative T wave in V₁–V₂ leads. These indicate the increased pressure in the pulmonary circulation and hypoxic, dystrophic changes in the myocardium.

Prevention and early treatment, which purpose is to stop progressing of the scoliotic disease, are an important intervention if fight for patients life.

So, the first condition of the scoliotic disease prevention is an earlier determining of children with the scoliotic posture and their treatment.

Second important task is the early determining of the scoliotic posture transition into the scoliotic diseases of the I degree. Pathognomonic sigh is the vertebral torsion. From this moment the scoliotic disease treatment should be started.

So, in the scoliosis diagnostics, the following clinico-historical and radiologic data are defined. Complaints of the patient draw attention during the examination. The main complaints of the patient or parents in most of the cases are curvature, back deformations, hump presence. In some cases complaints are presented from the point of the cosmetic defect. Low back pain is also the complaint of the patients. But the pain syndrome is more typical for adult patients, in which degenerative changes in the spine progress quickly.

During the history collection, scoliosis presence in relatives or parents is determined, its type, age of the deformation occurrence and character of progressing, age of the menarche occurrence in girls.

Symmetry of the shoulder girdle location, thorax form, level and symmetry of scapulas, body triangles symmetry, pelvis location are determined during the examination. Axis of the spine is assessed (the lead lower from the С 7 spinous process. Frontal, lateral and dorsal examination is performed. Rather simple, but effective Adams test is used for scoliosis determining.

Adams test – determining of the costal humpback, impairment of the spinous processes line during the visual assessment at and conduction with the investigator's hand along the patients back. Patient is examined from behind and asked to bend forward and try to touch the floor with fingers.

Scoliometer is used for the mass examination.

Additional investigation includes the performance of the X-ray in the anteroposterior projection (for the radiation decrease on the mammary glands in girls) with the performance of the traction tests and in the lateral projection. In case, when there is a suspicion of the spinal cord pathology (adhesion of the spinal cord tunics to the spinal canal walls), tumors, inflammatative processes, etc, MRI and CT are additionally performed.

Traction tests or tests with the trunk bending are used for the determining of the curvature mobility. Mobile and rigid deformations are defined depending on this.
Assessment of the risk and tendency to the deformation progressing is conducted including the following factors:

- patients gender: female patients have a higher risk of progressing;
- angle of deformation: the bigger is deformation, the higher is the risk of progressing;
- patients age: the earlier deformation occurs, the higher is the risk of its progressing, deformation progressing occurs in the "growth leap";
- bone maturity: the bigger is time after the skeleton maturation, growth zones closure, more will the deformation progress. Risser sign is used for the skeletal maturation determining – plan radiograph of the pelvis with the determining of the iliac bone apophysis maturity (Fig. 8.26). The points of this test consist in that the vertebral apophyses mature together with the iliac bone apophyses. According to this Risser 1, 2, 3, 4, 5 are defined. Risser 1 – apophysis occurrence on 1/4 of the iliac crest, and Risser 5 – merging of the iliac wing. So, in Risser 1 growth zones are opened and there is a high probability of the deformation progressing, and in Risser 5 growth zones are closed and the deformation progressing unlikely.

Mehta 1,2 radiologic signs, stability index of Kazmin, Conn’s, Movshovich, Farkas, Harrington signs are also used for the progressing assessment.

Progressing is observed in as called "growth leaps". In prognostically favorable course patient should be examined by the orthopedist for 1 time in 6 months, and X-ray should be performed 1 time a year. In prognostically unfavorable course patients is examined by the orthopedist and X-ray is performed each 4–6 months.

Deformation angle is determined at X-ray, which is performed with load (standing) in the antero-posterior projection (frontal plane). Magnitude of the deformation is calculated by the Koba and Fergusson methods (Fig. 8.27).
Treatment

Each type of scoliosis has its features of treatment. But the general issue is the progressing slowing or correction for the deformation decreasing.

Treatment of the idiopathic scoliosis is divided into conservative and operative. In deformation less than 20° according to Koba observation is performed. Deformations from 20° to 40° are treated conservatively.

The main purpose of the operative treatment – slowdown the diseases progressing. The complex of the conservative treatment includes corset therapy, exercise therapy, massage, swimming, physiotherapy. Conservative treatment is performed for the long period of time. Special boarding schools are organized in our country for children with scoliosis.

Corset has two functions – corrective and stabilizing. Boston, Sheno, Milwaukee braces are sued. A big amount of corsets were suggested, which combine cosmetic and corrective effects (Fig. 8.28).

Indication to the operative treatment of the idiopathic scoliosis is the deformation angle above 40 degrees according to Koba, deformation progressing for more than 10° a year. Surgical treatment is considered successful, when the correction of deformation is more than 50 %.

The main purpose of the operative treatment – deformation correction and conditions creation for the spondylodesis. Deformation is corrected with special fixators and the conditions for vertebral fusion into the one bone block are created. Insufficiency – loss of the part of the spinal motor function.

Several periods of the surgical treatment of scoliosis are defined. French and American orthopedic schools contributed a lot to the scoliosis surgery development (H. Harrington, Y. Cotrel and J Dubourett, L. Lenke).

H. Harrington suggested a distractor, which performed the scoliosis correction in the frontal plane. In 1980's Yves Cotrel and Jean Dubousett suggested instruments and fixators for the three-dimensional scoliosis correction – CDI (Cotrel Dubousett Instrumentation). They also suggested derotational manoeuvre, when the S-like curvature of the spine transits into physiological curves (thoracic kyphosis and lumbar lordosis) after rotation. Just these scientists were the founders of three-dimensional correction philosophy.

Current surgery of idiopathic scoliosis provides for the use of approaches to the anterior and/or posterior parts of the spine. Anterior instrumentation was suges (Dwyer). Cuk-Lenke method becomes
widely widespread, which provide for the posterior approach use with the transpedicular fixation and the spine and vertebrae derotation. Transpedicular screws and rods use allows to apply bigger corrective force to vertebrae and perform bigger correction, then using the CDI system of retractors and rods.

In deformations bigger than 80° according to Koba or significant rigid deformations combined interventions are performed on anterior parts of the spine – removal of the part of disks and nucleus pulposus (enucleation) at the top of deformation – anterior release and posterior instrumentation with transpedicular fixation. Anterior interventions in the thoracic curvature can be conducted with thoracoscopic minimally invasive technique.

In case of the juvenile idiopathic scoliosis increasing constructions are used, so the spine has the possibility to growth, which saves patients from the multiple interventions of the rod change. The system “MOST-2” was suggested by scientists from the Kharkiv institute named after MI Sitenko (Fig. 8.29).

One of the complicated issues is a treatment of congenital scoliosis. Congenital scoliosis should be operated till the 4–5-year ages. Till this age hemivertebrae are represented by cartilaginous structures, that allows to conduct their removal significantly easier and decrease the time of instrumentation.

Purpose of the operative treatment in neuromuscular scoliosis is the stop of progressing and recovery of the supporting function of the spine, that promotes the improvement of self-service in this group of patients. But surgery, in this case, does not influence the course of the main disease.

8.4. KYPHOTIC DEFORMATION OF THE SPINE

**Hump** (pathologic kyphosis) – pathologic acquired or congenital backward curvature of the spine, but more often its part, in the sagittal plane.

**According to IL Civian classification, the following are defined:**
1. Congenital humps – due to the congenital wedge-formed vertebrae, vertebral body aplasia, vertebrae synostosis.
2. Dyschondroplastic – in juvenile kyphosis, juvenile osteochondrites.
3. Involutional.
5. Acquired kyphosis after the inflammatory process in vertebrae, fractures, laminectomy.
6. Rachitic kyphosis.
Hump can spread on the entire spine and has shallow form, as it is observed in rickets, Scheuer-
mann’s disease. It more often occurs in one part of the spine and has the different form, which top is
directed backward.

Clinical manifestations. depending on the hump size and form different clinical manifestations
are observed.

Not only the chest deformation and hump size, but also imbalance between the trunk and limbs
draw attention during the examination: short, like an underdeveloped trunk and long limbs, especially
arms, as in the monkey, that are located below the knees. Chest is not only shortened, but also de-
formed: reminds chicken (keeled) chest from the front, and the hump of different sizes is determined
from behind. Neck seems shortened, head is thrown back, physiological lordoses of the cervical and
lumbar part of the spine are increased.

Contours of spinal muscles protrude under the skin below the hump as tensed reins.

X-ray investigation provides the possibility to discover the cause of the hump occurrence (con-
genital or pathologic), structures and condition of vertebrae.

Congenital kyphosis. Congenital kyphosis in newborns in most of the cases is determined, when
the physiologic curves start to deform. Early symptom – occurrence of the muscular rollers on each
side and increase (compensatory) of lumbar lordosis, head is slightly thrown back, the neck seems
short. Kyphosis and chest deformation, which obtain the keeled form from the front, increases with
the child’s growth, cervical and lumbar lordosis increase, trunk imbalance occurs, ie trunk becomes
shorter and limbs seem longer (especially upper limbs, which are located lower than knees like in mon-
keys). Respiratory amplitude of the chest is significantly limited. Children with congenital kyphosis
are not mobile, dyspnea occurs in the fast walking or running. Recurrent polyradiculitis is an often
complication in adult patients. The cause of the kyphosis occurrence is determined during the X-ray
investigation: additional wedge-form or aplastic vertebra, or vertebral fusion in the previous part of
the spine.

Juvenile kyphosis (Scheuermann - Mau disease). In the 1911 year, H. Scheuermann described
the clinical pattern of the juvenile kyphosis and considered it as the result of the spinal muscles weak-
ness. In the 1921 year, he was first, who detected the impairment of the ossification of the anterior
epiphyseal points of the vertebra at the radiograph and refer them to osteochondropathies. During
growth, vertebrae become wedge-formed with narrowing in the anterior part. Mau supplemented
the clinical pattern and pathogenesis of this process, so disease from that time is called Scheuer-
mann – Mau – chondropathy of apophysis of mainly VII–XI thoracic vertebrae. According to Schmorls
theory, the cause of the juvenile kyphosis development is cartilaginous nodules. Due to the congenital
insufficiency of the cartilaginous laminae nucleus pulposus deform them, so the static load is concen-
trated on the anterior part of vertebral bodies, applying a constant pressure on the anterior vertebral
foci of the ossification. Posterior nuclei are in the unloaded condition and grow freely, while the de-
velopment of anterior ones is delayed and vertebrae become wedge-formed in the anterior plane. Sway
back is formed.

Clinical manifestations. Expressive sway back with the compensatory increase cervical and lum-
bar lordoses draws attention during the examination. Patients complain of the low back pain during
the continuous sitting, standing, physical loads. Spinal muscles in the thoracic part of the spine are
hypotrophic, overextended, moderate tenderness in the paravertebral points is determined. Percus-
sion or pressure at the spinous processes does not cause pain. Symptoms of the intercostal neuralgia
occur in the older age. Patients get tired quickly, they are not tolerant to the physical exercises.

At the radiograph in lateral projection, the following is determined: wedge-formed vertebrae, ir-
regular contours of the endplates, Schmorl’s hernias are often, intervertebral disks height is de-
creased. Scoliotic rotation of vertebrae is sometimes determined. At the X-ray in lateral projection at
the onset of the diseases besides normal ossification foci at the anterior surface of vertebrae (nor-
mally like the triangle or flat plaque), separate ossification foci are determined or expressive irregular-
ity, blurriness of their contours. Upper and lower laminae lose their smooth surface simultaneously,
they become notched, wavy. Vertebral body loses clear structure. Vertebral body in adolescents ob-
tain the normal structure, but the vertebrae remain wedge-formed.

*Treatment* is general health-improving exercise therapy is administered, which is directed at the
kyphosis correction, spinal muscles strengthening. Braces are administered at the continuous work
in the vertical position. Children sleep in special correcting beds. Electromyostimulation of the spinal
muscles, backstroke are administered. Consciousness maintenance of the correct posture should be
formed in the child. Operative treatment is indicated in severe forms with the increasing neurologic
symptoms – wedge-form resection of the vertebra.

**Rachitic kyphosis.** In children with rickets, kyphotic deformation of the spine occur, which in-
volves all the spine; hump gets the shallow form. Rachitic hump is especially visible during sitting,
continuous standing it is typical, that rachitic hump disappears in the ventral decubitus position.

In timely rickets treatment and spinal muscles strengthening rachitic kyphosis is healed, but the
increase of the physiologic kyphosis preserves. Such children remain stooping. Also, the protrusion of
the ТХI and ІІІ spinous process remain more expressive.

*Treatment.* The main disease should be treated first of all – rickets, combining it with the inten-
sive exercise therapy, which is directed at the vertebral and spinal muscles strengthening. Backstroke,
breaststroke and front crawl, hydro- and usual massage, electrostimulation of the spinal muscles is
also effective. Child should sleep at the rough bed with the low pillow. Tempering and day regimen
also compounds treatment; labor work, exercise with long standing or physical loads on the spine are
contraindicated.

### TASKS AND TESTS

#### TASK №1

2-months old child. According to mothers words, there is the abduction limitation in the left hip joint. During
examination: skin folds are asymmetric at hips and different amount of folds, external rotation and moderate
abduction limitation in the left hip joint above 70°. To set preliminary diagnosis.

A. Congenital hip dislocation.
B. Hip subluxation.
C. Hip joint dysplasia.
D. Cerebral palsy.
E. Hip joint contracture.

#### TASK №2

To the pediatric orthopedist come parents of the 3.5 months old child. There is movements limitations in the left
hip joint according to the mothers words. External rotation of the lower limb, skin folds asymmetry at hips, sig-
nificant abduction limitation of the left leg in the hip joint. At the radiograph: acetabular index – 45° (acetabular
roof skew), hip dislocation upwards for 1 cm. Ossification focus of the femoral head is significantly smaller, than
at the opposite side, decentered relatively to the acetabulum, but does not leave its borders. Make a diagnosis.

A. Congenital hip dislocation.
B. Congenital subluxation of the left hip.
C. Hip joint dysplasia.
D. Hip joint contracture.
E. Hip joint injury during delivery.
TASK №3

During the clinical examination of the 4-months child during the gradual legs abduction – click in the left hip joint. At the pelvis radiograph: acetabular index from the left side = 40°, lateroposition of the left hip and dislocation upwards, Shenton’s line impairment from the left side and absence of the femoral head ossification. Make a diagnosis.

A. Hip joint dysplasia.  
B. Avascular necrosis of the femoral head.  
C. Hip subluxation.  
D. Congenital dislocation of the left hip.  
E. Hip joint injury during delivery.

TASK №4

Parents of the child drawn attention on the 8 week, that there are 4 folds on the right hip, and 2 on the left one. The following is determined during examination: skin folds are located asymmetrically; muscles hypotrophy of the right hip is observed. What this symptom indicates?

A. Rickets.  
B. Cerebral palsy.  
C. Perthes disease.  
D. Dysplasia of the right hip joint.  
E. Valgus deformation of the femoral neck.

TASK №5

Congenital bilateral clubfoot is diagnosed in the newborn on the 8th day. All components of the deformation are removed after the mild redressment. What treatment is reasonable to use in this period?

A. Stage plaster casts.  
B. Physiotherapeutical.  
C. Operative.  
D. Massage combined with redressment.  
E. Redressment with bandaging according to Fink - Ettingen.

TASK №6

In 3.5-year girl, congenital clubfoot of both feet was determined at the age of 2 weeks. Conducted treatment: redressment with bandaging according to Fink-Ettingen, stage plaster casts, corrective splints, orthopedic shoes. Feet deformation was corrected, but at the age of 2.5 years it occurred again and started to progress. Physical examination: deformation of both feet, equinus, supinatio, adductio are determined. Manual correction leads only to the partial removal of the deformation elements. Chose the further treatment tactics.

A. Treatment with stage plaster casts.  
B. Physiofunctional treatment.  
C. Wearing of orthopedic shoes.  
D. Operative intervention on soft tissues.  
E. Operative intervention on the feet bone tissues.

TASK №7

Boy, 3 months. From the medical history was determined, that manual assistance was used during the delivery. Moderate head bending to the left side and face rotation in the opposite side were determined during examination. Sternoceleidomastoid muscle is dense and shorter. Separate dense nodes are palpated closer to the place of its attachment to the clavicle. Make a diagnosis.

A. Dysplasia of the cervical part of the spine.  
B. Central palsy.  
C. Peripheral palsy.  
D. Consequences of the clavicle fracture during the delivery.  
E. Myogenic torticollis.
TASK №8

During the preventive examination of the 12-years old child, deviation of the internal margin of one of the scapula from the chest is determined. Contours of the scapula are well visible under the skin, muscles of the shoulder girdle are smooth and atrophic. What disease this clinical sign is typical for?

A. Ribs synostosis.  
B. Scoliotic disease.  
C. Schprengel's disease.  
D. Scapula alata.  
E. Additional ribs.

TASK №9

Child, 12 years. From 9 years is under the observation of the orthopedist for scoliotic disease. At control X-ray – scoliosis of the thoracic part, angle of the spine deviation from the axis measured according to the Cobb method consists 20°. What should be the further treatment?

B. Exercise therapy.  
C. Operative treatment.  
E. Spine fixation with the CITO-type brace with courses of the physiofunctional treatment.

TASK №10

Child, 8 years. Parents came with complains of the posture impairment, asymmetrical position of the right scapula. Examination: right scapula is lifted, shorter and wider. Its lower angle is close to the spine. Shoulder girdle asymmetry is observed; spinal axis is deviated to the right side in the thoracic part. X-ray – right scapula is smaller in size, has slightly oblique position and is located for 4 cm higher than the left one. Make the diagnosis.

A. Schprengel's disease.  
B. Scoliotic disease.  
C. Muscles palsy.  
D. Scapula alata.  
E. Scheuermann's disease.

TESTS

11. Which of the congenital impairments of the hip joint is observed more often?

A. Hip joint dysplasia.  
B. Subluxation.  
C. Luxation.

12. Which of the mentioned clinical symptoms is possible during the congenital hip dislocation diagnostics?

A. Symptom of reduction and dislocation of the femoral head.  
B. Gluteal folds asymmetry.  
C. External limb rotation on the side of affection.

13. From what age the X-ray diagnostics of the congenital hip dislocation is performed?

A. 3 weeks.  
B. 1 month.  
C. 3 months.  
D. 6 months.  
E. 1 year.

14. At what age the ossification focus of the femoral head occurs at X-ray film?

A. 3 weeks.  
B. 1 months.  
C. 3 months.  
D. 6 months.  
E. 1 year.

15. At the congenital hip dislocation presence in the children under 6 months clinical tactics provides for:

A. Observation.  
B. Exclusively conservative treatment.  
C. Operative treatment.  
D. Conservative and operative treatment.
16. Main symptoms of platypodia:
   A. Equinus, supinatio, abduction of the anterior foot part.
   B. Foot valgus, abduction of the anterior part and flexion.
   C. Foot varus and anterior equinus.
   D. Abduction of the anterior part.
   E. Foot supination andpes excavates.

   A. Till the clubfoot elements correction, but not longer than 1-year age.
   B. Till 3 years.
   C. Till 5 years.
   D. Till 6 months.

18. Operation of choice in the myogenic torticollis:
   A. Volkov’s operation.
   B. Myotomy operation of the attachment points and sternocleidomastoid muscle elongation.
   C. Myotomy operation of the sternocleidomastoid muscle attachment points according to Zacepin.
   D. Krogius operation.

19. X-ray changes in Grisel’s disease:
   A. Subluxation in the atlanto-axial junction.
   B. Absent.
   C. Additional hemivertebra.

20. The most common torticollis forms are:
   A. Myogenic.
   B. Osteogenic.
   C. Reflex.
   D. Inflammatory.
9.1. TUMOROUS AND TUMOR-LIKE DISEASES OF THE MUSCULOSKELETAL SYSTEM

Tumors of bones are included in a group of neoplasms of the musculoskeletal system, which arise from the tissues that make up the bone. A tumor arises from the reaction of the body to harmful external or internal factors and has its own individual biological properties. For benign tumors, a high degree of cell differentiation, slow non-infiltrating growth, and a lack of metastasis are characteristic. Malignant tumors are characterized by unlimited cell reproduction, loss of differentiation, the acquisition of atypism, the ability to infiltrate growth and metastasis.

The causes of development of bone tumors have not been fully studied. Ionizing radiation, genetic factors preceding benign or tumor-like tumors are among the known ones. According to the latest data, the trauma has a trigger or accompanying role rather than an etiological one. The morbidity of malignant neoplasms of bones and articular cartilages in Ukraine is 1.2 cases per 100 thousand of the population. These neoplasms in the structure of sex and age of morbidity among girls aged 0–14 years are 6.8 % and 5.6 % among young age groups of men aged 15–29 years. 63 % of patients are covered by special treatment, 38 % do not live one year after the diagnosis. Among malignant neoplasms of bones and articular cartilages of osteosarcoma constitutes 23–35 % (Fedorenko S.P., 2010). In the general structure of the incidence of malignant tumors, bone tumors are 1–2 %. Benign tumors of bones are found 2–3 times less often than malignant. The last ones are 1.5–2 times more common in men. Cancer metastases in the bone are found in 6–20 times more often than primary malignant tumors of bones.

The clinical classification of bone tumors is complex and is constantly being improved due to the detection of new forms of neoplasms. The most common classification of bone tumors for clinicians was the one proposed by S.T. Zatsepin (1981).

In 2002, WHO published the most acceptable international histological classification of bone tumors (Table 9.1). All primary bone tumors are divided into 3 groups – benign, malignant and nonspecific, borderline or uncertain behavior. In the complex diagnosis of bone tumors, it is necessary to consider the possibility of converting benign tumors and long-term tumor-forming processes into malignant tumors. In the classification there are: cartilaginous tumors (osteochondroma, chondroma, chondroblastoma, chondromixoid fibroids, chondrosarcoma and its varieties); osteogenic (osteoid osteoma, osteoblastoma, osteosarcoma and...
### Table 9.1. Classification of bone tumors (International classification of diseases-10, 2002.)

<table>
<thead>
<tr>
<th>THE TISSUE FROM WHICH THE TUMOR ORIGINATES</th>
<th>TUMOR</th>
<th>BENIGN</th>
<th>MALIGNANT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osteogenic tumors</td>
<td></td>
<td></td>
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<tr>
<td>Osteoid osteoma</td>
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<td></td>
<td>Conventional osteosarcoma: chondroblastic fibroblastic osteoblastic telangiectatic small-cell</td>
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<tr>
<td>Osteoblastoma</td>
<td></td>
<td></td>
<td>Low degree of malignancy, central</td>
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<td></td>
<td></td>
<td></td>
<td>Secondary</td>
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<td></td>
<td></td>
<td></td>
<td>Parosteal</td>
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<td></td>
<td></td>
<td></td>
<td>Periosteal</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>High degree of malignancy, superficial</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Chondrosarcoma central, primary, secondary peripheral dedifferentiated mesenchymal clear cell</td>
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<td></td>
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<tr>
<td>Fibrogenic tumors</td>
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<td></td>
<td>Fibrosarcoma</td>
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<tr>
<td>Fibrohistiocytic tumors</td>
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<tr>
<td>Ewing’s sarcoma (primitive neuroectodermal tumor)</td>
<td></td>
<td></td>
<td>Ewing’s sarcoma</td>
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<tr>
<td>Hematopoietic tumors</td>
<td></td>
<td></td>
<td>Plasma cell myeloma Malignant lymphoma</td>
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<tr>
<td>Giant cell tumors</td>
<td></td>
<td></td>
<td>Malignant giant cell tumor</td>
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<tr>
<td>Chordal tumors</td>
<td></td>
<td></td>
<td>Chordoma</td>
</tr>
<tr>
<td>Vascular tumors</td>
<td></td>
<td></td>
<td>Angiosarcoma</td>
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<tr>
<td>Smooth muscle tumors</td>
<td></td>
<td></td>
<td>Leiosarcoma</td>
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<tr>
<td>Lipogenous tumors</td>
<td></td>
<td></td>
<td>Liposarcoma</td>
</tr>
<tr>
<td>Neural tumors</td>
<td></td>
<td></td>
<td>Neurilemmoma</td>
</tr>
<tr>
<td>Various tumors</td>
<td></td>
<td></td>
<td>Adamanthoma Metastatic tumors</td>
</tr>
<tr>
<td>Various lesions</td>
<td></td>
<td></td>
<td>Aneurysmal bone cyst Simple solitary bone cyst Fibrous dysplasia Osteofibrotic dysplasia Langerhans cell histiocytosis Erdheim-Chester disease (lipoid granulomatosis) Hamartoma of the chest</td>
</tr>
<tr>
<td>Joint lesions</td>
<td></td>
<td></td>
<td>Synovial chondromatosis</td>
</tr>
</tbody>
</table>

its varieties); fibrogenic tumors; fibrohistiocytic; Ewing's sarcoma; hematopoietic tumors; chordal; vascular smooth muscle; lipogenous; neural, various tumors, various lesions (aneurysmal bone cyst, simple cyst, fibrous dysplasia, osteofibrosis dysplasia, etc.), joint lesions.
Among the clinical classifications in the world, the most common classification of malignant tumors is according to the TNM system, developed by the American Joint Cancer Committee (AJCC). This system is used in determining the stages and clinical groups of malignant bone tumors and is regularly supplemented.

**Clinical classification of bone tumors using the TNM system (7th edition, 2009)**

- **T** – primary tumor.
- **T<sub>x</sub>** – insufficient data to estimate the primary tumor.
- **T<sub>0</sub>** – primary tumor is not detected.
- **T<sub>1</sub>** – tumor <8 cm in the largest dimension.
- **T<sub>2</sub>** – tumor >8 cm in the largest dimension.
- **T<sub>c</sub>** – tumor without clear outlines in the affected bone.
- **N** – regional lymph nodes.
- **N<sub>x</sub>** – insufficient data to determine regional lymph nodes.
- **N<sub>0</sub>** – no signs of metastatic involvement of regional lymph nodes.
- **N<sub>1</sub>** – regional metastatic nodes are affected by metastases.
- **M** – distant metastases.
- **M<sub>x</sub>** – insufficient data to determine distant metastases.
- **M<sub>0</sub>** – there are no signs of distant metastasis.
- **M<sub>1</sub>** – there are distant metastases.
- **M<sub>1a</sub>** – metastases into the lungs,
- **M<sub>1b</sub>** – metastases to other distant organs.
- **G** – histopathological differentiation.
- **G<sub>x</sub>** – the degree of differentiation cannot be established.
- **G<sub>1</sub>** – high degree of differentiation.
- **G<sub>2</sub>** – middle degree of differentiation.
- **G<sub>3</sub>** – low degree of differentiation.
- **G<sub>4</sub>** – undifferentiated tumors.

<table>
<thead>
<tr>
<th>GROUPING BY STAGES:</th>
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<tbody>
<tr>
<td>Stage IA</td>
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<tr>
<td>Stage IB</td>
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<td>Stage II A</td>
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<td>Stage II B</td>
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<tr>
<td>Stage III</td>
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<tr>
<td>Stage IVA</td>
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<td>Stage IV B</td>
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</table>

Clinical, instrumental and laboratory methods of studying patients with tumors and various bone lesions are aimed at early detection of diseases with the goal of choosing the right treatment method. Not only the health, but also the patient’s life depends on this. Difficulties in diagnosis are due to the fact that bone tumors in the early stages of development have very few objective clinical signs.

9. Inflammatory, tumorous and tumor-like diseases of the musculoskeletal system
Clinical examination includes a thorough examination of the history of the disease. The main symptom for bone tumors is pain. In malignant neoplasms, it is expressed constantly and intensely, and when benign – it is absent altogether or disturbs the patient a little and only with physical activity. Local swelling, pain during palpation, impaired function, pathological fracture are late signs of bone cancer. In malignant tumors of bones, local signs of the disease and the general condition of the patient change rapidly. A slow increase in the size of the tumor and a prolonged stable condition of the patient indicate the presence of a benign neoplasm.

However, a well-studied case history and systematic observation of the clinical course of the disease are not decisive for determining the nature of the lesion, since without sufficiently competent interpretation of them they often lead to diagnostic errors. The correct diagnosis can be established only when comparing the results of the survey, obtained by at least three specialists – an oncologist or orthopedist, radiologist and pathomorphologist. A standard examination for suspected malignant bone tumors should include an oncologist's consultation, a general and biochemical blood and urine test, radiography and CT of the affected area and lungs, ultrasound of the abdominal organs and necessarily histological examination; on indications – osteoscintigraphy, MRI and consultation of related specialists. In the planning of treatment of patients with malignant bone tumors after the verification of the diagnosis, an oncologist or orthopedist, an oncologist (chemotherapist) and a radiation therapist must participate.

BENIGN BONE TUMORS

Benign bone tumors have clear contours, are characterized by well-marked boundaries from surrounding tissues, grow slowly, sometimes for years, pushing apart surrounding tissues. They don't give metastases and rarely recur after radical treatment. X-ray picture is characterized by the correct form of the tumor and its structural pattern, precise contours, the correctness of the processes of ossification and the normal degree of calcification. Microscopic manifestations of this group of tumors are distinguished by cellular and nuclear polymorphism, the absence or low mitotic activity, the absence of infiltrating growth. The general condition of the patient does not deteriorate.

Benign bony tumors occur with mild clinical manifestations and without disturbance of the general condition of a person. The exception is osteoid osteomas that grow inside the medullary canal. They are accompanied by severe pains that are constantly increasing, leading to an acute weight loss due to poor sleep and appetite.

In most cases, bone tumors are single. Multiple (polyossal) bone lesions are associated with the nature of the tumor or the pathways of distribution of metastasis.

Osteoid-osteoma

Young people are affected most often – from 10 to 25 years, mostly men, the tumor is more often localized in the femur and tibia.

Clinical picture. The main clinical manifestation is intense persistent nocturnal pain in the affected bone, which lasts for months. It is characteristic that pain occurs more often at night, does not subside during the day, is temporarily removed by strong analgesics (Ketanov). In long-term ill patients, lameness appears, muscle atrophy, contracture occurs.

Radiologically, or more precisely – according to CT, in the cortical layer of the bone, rounded bleaching (fig. 9.1) of small dimensions is revealed, the so-called "nest" (up to 1 cm). The cortical layer around is thickened and sclerosed (hyperostosis).
Morphologically lesion consists of osteoid tissue, trabeculae, osteoblasts, osteoclasts. Osteoid-osteoma is differentiated with tuberculosis of bone, osteoma, sclerosing osteomyelitis of Garre, Ewing's sarcoma. Treatment is operative – marginal resection of the bone with the removal of the tumor and the sclerosis zone.

Osteoma

Diseases occur at any age. The main clinical symptom of osteoma is unstable pain. The defining symptom in palpation of osteoma is a dense, painless formation, united with the bone.

There are 3 types of osteomas: a) dentate; b) compact; c) an intermediate form, in which the tumor consists of a cortical and a spongy substance.

Tumors of compact bone more often affect the bones of the skull. Spongy and intermediate ones are more often localized in long tubular bones, mainly the thigh and shin. The osteoma is solid, motionless, painless. Tumors are single and have a different shape and size. They can have a wide base, and sometimes a narrow leg. Osteoma is characterized by slow growth.

The main radiologic symptom of osteoma: a tumor of the spongy bone structure on a wide basis. The cortical layer of the maternal bone passes, not breaking integrity, into the cortical layer of the osteoma (fig. 9.2).

Osteomas of small sizes often occur asymptptomatically and are detected accidentally during X-ray examination on another occasion. With growth in the cavity of the skull they can bring functional disorders.

Microscopically the tumor does not differ from mature bone tissue.

Osteoma is differentiated with osteoid-osteoma, exostosis.

Treatment of osteoma is surgical. The tumor is removed along with the base within the healthy bone tissue. Radical surgery excludes relapse of the tumor.
Osteochondroma

Osteochondroma occurs more often in adulthood. Pain syndrome occurs when the tumor reaches a large size. Osteochondroma can reach a gigantic size. As a rule, it is solitary, but there are also multiple osteochondromas. More often the tumor originates from the upper third of the humerus, scapula, pelvis, femur and tibia.

**Clinically,** in the affected area of the skeleton, a painless tumor first appears, slowly increasing in size. When the tumor reaches a significant size, there are pain and impaired function.

**The radiological** appearance is characteristic – the tumor resembles a cauliflower, develops from the surface layers of the bone (fig. 9.3). Its surface is tuberous, but the contours are distinct. It consists of bony islets, located among the cartilaginous tissue. The cartilage component is better seen on CT.

**Histologically** the tumor contains mature bone tissue in the form of islets and a cartilaginous tissue.

**Treatment** consists in the marginal, or wedge-shaped resection of the bone within the healthy tissue. Partial or untimely removal of the tumor leads to transformation into the chondrosarcoma or to a relapse.

**The prognosis** with adequate surgical intervention is favorable. It should be taken into account that the tumor has large potential signs of malignancy.

Chondroma

The disease occurs in children and adolescents. Chondroma, which is located on the surface of the bone, is called the **enchondroma**, and located centrally – **enchondroma**.

The tumor affects primarily the tubular bones of the extremities, more often the phalanxes of the fingers, and also the metacarpal bones.

Chondromas are often multiple (multiple chondromatosis).

**Clinical picture.** Chondroma courses without symptoms for a long term. First, there is pain after trauma, physical activity, swelling, then deformation.
**Radiologically:** the main symptom of the chondroma is the presence of a lesion focus with clear contours. The tumor has a spherical or oval shape, clear boundaries. On the site of the chondroma, the area of enlightenment and unstructured bone substance are revealed (fig. 9.4).

**Macroscopically** the tumor tissue is a compact whitish mass, which has a granular structure and resembles a cartilaginous tissue.

**Microscopically** it's hyaline cartilage of varying degrees of maturity, chondral cells are placed randomly. Among the cartilage cells there may be droplets of lime.

**Chondroma is differentiated** with chondroblastoma, osteochondroma, chondrosarcoma.

**Treatment.** Chondromas are operated by intraosseous resection of the tumor within healthy tissues with bone defect plastics.

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**Chondroblastoma**

Chondroblastoma is a benign cartilaginous tumor, occurs in 1% of cases. It is more often localized within the epimetaphys of long bones. Malignancy of the tumor is possible.

**Clinical picture.** Moderate soreness in the bone at the site of tumor localization, impaired function of the joint are present. On X-ray in the central part of the epimetaphysis there is a lesion site, which has the form of an inhomogeneous rarefaction of the bone structure (fig. 9.5).

**Treatment** is surgical: tumor excochleation to healthy bone, coagulation of cavity walls, defect plasticity by autogenous bone graft or hydroxyapatite.

**Microscopically** the tumor consists of chondroblasts – cells with rounded nuclei and light cytoplasm.
Osteoblastoklastoma (giant cell tumor)

This disease occurs more often at the age of 25–35 years, but can manifest in adolescents, and in old age.

The process is localized in the epimetaphyseal sections of the tubular bones, in the spongy tissue, but it can be in the ribs and very rarely in the vertebral bodies. Often one bone is affected. Tumor growth leads to the destruction of bone structure, thinning, and sometimes to the breakthrough of the cortical layer. Typically, cartilage surfaces of the joint are a barrier that prevents the penetration of the tumor into the joint.

There are cellular-trabecular, lytic, mixed forms.

Clinical picture: for a long time, the tumor does not give any manifestation and it is not very symptomatic. Often the first sign of the disease is the appearance of constant pain, swelling, local increase in the size of the limb, a violation of the function of the joint. Sometimes, as a result of the destruction of a significant part of the epimetaphysis, a pathological bone fracture occurs. Then, during palpation it is possible to feel the typical parchment creping, aching pain in the area of the tumor. In the course of the development of the disease the symptoms grow. The dense tumor is palpated, the skin over the tumor has a pronounced structural pattern; there is a restriction of movements in the joint, intensifying pain.

On the X-ray On the X-ray, a picture is characteristic that consists of the enlightenment of the metaphysis in the form of a cysts cluster of various sizes, separated from each other by distinct partitions, which, with the progression of the GCT, lose their clarity. The cortical layer of bone is thinned and swollen, the periosteum does not react, the articular layer is never affected. The tumor resembles a cluster of soap bubbles. The site of destruction usually has a size of 10 × 6 cm in the metaphysis (fig. 9.6).

Macroscopically the tumor tissue is loose, has the appearance of brown, brown-yellow bunches.

Microscopically the tumor consists of round and spindle-shaped cells (osteoblasts) and multinucleate giant cells with multiple nuclei (up to 100 in one cell) – osteoclasts. The reddish-brown tissue of the biopsy contains many multinucleated giant cells. Osteoblastoklastoma in 15 % of cases is detected in the primary malignant form.

![X-ray bones of the forearm: GCT of the distal epimetaphysis of the radius. Cell-trabecular type: bulbous bloating, absence of bone structure, acute thinning of cortical layer](image)

Fig. 9.6. X-ray bones of the forearm: GCT of the distal epimetaphysis of the radius. Cell-trabecular type: bulbous bloating, absence of bone structure, acute thinning of cortical layer
Osteoblastoklastoma is differentiated with osteogenic sarcoma, tuberculosis, osteofibrodystrophy.

Treatment of osteoblastoclastoma is surgical. It is necessary completely, within the healthy bone, to resect the tumor, and replace the resulting defect with an auto-, homo- or heterograft. In cases of a large lesion of 2/3 of the diameter of the bone, the pathological fractures resection of the affected bone and endoprosthetics are used. When it is impossible to make a resection of the affected area, a severe.

Treatment for malignant GCT is carried out according to the scheme of treatment of osteosarcoma.

Prognosis: despite the complex treatment is not very favorable, relapses have rate from 20 to 50 %.

Fibrous dysplasia

The disease begins in childhood, although it can appear in young and adulthood, probably due to the replacement of bone tissue by fibrous one. Mono-, oligo-, and poly-osseous, diffuse and focal forms are possible. Various bones of the skeleton can be affected, but more often – metaphysis and diaphysis of long tubular bones, ribs and skull. Epiphysis, as a rule, does not suffer. Fibrous dysplasia can be combined with Albright syndrome.

Clinical picture depends on localization. Gradually, the bending and/or shortening of the bone occurs due to the slowing down of osteogenesis. A pain, neurological (skull, vertebrae), symptoms of joint function and pathological fracture may occur.

X-ray signs of fibrous osteodysplasia (fig. 9.7):
- presence of foci of rarefaction, densification of the cortical layer, absence of the medullary canal, deformation and uneven thickening of the bone contour;
- pathological fractures, thinning of the cortical layer;
- in the diffuse form, the lesion of the bone is uneven; a moderate or significant swelling of the metaphysis and diaphysis combined with a wavy homogeneous low-intensity darkening (a symptom of "frosted glass") or an inhomogeneous dimming, which is associated with the replacement of bone tissue, when bone tissue is repaired, uniform osteosclerosis occurs without differentiation of the cortex and spongy tissues;
- in focal lesions, one or more foci of oval shape, located intra-, subcortically or intra-medullarily, bounded by a clear rim of sclerosis, a characteristic swelling of the bone at this site. Deformations, pathological fracture, foci of bone repair are possible.

Conservative treatment is ineffective. The operative consists in excochleation and bone plastics of the pathological focus, less often it is resection, in pronounced deformations – corrective osteotomies.

Fig. 9.7. Fibrous dysplasia of the humerus and femur
Hemangioma

Hemangioma occurs in young or old age, more often in women. Among the bones of the skeleton, hemangioma is more often affected by the vertebrae and bones of the skull, especially the frontal and parietal, less often – tubular bones, pelvis.

**Clinical picture.** Typical clinical manifestations are pain, functional and neurological disorders caused by compression of the brain or spinal cord. When it is located inside the bone, a solid, unmoving, moderate swelling is noted, and when it is released outside, a soft new growth is palpable, which is easily squeezed and can change in size.

**Radiologically** oval or round enlightenment of the oval shape with scalloped contours reveals. The structure is foveolate, the delineation is clear, the bloating is moderate. When the body of the vertebra is damaged, it is enlarged, cellular with membranes, resembles a barrel.

**Microscopically.** Cytologically, blood is present. Histologically: the picture consists of vessels lined with a homogeneous endothelium.

**Treatment.** Radiation therapy, especially in hard-to-reach areas (vertebrae), or puncture vertebroplastics are used. For available sites it is surgical removal of the tumor within a healthy tissue.

**Prognosis:** with timely treatment it is favorable.

**MALIGNANT BONE TUMORS**

*Malignant bone tumors* are characterized by aggressive clinical course, rapid infiltrating growth, do not have clear boundaries from healthy tissue and metastasize, more often into the lungs, less often – to the bones of the skeleton. It relapses even after radical treatment. On X-ray it is characterized by contours of irregular shape, destruction of bone tissue with the formation of an edge defect or intraosseous focus, disordered structural pattern, irregular uneven ossification and calcification, periosteal reaction. Microscopically cellular and nuclear polymorphism, a violation of structural and cellular differentiation, high mitotic activity with a significant number of pathological fission patterns, structural and cellular atypism of the structure are significantly expressed. The general condition of the patient deteriorates rapidly.

**Osteogenic sarcoma**

Osteogenic sarcoma occurs more common among primary malignant bone tumors. Osteogenic sarcoma is 35–50 % of all malignant tumors of bones, more often affects people of 10–25 years old, but can occur even in old age (Fedorenko S.P., 2002). The morbidity of osteosarcoma, according to the European Community of Medical Oncology (ESMO) is 0.3 cases per 100 000 population per year. The peak incidence falls on adolescence with a median of 16 years. Twice as many men are sick. Mortality is 0.15 cases per 100 thousand population per year.

The tubular bones of the limbs and pelvis are mainly affected: in the first place (80 %) takes the bones forming the knee joint, the distal femur, the proximal tibia, and rarely it is the shoulder and other bones. Osteogenic sarcoma spreads to adjacent parts of bone and soft tissue.

Developing near the joint, the tumor usually does not cross the boundaries of the germ or articular cartilage, which distinguishes this disease from chondrosarcoma.

**Clinical picture.** The tumor develops unexpectedly, for no reason. Cases of development of osteogenic sarcoma at the background of long-term chronic osteomyelitis and Paget’s disease are described. The tumor grows rapidly.
The dominant symptom is persistent pain in the area of the focus, which are of a growing permanent character. Effective drugs are only drastic or narcotic analgesics. Limitation of movement is developed, there is lameness. The swelling quickly increases. The skin becomes shiny. Through the skin, a network of veins is visible. In palpation, the tumor is sharply painful, of a hard-elastic consistency. Lymph nodes are rarely affected. Patients lose sleep, appetite. Very quickly there are metastases in the lungs. More often the lesions by metastases develops already at 6–8 months.

A blood test reveals a decrease in hemoglobin, leukocytosis, an increase in ESR. On X-ray: the tumor has no clear boundaries (fig. 9.8). According to X-ray signs, 3 forms of osteosarcoma are distinguished: osteoblastic, osteolytic and mixed.

Osteoblastic OS is characterized by pronounced processes of pathological bone formation, the formation of osteogenic tissue in the tumor. Due to irritation and delamination of the periosteum, the development of bone needles, the so-called spicules, placed transversely to the bone is characteristic.

In osteolytic sarcoma – the process of destruction, lysis of the bone tissue prevails, often there are pathological fractures. More often manifested by destruction with fuzzy contours, periosteal reaction. Periodontal marginal growths at the base of the tumor – a defect in the cortical layer (Codman’s peak or triangle) is a hallmark of osteolytic osteosarcoma.

The examination must include:

- laboratory blood test, including level of alkaline phosphatase, creatinine clearance;
- Ultrasound of the abdominal cavity;
- consultations of an oncologist, chemotherapist, radiologist, therapist;
- X-ray examination of the affected area and lungs;
- CT of the affected area and lungs;
- osteoscintigraphy;
- incisional biopsy of the tumor (with trepan or open) for up to 10 days with morphological examination of the biopsy material, according to indications – immunohistochemical examination.

Macroscopically, the tumor has a whitish color, resembling fish meat. Microscopically it is fusiform polymorphic cells (osteoblastic osteosarcoma).
Treatment is combined (chemotherapy and surgery), amputation or exarticulation of the limb. Amputation is done to eliminate intolerable burning pains. Radiation therapy has little effect on the course of the tumor. The outlook is unfavorable. Five-year survival rate ranges from 15–20 % with a purely surgical and up to 55–70 % with combined treatment.

Chondrosarcoma

Chondrosarcoma can develop in any part of the musculoskeletal system, which includes cartilage; occupies the second place in frequency (from 10 to 16 %) among primary malignant tumors of bones after osteogenic sarcoma.

Chondrosarcomas affect people of middle and old age. They are conditionally divided into primary and secondary. Secondary chondrosarcomas include regenerated from chondromas, osteochondrosis, chondroblastoma, cartilaginous dysplasia (Ollier’s disease).

Clinical picture of chondrosarcoma is characterized by the appearance of a tumor that grows slowly and has no symptoms for a long time, during which it can reach considerable dimensions. Subsequently, pain and disruption of the function of the nearby joint appear. Chondrosarcoma does not metastasize for years. It destroys articular cartilage at growth.

According to X-ray (fig. 9.9): it is a tumor with a broad crus with indistinct contours and borders, with a homogeneous and diffuse pattern or spotted pattern. The histological picture is characterized by the presence of large cartilaginous cells with one or more nuclei. There are 5 varieties of chondrosarcoma, which are given by frequency: central, primary, secondary; peripheral; undifferentiated; mesenchymal; bright cell. It is differentiated with osteosarcoma.

Treatment is bone resection within healthy tissues. Radiation and chemotherapy are ineffective. Mesenchymal forms of chondrosarcoma are treated by a combined method according to the scheme of osteogenic sarcoma. The prognosis is more favorable than with osteosarcoma.

Ewing’s sarcoma

The disease affects people of young age. Ewing considered the origin of the tumor related to the endothelium of the lymphatic vessels of the bone marrow. The process takes place simultaneously in the medullary cavity, and in the Havers channels. The tumor is localized in the diaphysis of long tubular bones. It has the feature that quickly gives multiple metastases to the lungs and bones.

Clinical picture. The disease begins with the appearance of pain, swelling, increase in local and general temperature (38–39 °C). In the blood leukocytosis (15–20 thousand), ESR 50–70 mm per hour is detected. Clinically, the disease resembles osteomyelitis. The skin turns red, the temperature rises. At times, the condition of the patients improves, local events subsided, the swelling decreases, but after a while the disease flares up with renewed vigor.
On the X-ray (Fig. 9.10): due to the periodic detachment of the periosteum, a periosteal shell is formed around the bone, which has a number of layers resembling platelets of onions. Bone marrow at the beginning of the disease expands and narrows in the late stages. Microscopically, the lesion consists of homogeneous cells in which the nucleus occupies almost the entire cell, there is no intermediate substance.

**Treatment.** The main treatment for Ewing’s tumor is chemotherapy and radiation therapy. Radiation is carried out in 2 stages up to 60 Gray. If the effect of treatment is temporary, amputation of the limb is made.

**Prognosis** is unfavorable. After radiation treatment only 10 % of the diseased live 5 years. After combination with chemotherapy, survival is increased by 40 %.

Metastases in the bone

Metastases in the bone are found in 6–20 times more often than primary sarcomas of bones. Cancer of the lungs, breast, kidneys, myeloma metastasizes in the bone more often, less often it is the thyroid gland, prostate, lymphoma and others. Metastases can be located in any bone, but are more often in the vertebrae, pelvis, tubular bones and skull, it is less often in the ribs.

Often at the beginning, metastasis is detected in the bone, while the localization of the primary tumor has not yet been established. In such cases it is necessary to thoroughly examine the patient in order to reveal the primary focus. In 15–20 % of the cases of the primary focus is not found even with autopsy.

**Symptoms** of metastatic bone tumors vary depending on localization. First of all, they manifest with severe pains, which are intensified by pathological fractures. Later, tumor growth is detected, the function of the affected skeleton is impaired.

**Treatment** is carried out according to the scheme of treatment of the IV stage of the corresponding cancer. Solitary metastasis is removed, with expectation of recovery of the patient, multiple treat conservatively, with the expect of pathological fractures, in which osteosynthesis is performed in order to improve the quality of life of the patient.

The prognosis is unfavorable.

**TUMOR-LIKE BONE DISEASES**

Such bone lesions include pathological processes that, according to clinical-X-ray and structural features, are close to tumorous, while remaining favorable in its prognosis.

Diagnostics of these lesions is often complicated, and an erroneous diagnosis can lead to inadequate, overly radical medical measures that can lead to a patient's injury.

**Solitary bone cyst**

This is a single mono- or multi-chamber cavity, located in the proximal metaphysis of long bones, primarily the shoulder, femoral, tibial and fibular. The disease is mainly observed in childhood and ado-
lescence (5–10 years), more often in boys. The etiology and pathogenesis of the disease remains unexplained until now. Often the occurrence of a cyst is associated with osteodystrophic processes.

The solitary bone cyst is asymptomatic, slowly developing. The disease is diagnosed after a minor injury, resulting in a pathological fracture. A significant displacement of fragments, rough deformation, massive hemorrhage in the fracture region, as a rule, does not happen. With this, the pain is insignificant, it increases with palpation, the function of the adjacent joint is not significantly disturbed.

Crucial role in the diagnosis of solitary bone cyst belongs to the X-ray examination (fig. 9.11). In the metaphyseal region, a focal osteolytic character with a uniform spindle-shaped swelling of the bone is determined (fig. 9.11).

The vast majority of scientists in the analysis of clinical and radiological manifestations of the disease distinguish several phases of the development of the process: phase I – osteolysis, II – delimitation, III – recovery.

In phase I the focus of destruction has the form of uniform bleaching, without clear boundaries, with uniform thinning of the cortical layer of bone. In the II phase there is a thin layer of sclerotized bone around the focus, clearly limiting the cyst. There is a spindle-shaped swelling of the bone. In the III phase the zone of sclerosis around the pathological focus is amplified and increased, in the focus there are calcareous sediments, membranes from the bony beams, due to which the coarse-grained pattern of the cell is determined. The first two phases of the current are considered active when the solitary bone cyst tends to develop, and the third phase is considered passive, as the disease gradually regresses.

The puncture cyst is important for diagnosis. During the I–II phases of the course, a bloody liquid is released from the cavity under pressure, and in the III phase, the yellow liquid drops.

Microscopically, the structure of the lining covering the inner surface of the solitary cyst is represented by a stringy fibrous tissue with a moderate number of cells of the fibroblast type. There are sediments of lime, osteoid structures of round shape.

Differential diagnosis should be carried out with a giant-cell tumor.
**Treatment** of solitary bone cysts is currently considered depending on the course phases. In the first two phases, preference is given to minimally invasive, puncture therapies (washing the cavity with amicaproic acid solution followed by powdered hydroxyapatite ceramics, prednisolone). In the third phase, intraosseous resection of the bone with plastics of the cavity with hydroxyapatite ceramics, autogenous bone graft or a its mixture is used. In the presence of a pathological fracture, fixation is performed with a plaster splint. Recovery comes with adequate treatment of solitary bone cyst.

Aneurysmal bone cyst

The etiology and pathogenesis of the disease has not been fully elucidated. The origin of cysts is associated with osteodystrophic processes.

The disease manifests itself as a single focus. It is rare, occurs mainly in 10–20 years of age, equally common in girls and boys. The main location of the aneurysmal bone cyst is the vertebrae. Then it is the femur, tibia (diaphysis) and pelvic bones.

One of the main clinical signs of the disease is pain. It is unstable, has low-intensity, increases with physical activity. With the development of the process, the pain intensifies and becomes permanent. With the damage to the vertebrae, the pain has a progressive nature. In this localization, the disease is complicated by the compression of the spinal cord or its roots.

An important sign is also a swelling above the lesion. Palpation of swelling causes pain, sometimes crepitation may occur. Skin over the site of the lesion have an elevated temperature, there is an expansion of venous vessels.

With X-ray, an eccentrically located unstructured lytic focus of destruction is defined. It sometimes has a cellular structure in the form of "soap bubbles" with a sharp thinning of the cortical layer of the bone in the form of an "egg shell". The periosteal reaction is not very pronounced (fig. 9.12).

As in the case of solitary cysts, in the analysis of clinical and radiological manifestations of aneurysmal cysts, three phases of the development of the process are distinguished with corresponding changes reflecting the dynamics of the disease. The duration of clinical symptoms is from 1 month to 3 years.

**Fig. 9.12. X-ray of the shin bones: A–B – aneurysmal bone cyst of the upper third of the fibula in the stage of osteolysis; C–D – 6 months after a minimally invasive puncture osteoplastic operation with filling the cavity of the cyst with a powdered biological osteopatite, alloyed with copper: against the background of the restoration of bone structure, a decrease in bone density is present, ceramic cells are contoured, the degree of osteopatite biodegradation is significant**
Puncture of the cyst cavity with subsequent examination of the punctate is mandatory. At the I-II phases of the course, blood is released from the cavity under pressure, at III bloody liquid drops.

Microscopically, the inner surface of the aneurysmal bone cyst, including the septa, is represented by a filament fibrous tissue. It determines a significant number of cells such as osteoclasts and thin-walled blood vessels, sometimes foci of calcification. The aneurysmal bone cyst is differentiated necessary with a giant cell tumor and osteosarcoma.

**Treatment** of an aneurysmal bone cyst located in the diaphysis of the long bone is now considered similarly to a solitary one, depending on the phases of the course. Relapses are possible. When the lesion is localized in the spine, the resection of the affected vertebra with subsequent plastic surgery is considered the most rational.

## 9.2. INFLAMMATORY DISEASES OF THE MUSCULOSKELETAL SYSTEM

### Rheumatoid arthritis

Rheumatic diseases of joints are considered as one of the most common pathologies of modern society worldwide. In the classification of the American Rheumatological Association, there are XIII groups of rheumatic syndromes and diseases distinguished with a total number of more than 100 titles. The same number of groups includes the domestic classification "Classification and Nomenclature of Rheumatic Diseases".

In Ukraine, according to prevalence, rheumatic diseases occupy the third place after diseases of the cardiovascular and digestive organs and make up about 10 %. That means, more than 4 million people suffer from them.

Rheumatoid arthritis (RA) is an autoimmune systemic connective tissue disease characterized by symmetrical erosive arthritis (synovitis) and a wide spectrum of extra-articular (systemic) manifestations with chronic progressive course and predominant joint damage, development of persistent limb deformities, impaired function, working capacity loss and patient disability.

The disease can begin at any age. However the increase of RA with age is noted. The peak of morbidity rate falls on the age of 40 to 50 years and persists to 70 years. Five years after the onset of the disease, up to 60 % of patients lose their ability to work, and after 20 years – 90 %, a third of whom become disabled. Within 5 years of illness, about 30 % of the joints are affected, within 20 years – 50 %.

A significant importance in the development of the RA belongs to the hereditary factor. A controversial issue is the role of an infection, mainly viral, in the development of the disease. Special attention requires Epstein – Barr virus, which can persist in lymphocytes for a long time, impairing the synthesis of immunoglobulins. People with congenital inferiority of immunoregulation tend to have RA. It is not ruled out that the direct triggering factor of the disease is an infectious agent, which has not yet been identified. The main links of the etiopathogenesis of RA can be represented as follows (fig. 9.13).

The basis of pathogenesis of RA is the development of immunopathological reactions – the syndrome of immunocomplex disease. The factor of such a reaction is a violation of the regulation of the immune response as a result of imbalance of the function of T- and B-lymphocytes, namely: immunodeficiency of the T-lymphocyte system, which leads to uncontrolled synthesis of B-lymphocytes of anti-
bodies, in particular IgG. If the joint is affected by the etiologic factor of the synovial membrane of the joint, a local immune reaction arises with the formation of aggregated (altered) IgG possessing autoreactivity, which allows them to react in the "antigen-antibody" type.

RA is considered as a polyetiologic disease, which is determined by a complex combination of genetically determined and acquired defects ("unbalance") of regulatory mechanisms that limit the pathological activation of the immune system in response to potentially pathogenic, and often physiological stimuli, which leads to rapid transformation of the physiological (protective) acute inflammatory reaction to chronic progressive inflammation, which is its inherent feature.

According to ICD-10, all cases of RA are divided into seropositive and seronegative.

The main indicators of the activity of RA are shown in the fig. 9.14.

In recent years, an important indicator of the activity of the process is the level of hemoglobin. In the absence of other factors of anemia (bleeding of gynecological genesis, gastrointestinal, CRF, etc.) a decrease in hemoglobin below 100 g/l indicates an active pathological process.

The following X-ray stages of the RA are distinguished (according to Steinbroke):

- I – periarticular osteoporosis;
- II – osteoporosis + narrowing of the joint space (there may be single usuras – to 5 usuras);
- III – the same + multiple usuras (more than 5 usuras);
- IV – the same + bone ankyloses.

According to clinical and anatomical characteristics there are:

- monoarthritis, oligoarthritis, polyarthritis;
- a combination of lesions of the RA in systemic manifestations: a lesion of the reticuloendothelial system, serous membranes, lungs, heart, vessels, kidneys, eyes, nervous system, organs amyloidosis.
Fig. 9.14. RA activity indicators. The combination of these indicators provides a basis for determining the degree of activity in scores: zero − 0 scores; I − 8 scores, II − 9–16 scores; III − 17–24 scores

A common assessment of the functional state of the joints distinguishes four degrees:

- FJI 0 – joint function is preserved;
- FJI I – the inability to perform work associated with physical activity, walking;
- FJI II – impossibility of performing any professional work, corresponding to the II group of disability;
- FJI III – loss of the ability of self-service (group I disability).

In the scientific and practical sense the clinical, radiological and pathomorphological classification of RA, suggested by E.T. Sklyarenko and V.I. Stetsula, is reasonable. According to it, there are:

- I stage – synovitis (acute, subacute, chronic);
- II stage – productive-destructive panarthritis (damage to all elements of the joint), which has three phases:
  - exudative-proliferative;
  - proliferative-destructive;
  - destructive-sclerotic;
- III stage – ankylosis (fibrous, osseous).

The articular syndrome is leading in the clinical picture of RA. In the initial period of the disease, in 2/3 of the patients a symmetrical arthritis of the small joints of the hands and feet is noted, in 1/3 –arthralgias, which increase with movement. In 8–15 % of the cases the disease begins acutely in several days, in 15–20 % of cases, RA begins unnoticeable.

The provoking factor may be an infection (acute or exacerbation of chronic one), hypothermia, trauma, physical or nervous overexertion. In 79 % of patients the development of the disease was preceded by influenza, angina, exacerbation of chronic tonsillitis, sinusitis, otitis, cholecystitis and other foci of chronic infection. Usually in 1–2 weeks after this, the first signs of arthritis appear. There is also a link between the onset of the disease and meteorological factors (frequent development of the disease in spring and autumn), as well as with periods of physiological allergization. Prodromal phenomena may appear several weeks or months before the onset of the disease. The earliest and most significant of them is the morning stiffness in the whole body, especially in the joints of the hand, which disappears after active movements. There is a symptom of "tight gloves" or a symptom of
"corset", which makes difficult rising from the bed independently, dressing, combing, etc. The origin of this symptom is associated with an impairment of the normal rhythm of adrenal production of endogenous hydrocortisone. The peak of the maximum production of this hormone is shifted from 7–8 a.m. to a later period of the day.

The prodromal syndrome of the disease can also be manifested by minor periodic joint pains, decreased appetite, palpitation, anemia, sometimes subfebrile temperature, a slight increase in ESR.

Pains in the joints are evenly increased during movements. The "inflammatory rhythm" of pain sensations is characteristic. Its highest intensity is observed in the second half of the night and in the morning.

Significantly less often, RA begins acutely with sharp pain and considerable swelling in the joints, morning stiffness that continues throughout the day and is accompanied by a fever, complete immobilization of the patient.

In the early period of the disease, these symptoms are unstable and can disappear on its own for several months or even years, during which the patients do not contact the doctor. However, more often arthritis becomes persistent and the inflammatory process progresses.

RA is characterized by the damage to the second and third metacarpophalangeal and proximal interphalangeal joints. On the second place on the frequency of lesion are knee and radiocarpal joints, wrist joints, less frequent – ulnar and ankle joints. Some joints are never affected and are the "joints of exclusion" (distal interphalangeal joints, the first metacarpophalangeal and proximal interphalangeal joint of the fifth finger). In 70 % of cases, the lesion is symmetrical. Excessive processes prevail in the early period of the disease. With palpation, which is usually painful, the symptom of fluctuation is determined, which indicates the presence of intra-articular effusion. The joints are hyperemic, especially in the joints of the hand. The movements in the affected joints are painful and limited due to edema and reflex spasm of the muscles. Painful sensations and restriction of movements are most expressed in the morning.

Exudative period of the disease is observed for about a year: in patients, there may be a decrease in symptoms of arthritis or even a remission, but more often the disease passes into the exudative-proliferative phase.

During the full-scaled picture of RA, general weakness, asthenia, weight loss, sleep and appetite disorders, low-grade fever and stable, characteristic joint damage appear in patients. As a result of the development of proliferative processes, articular tissues thickening, the persistent swelling of the para-articular tissue is characteristic, which leads to deformation of the affected joints. The development of fibrotic changes leads to a gradual wrinkling of the capsule, ligaments, tendons, destruction of the articular surfaces, pronounced deformations of the joints, subluxations and contractures, especially in the joints of the hand, elbows and knee joints. Simultaneously, muscle hypotrophy and atrophy and trophic skin disorders occur.

**Diagnostic criteria for RA, which were developed by the American College of Rheumatology has significant importance:**

1. Morning stiffness for one hour.
2. Arthritis of three or more joints – swelling of soft tissues, synovitis, defined in three or more articular zones: interphalangeal, metacarpophalangeal, wrist, elbow, knee, ankle, metatarsophalangeal joints.
3. Arthritis of the joints of the hand – swelling of the wrist, metacarpophalangeal, proximal interphalangeal joints.
4. Symmetrical arthritis – the simultaneous inclusion in the pathological process of the same joint zones on both sides (bilateral involvement of proximal interphalangeal, metacarpophalangeal or metatarsophalangeal joints).
5. Rheumatoid nodules – subcutaneous nodules on protruding sites of bones, extensor or periarticular surfaces.

6. Rheumatoid factor in serum is the detection of an abnormal amount of rheumatoid factor in the blood serum by any method, in which a positive result in the control group of healthy people is <5 %.

7. X-ray changes – on the chest and wrist X-ray in the frontal-posterior projection there are erosion, osteoporosis of the bones of the affected joint and bones directly adjacent to it (changes typical for osteoarthritis are not taken into account).

The diagnosis is reliable if there are any four criteria that are observed for at least 6 weeks.

Clinical signs that allow suspecting an early RA are:

- three or more affected joints;
- symmetrical lesion of metacarpophalangeal and metatarsophalangeal joints;
- positive "compression " test;
- morning stiffness for more than 30 minutes.

Before the appearance of symptoms specific for the advanced stage of RA, the following symptoms can also be observed:

- fast fatigability;
- increased sweating;
- subfebrile body temperature;
- loss of body weight and poor appetite;
- increased sensitivity to cold;
- minor anemia;
- increased ESR;
- hyperhidrosis of the palms.

The joint process has a recurrent and progressive nature. With further exacerbation, new joints are involved in the pathological process, because some joints are in an early stage, others are in a later stage of the development process. Movement in the joints becomes even more limited, and in the terminal stage, as a result of the formation of ankylosis, complete immobility occurs.

The joints of the hand are affected in the first place. Swelling, soreness, and then deformation and restriction of movements in the metacarpophalangeal and proximal interphalangeal joints are specific. As a result of pathological changes, the fingers become spindle-shaped, and later, as a result of subluxations and contractures, there is a typical deformation – the ulnar deviation of the hand (the deviation of the fingers towards the ulnar bone), and the hand itself takes the form of "walrus fins".

The deformation of the fingers in the form of a "swan neck" (flexion contracture in metacarpophalangeal joints, which is combined with overextension in the proximal interphalangeal and flexing of the nail phalanges) and "boutonniere" (significant flexion in the metacarpophalangeal and overextension in the distal interphalangeal joints) is specific.

The damage to the wrist joint is usually combined with the involvement of the wrist joints. Arthritis of the wrist leads to the destruction of articular surfaces of small joints and their ankylosing (bone block). In the process of ankylosing, the metacarpal joints are retracted, while ankylosing of the wrist joint itself is quite rare. The inflammatory process in these joints is manifested clinically by painful swelling; movements in the fingers and hands are limited. With radioulnar arthritis, soreness is characteristic of pronation and supination. Quite often it is accompanied by a posterior sub-
luxation of the head of the ulna, which becomes immobile. In severe periarticular osteolysis of the hand and fingers with pronounced flexion contracture, the hand acquires a typical "lornette" shape. Pathological changes in joints are often combined with lesions of synovial tendon shells – tendosynovitis.

The damage to the elbow joint is rarely observed in the debut of the disease. When it is affected, flexion and extension are limited: the elbow is fixed in a half-flexed and half-pronated position. In the pathological process, the ulnar nerve is involved, which is manifested by the corresponding neurological symptoms.

In arthritis of the shoulder joint, which develops in a later period, diffuse swelling and tenderness in palpation is determined. Adductive contractures are typical, which significantly complicate the professional and household activities of patients.

The joints of the foot, like of the hand, are affected in the initial stages of the RA, mainly the metatarsophalangeal joints are damaged, which gradually leads to deformation of the entire foot.

The knee joint is a quite frequent localization of the pathological process in RA that begins in the onset of the disease. Deformation occurs due to edema of periarticular tissues and an effusion in the joint cavity. In some cases, a popliteal fossa has a rounded tumor (Baker's cyst). The knee joint is in the flexion position, which reduces the tension of the ligaments and tendons, alleviating the pain. If the patient does not change the position of the knee joint, the joint is quickly fixed in this position, a flexural contracture is formed due to the wrinkling of tendons and capsule.

The ankle and hip joints are affected much less often than the others. The inflammatory process in the hip joint is manifested by pain, often localized in the inguinal region, a significant restriction of all movements and walking, especially with the development of the protrusion of the iliac cavity. The hip is fixed in the position of a slight flexion. A pronounced atrophy of the muscles of the thigh and gluteal muscles develops.

Joints of the spine are affected at a late stage of the disease. The cervical section is predominantly affected. This is manifested by pain and stiff neck, sometimes accompanied by symptoms of compression of the spinal cord. Sometimes intervertebral joints are involved in the process, which can lead in some cases to spondylolisthesis III, IV or V cervical vertebrae. The maxillofacial and sternoclavicular joints are very rarely affected.

In RA, there are various extra-articular manifestations caused by generalized lesion of the bloodstream, as a result of which the muscles, skin, lymphatic system and internal organs are involved in the pathological process; it is based on vasculitis, which have an immunocomplex character.

At the early stage of the disease, with active arthritis, muscle atrophy begins. Primarily the atrophy of the muscles of the hands: interspinal muscles, tenar and hypotenar. The combination of atrophy of these muscles with the swelling of the metacarpophalangeal, proximal and interphalangeal joints of the wrist and wrist joint creates a picture of a typical "rheumatoid hand".

At severe forms of RA, atrophy can be quite pronounced. The extensor atrophy is more common. Skin changes are noted in many patients, especially in the long course of the disease: pale skin due to anemia, a violation of skin vascularization, caused by changes in the tonus of the capillaries and capillary circulation. Myopathy is caused by muscular atrophy, which is secondary to inflammation of the joints. Its share is 5–75 %. The main factors are violations of muscular tissue trophism due to rheumatoid damage of the peripheral nervous system and a decrease in the functional activity of the muscles.

Trophic changes in the skin capillaries also cause the appearance of a bright pink, sometimes cyanotic, color of the palm and fingertips. Sometimes on the skin of the fingers, especially near the nail bed, small brown foci appear (necrosis of soft tissues as a result of rheumatoid vasculitis). The skin covering the affected joints also changes. It is dry, pale, thinned, especially on the hands, with spots

9. Inflammatory, tumorous and tumor-like diseases of the musculoskeletal system
of enhanced pigmentation and hyperkeratosis. There are also trophic changes in the nails – thinning, fragility, longitudinal striation.

Subcutaneous rheumatoid nodules are one of the essential features of extra-articular manifestations of RA. They are so specific for this disease that they are considered one of the diagnostic criteria of RA, and are represented by dense rounded forms of connective tissue formations ranging from lentil grain to nut. Nodules are painless and mobile in palpation, but sometimes soldered with aponeurosis or bone. They appear suddenly, mainly during an exacerbation of the disease. Most often they are localized near the elbow on the extensor surface of the forearm. Sometimes observed on the back surface of interphalangeal and metacarpophalangeal joints, on the outer surface of the knee joint, in the thickness of the calcaneal tendon. Usually nodules are located symmetrically, but sometimes they can be unilateral. They never become inflamed or suppurate. Often 2–3 nodules are revealed; in rare cases they can be multiple. The number and size of the nodules can decrease under the influence of treatment (especially corticosteroids), and during the period of remission they can disappear completely. The early appearance of nodules is considered an unfavorable prognostic sign, since it always indicates a higher activity of the disease.

Lymphadenopathy is one of the frequent extra-articular manifestations of RA. It occurs in 25–30 % of patients. The enlargement of the lymph nodes often manifests itself in the severe course of the disease. Lymph nodes are ranged in size from pea to nut, dense, painless and mobile. They are palpated in the submaxillary region, on the neck, in the armpit, in the region of the internal epicondyle of the elbow. With pronounced activity and generalization of the pathological process, the internal organs and systems – the heart, the pleura, the lungs, the kidneys, the liver and others, which is based on rheumatoid vasculitis – are affected.

The manifestation of RA as a systemic disease is osteoporosis, which should be considered as a complication of long-term glucocorticoid therapy. Osteopenia syndrome is a common complication of RA with two characteristic manifestations: periarticular (local) and generalized (decrease in the density of the mineral component of the bone). Periarticular osteoporosis belongs to the earliest manifestations of RA and is one of the diagnostic criteria of the disease and its course. In RA, heart disease (rheumatoid carditis) can also occur with the development of fibrinoid layers in the connective tissue stroma of the heart, nonspecific exudative-proliferative reactions, typical rheumatoid nodules, damage to muscle fibers, mainly dystrophic, changes in blood vessels and finally sclerosis as a possible outcome of all processes.

The damage to the lungs and pleura is manifested by dry or non-exudative pleuritis with a slight fibrinous effusion, which is rarely clinically determined. In pulmonary tissue, the process develops as a sort of chronic pneumonia, focal or diffuse pneumosclerosis, accompanied by the development of pulmonary tissue characteristic for this disease nodules.

The kidneys in RA are affected in 60 % of cases, which can be diverse: amyloidosis, glomerulonephritis (membranous or membranous-proliferative), nephroangiosclerosis, chronic interstitial nephritis. A frequent manifestation of rheumatoid nephropathy is amyloidosis. Lesions of the gastrointestinal tract are combined with amyloidosis of other internal organs.

During RA the various parts of the nervous system and its elements (vessels, connective tissue), the actual nervous system are affected. The peripheral nervous system is involved in the process, mainly due to vascular lesions, in which, in addition to vasculitis and thrombovasculitis, immunohistochemical deposition of immunoglobulins and complement is noted.

The laboratory and instrumental methods of examination has a great importance in the diagnosis of the RA. In patients with RA, blood hemoglobin, the number of erythrocytes and leukocytes can decrease in clinical blood analysis and ESR increases almost always.

Severe forms and a long period of the disease are accompanied by an anemia of hypochromic nature with a decrease in hemoglobin to 35–40 g/l.
In severe patients, ESR can reach 60–80 mm/h, especially in the presence of pseudo-septic syndrome, and almost always correlates with the activity and severity of the pathological process and characterizes its dynamics.

RF (rheumatoid factor) in the early stages of the disease (up to one year) is rarely detected (in 20–30 % of cases), and in the earlier period (up to 6 months) is not determined. Early detection of the RF indicates an unfavorable course of the disease, and a high titer of the RF, despite clinical improvement, indicates the possibility of relapse.

The change in protein content in blood serum in the RA patients is considered as an indicator of the activity of the process. In RA disproteinemia (a change in the ratio between the number of albumins and globulins, as well as protein fractions) is detected.

The indicator of disease activity representing its dynamics is the level of fibrinogen of the blood, an increase of which sometimes up to 0.01 g/l instead of 0.005 g/l can normally occur in acute and severe cases of the disease.

Important diagnostic indicators in RA are the investigation of synovial fluid taken by joint puncture: its viscosity is reduced significantly; the number of leukocytes increases abruptly.

Biopsy of the synovium with morphological examination of synovial tissue is an important diagnostic indicator. There is always a deposition of fibrin on the surface of the synovial membrane or in the interstitial tissue, which is combined with vascular dilatation and edema. Foci of necrosis with erosions on the surface of the synovium can be formed.

The early X-ray evidence of RA is epiphyseal osteoporosis, which appears in the first weeks of the disease. With development of osteoporosis, the epiphyses of the affected joint look more transparent, with a clear structure of the bone. Osteoporosis can be spotty or diffuse, but always spreads to the epiphyses of the bone. If there is an effusion in the joint, its contours and structure become indistinct, veiled. With a longer period of the disease due to destruction of the articular cartilage, the gap gradually narrows, which then disappears. The most characteristic is the formation of erosion or usuras as a result of their degeneration after destruction of the articular cartilage with a granulation connective tissue (pannus).

Ultrasound, CT, MRI have a great importance in the diagnostics.

"Early" RA should be differentiated with:
- arthritides (psoriatic, reactive, ankylosing spondylitis, gouty, septic);
- systemic diseases of connective tissue (systemic lupus erythematosus, systemic scleroderma, Sjogren’s disease, polymyositis);
- systemic vasculitides (Wegener’s granulomatosis, Shenlaine-Henoch purpura, rheumatic polymyalgia, sarcoidosis, Behcet’s disease);
- osteoarthritis;
- fibromyalgia;
- metabolic diseases (ostomalacia, hyperparathyroidism, hypothyroidism);
- infections (infectious endocarditis, rheumatic fever, postvirus arthritis (influenza, measles, hepatitis B, rubella, HIV, etc.).

Treatment of RA is a rather difficult task. Its aim is:
- reduction in the severity of symptoms of arthritis and extra-articular manifestations;
- prevention of destruction, dysfunction and deformation of joints;
- maintaining or improving the quality of life of patients;
- achievement of remission;
- increase in life expectancy.

9. Inflammatory, tumorous and tumor-like diseases of the musculoskeletal system
A basis for therapeutic measures, can be the method suggested by N.M. Shuba (2003) (fig. 9.15). Among the medicines, non-steroidal anti-inflammatory drugs (NSAIDs) are widely used. By the properties of inhibiting COX-1 and COX-2, selective and nonselective NSAIDs are isolated. All of them have anti-inflammatory, analgesic and temperature-reducing properties. However, nonselective NSAIDs are more aggressive to the mucosa of the gastrointestinal tract, kidney vessels, platelet aggregation, which often leads to undesirable side effects.

The main pathogenetic drugs in RA are basic drugs ("slow-acting", "drugs that modify the disease"). Their peculiarities are the slow development of the therapeutic effect, deeper inhibition of clinical, biochemical and immunological manifestations, a relatively long-term preservation of the therapeutic effect after drug discontinuation, the possibility of inhibition of joint destruction.

The main modern principles of the "basic" therapy of the RA are the following:
- the choice of "basic" therapy depends on the severity of the RA course;
- if necessary, "basic" drugs are combined with small doses of GC or depot-GC intra-articularly, when the effect of GC are removed;
- "basic" therapy begins immediately after the diagnosis of RA;
- in the process of treatment with "basic" drugs it is necessary to carry out a constant monitoring of the activity of the disease and the side effects of therapy;
- "basic" drugs must be combined with NSAIDs;

Fig. 9.15. Algorithm of therapeutic tactics for the RA patient
• with insufficient effectiveness of the "basic" drug, it is combined with another or replaced, in case of inefficiency, the "basic" drug is changed;
• when the effect of "basic" therapy is achieved, it continues in the individual maintenance dose for a long time, while the effect remains in the absence of side effects.

There are two techniques of combining of "basic" drugs:
1. "Basic" therapy is started with two drugs (the "step-down" method), after achieving a clinical effect, one of the drugs is canceled.
2. It is begun with monotherapy, and only with its ineffectiveness a second drug is appointed (the "step-up" method).

The leading position among the basic drugs belongs to methotrexate. An important place in the treatment of RA belongs to glucocorticoids, which are the most effective anti-inflammatory drugs, especially in cases of participation in inflammatory processes of immune disorders.

The use of GC in RA treatment for today is limited to the following cases:
• exacerbation of the articular process with moderate systemic manifestations, which cannot be treated with NSAIDs with "basic" drugs;
• in the case of a small number of affected joints, intra-articular injection of depot forms of GC (Diprospan, Kenalog, Metipred) is possible;
• GC can be administered in low doses to patients who have not been able to select "basic" therapy;
• pulse therapy, including with systemic manifestations of the RA (generalized vasculitis, necrotizing vasculitis), which are life-threatening.

Usage of GC, despite their high effectiveness, is limited due to the risk of side effects, among which a special place takes GC-induced osteoporosis as one of the most characteristic and potentially dangerous complications of systemic GC therapy. In the majority of RA patients who have undergone GC systemic therapy for a long time, significant bone structure disorders have been revealed.

The effective direction in the treatment of RA is the use of systemic enzyme therapy. Wobenzym and Flogenzim are used most often, which present anti-inflammatory, immunomodulating and secondary analgesic effect.

Pathogenetically conditioned infusion therapy has proved to be positive, which consists in the intravenous administration of Reosorbilact, Contrykal and Heparin.

Rheumatoid-associated osteopenia is one of the manifestations of the systemic rheumatoid process, and the progressive re-calcification of bone tissue is its integral part.

Pathogenetically determined treatment of osteoporosis in patients with rheumatologic profile is:
1. Drugs that stimulate bone formation: fluorides, anabolic steroids, Ipriflavone (Osteohin), ossein-hydroxyapatite, somatotropic hormone.
2. Bone resorption inhibitors (antiresorbents): calcium, vitamin D and its active metabolites, Ipriflavone (Osteochin), Calcitonin, bisphosphonates (Alendronate), anabolic steroids, hormone replacement therapy.

The calcium drugs recommended for the treatment of osteoporosis are divided into three groups:
1. Simple calcium salts: calcium carbonate, calcium chloride, calcium triphosphate, etc.
2. Complexes of calcium with vitamin D.
3. Complexes of calcium with vitamin D and trace elements, which have an osteochondroprotective effect (Calcemin).

In the complex treatment of severe, resistant to standard "basic" RA therapy, it is advisable to use extracorporeal procedures, including plasmapheresis, lymphocytosis, hemosorption, immunosorption, etc.

As local therapy, intra-articular injection of depot forms of GC is used; in the presence of periarticular inflammation, GC is administered periarticularly. It should be noted that in the early stages of RA, the effectiveness of local therapy is higher than with prolonged flow and severe destructive disorders.

Local therapy also includes chemical and physical (radiation) synovectomy, based on the introduction into the joint cavity of agents that destroy the surface and most aggressive layers of the altered synovial membrane. As a physical synovectomy, the radioactive isotopes $^{198}$Au, $^{186}$Re, $^{169}$Er, $^{89}$Y are used. It gives a 100 % result throughout the year and reduces the effect to a half after 6 years of this type of treatment. However, radioactive radiation is characterized by a destructive effect on chondrocytes, and the possibility of subcutaneous sclerosis, radiation dermatitis limits its use. The advantage of chemical and physical synovectomy in comparison with surgical is the smaller number of complications, the possibility of conducting repeated courses of treatment in case of relapse of arthritis.

To reduce pain and inflammation, physiotherapy is performed. Among physical effects in the acute phase, laser therapy, magnet therapy, short-pulse electroanalgesia are recommended. In the subacute phase, it is possible to prescribe athermal physical factors: low-frequency impulse, interference currents, ultrasound therapy. In the stage of remission, paraffin therapy, peloid therapy, high-frequency electromagnetic therapy are carried out. However when prescribing physiotherapy procedures, it is necessary to remember that physiotherapeutic treatment must be administered taking into account the activity of the rheumatoid process, the age of the patient, the concomitant diseases.

The RA patients need diet therapy (especially those who take GC for a long time), psychotherapy, which can include the use of psychotropic drugs (tranquilizers, antidepressants).

The leading position in the treatment of the RA patients has orthopedic prophylaxis and treatment. Violation of the interaction of muscles and ligamentous apparatus against the background of pain syndrome at the initial stages of the disease creates additional prerequisites for the emergence and development of contractures, non-physiological positions. The use of orthopedic methods of prevention and treatment at the onset of the disease enables to avoid severe deformations and vicious installations, to prevent the occurrence of stiffness; contributes to the elimination of inflammation in the joints.

From the very beginning of the disease, it is necessary to carry out orthopedic measures aimed at creating rest, by applying corrective splints, plaster dressings, lining to reduce the pain syndrome, restore muscle antagonists, prevent their atrophy. Fixation of the joint in the physiological position prevents the occurrence of reflex contractures, contributes to reducing the inflammatory process, and therefore immobilization in the acute period is an effective therapeutic and prophylactic mean.

In the case of minor contractures, with low activity of the process with the aim of eliminating them, the joint is replaced, followed by fixation with the plaster splint in a functionally advantageous position. In the treatment of resistant contractures in patients with RA it is possible to use hinge-distraction apparatus. Usage of the Volkov-Oganesyan’s device on this purpose allows expanding the joint gap and creating the possibility of metered movements in the affected joint.

Indications and contraindications to surgical treatment are conditioned by the general physical and psychological state of the patient, the nature of deformities and the degree of disruption of the function of the joints and the limb as a whole. There are absolute and relative indications divided for surgical treatment.
The absolute indications are:

- resistant or often recurrent, synovitis resistant to conservative therapy, including hormonal therapy, for 4–6 months;
- pronounced proliferative changes in the affected joints;
- long-term pain syndrome caused by the inflammatory process or secondary degenerative-dystrophic changes in joints that cannot be treated conservatively;
- deformities of the limbs with stiffness or joint ankylosis.

Relative indications are:

- deformities of the limb with stiffness or ankylosing of two or more joints;
- a chronic, slow-progressive course of the disease with sufficient compensatory limb capabilities;
- slightly expressed proliferative changes in joints with periodic or constant moderate joint pain;
- deformities of the extremities in patients older than 60 years.

Absolute contraindications for surgical treatment are:

- "septic" course of the rheumatoid process;
- purulent infection;
- severe visceropathies (primarily amyloidosis of the kidneys);
- constantly recurrent RA course with high activity;
- cardiovascular diseases in the sub- and decompensation stage;
- diseases of the respiratory system;
- weak volitional qualities of the patient and absence of the "doctor-patient" contact.

Relative contraindications include:

- chronic kidney diseases without significant impairment of their function;
- cardiovascular diseases in the stage of compensation;
- iatrogenic hypercorticism due to severe osteoporosis;
- age of the patients is 60 years old with satisfactory functional adaptation to the occurred deformity.

Surgical interventions should be adapted to the stage of the pathological process. One of the methods of surgical treatment in RA is synovial and synovucapsectomy. Indications to this are the inflammatory process in the I stage of RA (persistent synovitis), when the signs of lesion of the osteochondral part of the joint that does not respond to conservative treatment for 4–6 months, recurrent synovitis, arthritis with persistent pain syndrome and function restriction. The objective evidence for the need for it is the data of the Ultrasound.

Timely removal of the affected synovial membrane prevents the intensive development of granulation tissue and pannus, which lead to the destruction of bone-cartilaginous components and irreversible loss of joint function. Surgical intervention is most effective in cases where the focus of inflammation is mainly localized in the synovial membrane without penetrating the subchondral parts of the joint. In most of the patients immediately after surgery, the pain disappears, the function of the joint significantly improves, the level of the inflammatory process as a whole decreases, which improves the quality of their life.

In the II stage of the disease (productive-destructive panaarthrite), the amount of surgical intervention depends on the phase of the pathological process. In the first phase (exudative-proliferative), total synovucapsectomy is shown with mandatory removal of pannus, replication of affected joints.
In the presence of a stable synovitis, which doesn’t respond to conservative treatment in the II–III stages of the RA, an extended synovcapsullectomy is performed (along with the removal of the affected synovia, the removed areas of the cartilage, osteophytes, pannus, granulation tissue, altered menisci) are removed.

In the second phase (proliferative-destructive), synovcapsullectomy can be combined with arthrolysis and cheilectomy – joint debridement.

The above mentioned surgical interventions can be performed in a "classical" way or with the use of modern minimally invasive techniques – the arthroscopic method, which is low-traumatic, allows radically removing the synovial membrane and other affected structural elements of the joint, conduct adequate diagnosis of the lesion, and shorten the period of restorative treatment.

In the third phase (destructive-sclerotic), as in the III stage of RA (ankylosing), reconstructive-restoring operations on joints-arthroplastics or arthrodesis in a functionally advantageous position are indicated.

A modern method of restoring the function of the joints in third phase of the II and the III stage of the pathological process is total endoprosthetics. The application of this method allows in a short time eliminating pain syndrome, restoring the volume of movements in the joint, significantly reduce disability.

Sanatorium-resort treatment for RA patients is indicated only with minimal RA activity or in the stage of remission. Balneotherapy (radon, hydrogen sulphide baths), mud applications at the resorts of Odessa, Eupatoria, Sak, Khmilnik, Pyatigorsk are indicated.

An important point for achieving positive results in RA patients are non-pharmacological measures, including patient awareness and understanding of their illness, social services, recreation, compliance with orthopedic regimens (changing the stereotype of motor activity, using orthoses during sleep to maintain the limb in the right position), isometric (static) exercises, kinesitherapy, hydrokinetic therapy, occupational therapy.

Syphilis of bones and joints

Earlier syphilis was considered an exclusively skin disease, but involvement of the bone system in the pathological process (up to 90–95 % of cases) makes it extremely relevant for orthopedics. Congenital syphilis of bones, lesions of bone tissue in tertiary syphilis and syphilitic joint damage are divided. Sometimes changes in the bones are the only sign of syphilis.

From the clinical point of view, congenital syphilis is divided into four groups: intrauterine, infancy, syphilis of a recurrent period and congenital late syphilis. There is no fundamental difference between fetal syphilis and the breast period, it is a continuation of the intrauterine disease. On the other hand, syphilis of a recurrent period, affecting children under 4 years old, and late congenital, affecting children aged 4–14 years, is almost the same anatomically and on X-ray, and does not differ from the tertiary acquired syphilis.

In syphilis of the fetus and newborn Treponema Pallidum penetrates into the bone with hematogenic way and settles in typical places where the most vigorous growth of bone tissue passes, and from 5–6 months of intrauterine development to 5–6 months after birth syphilitic infection reaches its maximum in bone. The most specific changes occur at the site of bone growth in length – in the epiphyseal cartilage zones, and at the growth site in thickness – in the inner layer of the periosteum.

Thus, congenital syphilis causes two types of characteristic changes:

- syphilitic osteochondritis on the epiphyseal ends of long tubular bones;
- syphilitic periostitis mainly in the region of diaphysis of long tubular bones.
Less common syphilitic osteomyelitis occurs, leading to diaphysial destructive changes in the bone tissue.

Both osteochondritis and periostitis are multiple lesions of the skeleton, but are more often affected by symmetrical sites. The most sharply syphilitic periostitis appears on the humerus, radius, ulna and tibia, less often on the femur and fibula.

The X-ray picture of syphilitic osteochondritis is reduced to several elements. First, the appearance of individual small defects in the zone of preliminary ossification or its fragmentation, that is loss of homogeneity. Secondly, the destruction of the zone of preliminary ossification takes place, which is manifested by the transition of the sharpened and expelled end of the metaphysis into the light shadow of the epiphyseal cartilage. Since the spongy and cork substance can be significantly destroyed in the metaphysis, pathological displacements or even intra-metaphyseal pathological fractures (Parro’s pseudoparalysis) are quite common. Sometimes it is the only manifestation of congenital syphilis and is manifested by edema of the periarticular tissues, which is very painful upon palpation.

Syphilitic periostitis occurs less frequently than osteochondritis. Localization of syphilitic periostitis is diaphyseal and epimetaphyseal.

Diaphyseal periostitis is a typical picture of a clutch or a cylindrical casing that surrounds the entire diaphysis of the long bone in the form of a symmetrical or eccentric shell.

Epimetaphyseal periostitis always accompanies syphilitic osteochondritis, periosteal reaction is less pronounced. The shell surrounding the peripheral third of the bone has the shape of a bottle, the narrow part of which gradually merges with the bone diaphysis.

Late congenital syphilis of bones is manifested at the age of 8–14 years. It is characterized by a Hutchinson’s triad (syphilitic teeth, lesions of the hearing organ and parenchymal syphilitic keratitis), a symptom of the Avsididian – Igumenakis (thickening of the sternal end of the right collarbone). Advantageously, the process is localized in areas of diaphyseal and metaphyseal sections of tubular bones. Most often, the tibias are involved in the process, which as a result of toxic stimulation of the epiphyseal zones extend and take a saberform shape, although sometimes multiple lesions of the bones are also observed.

For the X-ray picture, periostitis, sclerosis, and bone destruction with the formation of sequestrers – gummas are typical. Usually they have a round or oval shape, diameter up to 2 cm, located on the surface of a compact substance, less often they are in the center of a tubular bone. Around the centers of destruction there are sclerotic zones. Syphilitic diffuse osteoperostitis are often identified. They are localized in the diaphyseal and metaphyseal parts of the bones, but can extend to the meta- and epiphyseal areas. Due to necrosis of bone substance and the formation of sequestrers, the process breaks out and syphilitic osteomyelitis occurs. It can be complicated by a pathological bone fracture. In the diffuse lesion of bone tissue with a gummos process of destruction, necrosis and bone sequestration are less pronounced. They are represented in the form of multiple hardly noticeable, small foci of destruction. The bone looks darkened, thickened and sharply delineated.

Tertiary syphilis of bones. It occurs very rarely. Pathological processes in the bone appear several years after the onset of the disease and affect mostly superficially located long tubular or flat bones: the superficial parts of the tibia, the medial surface and anterior crest of the tibia, the skull, collarbone, sternum, forearm bones, especially the ulnar bone.

The process in the bone has a limited or diffuse gummos character. Thus, the syphilitic process can be shown in any part of a bone – in the periosteum, cortical or cancellous tissue, less often – in the bone marrow.

Clinically, periostitis is manifested by limited or widespread bone roughening, very painful during compression. A characteristic feature is night pain, which decreases in the afternoon, during movements. Locally swelling and tension of the skin are present, after pressing the finger a fossa is formed.
The X-ray picture of gummous osteoperiostitis is quite specific. In a typical place, namely – on the diaphysis of one of these bones, most often tibial, a slight limited thickening of the bone appears. The outer contours of periosteal osteophytes are smooth and sharply limited, the medullary canal at the level of gummous osteoperiostitis may be narrowed.

The gumma itself is a saucer-like or oval light unstructured defect located on the most convex and central place of the osteophytes directly under the periosteum. The cell size of the destruction is no more than 1.5–2 cm, the long axis of the gumma is parallel to the axis of the bone.

Multiple isolated gummas represent the same picture. If the gummas are located nearby, then on the affected area against the background of the dark sclerotized bone there are oval and round light defects that merge with each other. Significant necrosis, destruction and sequestration are not characteristic for gummous periosteasis, but can be observed in rare severe cases.

The diffuse syphilitic periostitis affects mainly the tibia, a symmetrical bilateral process predominates. The diffuse periosteal osteophyte, raised above the bone in the form of a segment of different size, appears along the front surface of the bone. The pathological shadow is more often homogeneous, but sometimes very small round or oval bright spots can be observed. It corresponds to the gummas that merge with each other.

Separate gummas, merging with each other, reach the size of the nut and more, lead to the destruction of bone marrow and bone elements and their replacement with granulation tissue, and an osteosclerotic process develops around the gumma itself. This phenomenon is called syphilitic osteomyelitis.

In tertiary syphilis, the destruction of the osseous nasal septum (saddle nose) is often detected.

An important point is the relationship between clinical and anatomical and X-ray symptoms. The discrepancy between them, namely – significant anatomical and X-ray changes in the bone with small clinical, especially subjective signs, always testifies in favor of syphilis. The generalization of pathological changes excludes the possibility of tertiary syphilis, and the multiplicity of skeletal lesions, that is, the disease of two, three or more bones, supports the latter.

Syphilitic lesions of the vertebrae are rare, mainly at the age of 30–40 years. Gummas form leads to the destruction of the vertebrae, more often II-III and V-VII cervical, less often – thoracic and very rarely – in the lumbar spine. Syphilitic spondylitis is manifested by the destruction and disappearance of the intervertebral disc, narrowing of the intervertebral space, flattening of the affected vertebra and secondary deformation of the spine. Sometimes there are perifocal and incurable abscesses, osteoporosis.

Syphilitic joint damages. They are quite rare, syphilitic joint damage occurs 8 times less frequently than tuberculosis. People are mostly affected at the age from 20 to 50 years, equally often men and women. In half of the cases, the knee joint is affected, and then it is the ulnar, ankle, shoulder, sternoclavicular joints.

Lesions of joints are characterized by a painless symmetrical accumulation of serous fluid, which gives a positive Wassermann reaction. Syphilitic gonitisises course in the form of chronic synovitis, sometimes patients are disturbed by night pain. Joints sharply increase in volume, but functional disturbances are usually not expressed, there is no formation of contractures.

The main diagnostic sign is the discrepancy between clinical manifestations of the disease and X-ray symptoms: significant changes on the X-ray with a good joint function and minor pain testify to the syphilitic nature of the lesion. Another X-ray evidence is the absence of osteoporosis. The most valuable objective X-ray symptom is periosteal stratification at the ends of one of the bones. There are no sharp or comb-shaped edge exostoses, characteristic for deforming osteoarthritis. When the knee joint is affected, the increase in the size of the patella can have diagnostic importance. The cellules of osteosclerosis in the epiphyseal parts of the bone are also important.

A particular kind of syphilis of the musculoskeletal system is tabetic osteoarthropathy, which arises from the late damage of the central nervous system by syphilis, more precisely – the posterior
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columns of the spinal cord and the posterior roots. Tabietic osteoarthropathy is combined with the
classical triad: Robertson’s symptoms (pupillary reflex immobility), Westphal (attenuation and loss of
knee reflexes) and Romberg (disruption of the body’s static coordination). More often the process is
localized in the knee joint, less often – in the ankle, hip, shoulder and elbow joints, spine. The disease
manifests in mature and old age. Trauma is often the provoking factor.

When the process is localized in the joints, a synovitis with a large amount of fluid in the joint is
observed. The marginal growth of osteophytes is characteristic, which leads to the curvature of the
joint, its increase in volume, looseness and deformation. Movement is accompanied by clicks, with
no pain, the function suffers insignificantly. In the tabetic lesion of the spine destruction of the verte-
brae (often in the lumbar and cervical spine) is marked and a hump may be formed.

The X-ray picture is characterized by destructive and sclerotic changes in the bones. The de-
struction of the articular surfaces leads to subluxation or dislocation in the affected joint, its de-
formation, the presence of free intra-articular bodies. The bones forming the joint are characterized by
periosteal stratifications of bone substance. Tabetic spondylopathy is characterized by a compres-
sion pathological fracture of one or more vertebrae and massive bony growths on the sides.

Thus, the main feature of syphilitic damage to bones and joints is a chronic course, a discrepancy
between large morphological changes in tissues, especially in bone and cartilaginous, and insignifi-
cent functional disorders.

Treatment. Specific antibacterial therapy according to the general principles of venereology is
used. From orthopedic measures, cuff or glue traction is used, with the involvement of the joints, the
limb is fixed with a plaster bandage. During synovitis, joint punctures are performed; punctate must
be to mandatory undergo bacteriological and cytological examined. With persistent and neglected
changes in the joints with synovitis, arthrotomy and synovectomy can be performed. In destruction of
articular surfaces, resection of the joint, arthrodesis is performed.

Tuberculosis of the bones and joints

Now in Ukraine, tuberculosis is one of the main state medical and social problems. Every year the
epidemic situation on this disease worsens. According to statistics, during 2000–2010, the incidence of
tuberculosis increased in 3.5 times. In 1995 an epidemic of tuberculosis was registered in our country.

Osteoarticular tuberculosis (OAT) is an integral part of a major problem and ranks first in the in-
cidence of extrapulmonary tuberculosis.

Tuberculosis of the spine and joints is still an actual problem of orthopedics, because in the
course of its development it leads to a sharp deformation of the skeleton and impairment of mus-
culoskeletal function in the patient, which often causes disability. The main causes of disability of
patients with osteoarticular tuberculosis are late diagnosis of the disease, unreasonably long term of
conservative-orthopedic treatment, low specific gravity of patients subject to surgical treatment, and
late terms of its performance.

Therefore, one of the main tasks of fighting this disease is active timely detection of various
forms of tuberculosis, their correct diagnosis and treatment. The first stages of actions are carried out
by specialists of the general medical network, then by specialists of the tuberculosis service.

The most ancient findings, indicating the tuberculosis of the bones and joints in humans, belong
to the Stone Age. It is known that in the mummified corpses of the Egyptians, who lived 2750–2000
years BC, there were specific lesions of the spine and large joints with abscesses and fistulas.

The main clinical manifestations of tuberculosis as a disease have been described by Hippocrates,
In the former USSR, P.G. Kornev made a particularly significant contribution to the development of operative methods for treatment of OAT ("Surgical Treatment of Osteoarticular Tuberculosis" (1961), which was published for the second time in 1971, and today is the reference book of phthisiophrophathists) with his co-workers and students G.D. Kovalenko, D.K. Khokhlov, A.E. Garbuz and others, in Ukraine – B. S. Kutsenok, I. P. Vernigora, N. P. Novachenko, A. A. Korzh, N. I. Khvisiuk and others.

The incidence of tuberculosis of bones and joints ranks second place (2.6 %) among all clinical forms of this disease and the first place (35.5 %) among extrapulmonary tuberculosis. A similar trend is observed in other countries. Among all patients with tuberculosis of bones and joints, the spine is affected in 40 % of cases, the hip and knee joints in 20 %, the remaining cases – other joints.

The main source of tuberculosis infection is a patient that releases Mycobacterium tuberculosis into the environment.

In summary, the modern concept of the pathogenesis of the OAT is reduced to the following. Tuberculosis is a common disease of the body, that is, primarily multiorganic. Osteoarticular tuberculosis is a local manifestation of this disease mainly of hematogenous origin, begins with tubercular lesions of bones and joints, mainly vertebral bodies and epimetaphyses of long tubular bones.

These lesions usually occur during the initial period of tuberculosis infection, before the formation of immunity, and do not directly depend on pulmonary tuberculosis, which can precede tuberculosis lesions of the skeleton, follow them, occur simultaneously or be absent altogether. Breathing organs play a role, mainly, as one of the ways of infection of the body with tuberculosis, however, the most frequent and important. Another frequent path of infection is alimentary, it has great importance in regions with an unfavorable epizootic situation, where it is possible to eat animal products infected with Mycobacterium tuberculosis (MBT).

Classification of tuberculosis of the bones and joints. Due to order of the Ministry of Health of Ukraine from 09.06.2006 № 385 "On approval of instructions for providing assistance to patients with tuberculosis" recommended such a clinical classification of tuberculosis of bones and joints.

A. Main clinical forms:
1. Tuberculosis of bones and joints of the spine with such possible localizations of the process:
   - Primary ostitis. In this case, the vertebral body is affected without spreading the tuberculosis process beyond its limits.
   - Progressive spondylitis, in which the tuberculosis process extends beyond the vertebrae.
   - Chronic destructive spondylitis. It is characterized by a long undulating course with gradual progression and with the progressive spread of destructive changes in the vertebrae after another exacerbation.
   - Metabuberculous spondylopathy. During this condition tuberculous process is relatively stable. It is characterized by varying degrees of anatomical and functional disorders and dystrophic changes in all elements of the spinal column.
2. Tuberculosis of the bones and joints of extremities. It is divided into:
   - Primary periarticular osteitis, characterized by the presence of a focus of specific inflammation in the metaphysis, epiphysis with a violation of the function of the joint and effusion in it.
   - Progressing arthritis with the spread of the tuberculosis process beyond the articular ends of the bones to the synovial membrane. At the same time, the bone focus of destruction opens into the joint cavity.
   - Chronic destructive arthritis is a severe joint injury with subtotal destruction of articular surfaces, with gross deformity, contracture and functional inferiority of the limb.
   - Metatuberculous arthrosis is the final stage of the disease, its transition to the inactive phase, when changes of a degenerative nature predominate.
3. Tuberculosis of flat bones of the pelvis and thorax.
4. Tuberculosis of the bones and joints of the skull and face.
5. Tuberculosis-allergic synovitis and arthritis.

B. Characteristics of tuberculosis process. Localization and distribution with specific indication of bones and joints, prevalence in their individual parts, depth and degree of injury.

Phase:
a) infiltration, caseous-necrotic, destruction, seeding with mycobacteria;
b) resorption, compaction, scarring, calcification.

Bacterial excretion:
a) with the isolation of mycobacteria tuberculosis (MBT+);
b) without isolation of mycobacterium tuberculosis (MBT-).

Activity of the process: doubtful activity, active process, loss of activity, silent process.

C. Complications:
1) compression of the spinal cord;
2) the formation of sores, fistulas, abscesses;
3) contracture of the joint;
4) pathological set;
5) impairment of the function of the joints;
6) degenerative-dystrophic changes, osteochondrosis;
7) amyloidosis of internal organs.

D. Residual changes after the completed main course of chemotherapy:
1. Minor residual changes:
   ● deforming arthrosis of I–II degree (joint damage with low mobility restriction);
   ● ankylosis of the small joints;
   ● spondylopathy (involvement of one or two vertebrae without deformity of the spine and thorax).
2. Major residual changes:
   ● ankylosis of the large joints in non-physiological position with limb shortening;
   ● spondylopathy with deformity of the vertebrae and secondary deformation of the thorax;
   ● deforming arthrosis of III-IV degree.

Clinical examination is of great importance for patients with tuberculosis of bones and joints. These patients are observed in group V of the dispensary observation, which is divided into the following subgroups:

V-A1 subgroup – patients with active tuberculosis of bones and joints are referred here; they are observed in this subgroup up to 2 years;
V-A2 subgroup – for patients with chronic forms of tuberculosis of bones and joints; they are observed in this subgroup before curing;
V-B subgroup – patients with fading active tuberculosis of bones and joints are observed, duration of observation is up to 2 years;
V-C subgroup – patients with clinical cure for tuberculosis of bones and joints are referred here; they are observed in this subgroup up to 3 years;
V-D subgroup – for people cured of tuberculosis of bones and joints with pronounced residual changes. The duration of observation in this subgroup can be until the end of life (constant).

Persons with tuberculosis of bones and joints of dubious activity who are not registered in other groups are referred to as “0” (zero) group. In this group, patients are observed no more than 6 months – during this time the diagnosis should be refined.

General principles of diagnosis of osteoarticular tuberculosis. Difficulties in diagnosing the initial forms of osteoarticular tuberculosis are not so much due to the latent nature of the development of the specific process and the asymptomatic nature of its manifestations, but to an incorrect interpretation of the clinical and X-ray signs of the disease, as well as laboratory data.

At the initial stage of development, OAT is usually manifested with common symptoms of intoxication in the form of weakness, rapid fatigue, sleep disturbances, decreased appetite, subfebrile temperature, night sweats. Quite often, the disease is mildly symptomatic, with an effaced clinical symptomatology.

An important indicator of general changes is the temperature reaction of the patient. At an early stage of development, the tuberculosis process in both children and adults often occurs with a normal or subfebrile temperature, which may be unstable. The body temperature is more stable and more pronounced in patients who, in addition to bone lesions, have specific changes in other organs or in which the periarticular tuberculous focus is progressing and involves nearby tissues in inflammation. A sudden burst of the focus to the joint is accompanied by a significant increase in temperature, but in these cases it usually does not exceed 38.0–38.5 °C and lasts no more than two to three weeks, and as long as the focus remains located in the thickness of the bone and is at a distance from the attachment of the synovial membrane or cortical bone, it remains clinically "silent." But when the focus is located directly under the articular cartilage, or a specific process involves inflammation of the cortical layer, periosteum and synovial membrane, in the soft tissues adjacent to the focus or in the joint, there are signs of inflammation. This inflammation initially has a nonspecific reactive character and is basically the actual initial clinical manifestation of the tuberculous process in the bone. One of the initial manifestations of OAT is also a violation of joint function in the form of movement restrictions. The degree of this can be pronounced, depends mainly on the activity of inflammatory changes in the joint tissues and it has a reflexive nature as a protective reaction to inflammation in the joint.

In the complex diagnosis of OAT, radiation imaging of pathology plays a central role. At present, it is performed by X-ray, computed tomography (CT) and magnetic resonance image (MRI), osteoscin-tigraphy and other methods. These methods, acting on the basis of various physical processes, give different images in character, complementing each other. They cannot be contrasted or excluded, so they should be used according to the available capabilities and specific diagnostic tasks.

Diagnostics of OAT should always start with an survey X-ray. The X-ray method retains the base value.

With proper technical use, radiography and X-ray tomography are quite informative in characterizing the bone structure, the extent of destruction and the nature of its limitation, the overall structural background, changes in paravertebral (pararticular) tissues (fig. 9.16). Survey images in two projections should be target, centered on the level of damage and with adjusted diaphragm.

The main radiographic signs of tuberculosis lesion of the musculoskeletal system are (fig. 9.16):
- the presence of early trophic changes in the bone tissue – osteoporosis, atrophy, absence of a pronounced endosteal reaction, weakness of periosteal reaction;
- change in the size of the joint space, intervertebral spaces: expansion (in the early stage of the process) or narrowing, until disappearance with further development;
• focal character of the primary bone destruction: the destructive focus is more often oval or rounded, localized in vertebral bodies and epimetaphyseal zones of long tubular bones, in the thickness of the spongy bone, bounded by a thin rim of the denser bone, can have dense inclusions – calcified caseous masses;
• contact "kissing" type of bone destruction: development of foci of destruction in the epiphysis due to destruction of epiphyseal cartilage in adjacent vertebral bodies as a result of destruction of the intervertebral disc, in adjacent bones of the joint with destruction of the integumentary cartilage. The nature of contact destructive changes is specified tomographically;
• change in the degree of density of para-articular and paravertebral soft tissue near the lesion: during the joint tuberculosis densification and spread of the shadow of the joint capsule occur, as well as the appearance of limited dense shadows in the thickness of the soft tissues of the limb – abscesses. During the spinal tuberculosis symmetrical spindle-shaped or globular thickenings of pre- and paravertebral tissues, spread and deformation of the contours of the large loin muscle from one or both sides take place;
• early change of normal anatomical relationships in the affected parts of the skeleton: deformation, alteration of the right limb axis, joint, spine, in joint tuberculosis – subluxations, dislocation of the joint ends, with spinal tuberculosis – slipping and displacement of vertebral bodies, angular deformation.

Destructive focus in the bone on X-ray can be well recognized when its size exceeds 2–3 mm in diameter. In general, in adults with tuberculosis of bones and joints, there is often a lag in the X-ray pattern from the clinical manifestations of the disease. Therefore, an X-ray diagnosis should be based not only on the interpretation of radiographs, but also on anamnestic and clinical data.

In recent years, highly informative methods of investigation using computer tomography and nuclear magnetic resonance have become widespread.

For bacteriological investigation, the most accessible pathological material for tuberculosis of bones and joints is the pus of infiltrating abscesses. In fistulous forms of OAT for bacteriological analysis pus is taken from the fistula.
In recent years, for the rapid diagnosis of tuberculosis, a polymerase chain reaction (PCR) is used, which allows to reveal unique DNA sequences specific for mycobacteria of the tuberculosis complex in several hours. According to its sensitivity (10–100 microbial cells/ml), PCR significantly exceeds bacterioscopic and even cultural methods of detecting MBT.

The most modern and promising method of serological diagnosis of tuberculosis is a solid-phase enzyme-linked immunosorbent assay (ELISA). Identification of antibodies to the causative agent of tuberculosis in the ELISA is based on their specific interaction with the tubercle bacillus.

A positive tuberculin test in adolescents and adults indicates infection with tuberculosis, but does not provide reliable information about the presence of bones and joints tuberculosis. The negative Mantoux test is informative, because in many cases it allows excluding tuberculosis lesions. Although, it should be noted, that among patients with severe immunological failure, in HIV-infected patients, tuberculosis of bones and joints may be accompanied by a negative tuberculin test.

Thus, the diagnosis of OAT is based on the comparison of clinical, laboratory, bacteriological and radiographic data, modern methods of radiation diagnostics. It is necessary to take into account the nature of the development of the disease, usually gradual and prolonged, previous or concomitant tuberculosis lesions of other organs or systems, the presence of conditions conducive to contact with tuberculosis patients.

At the same time, in recent years, due to pathomorphosis of the disease, there are significant deviations from a typical clinical picture with acute inflammatory manifestations at the time of the onset of diagnosis, including laboratory data, with effaced immunological indicators against a background of weakened immunity, as well as with atypical X-ray signs.

To verify such lesions, trial therapy, trepanobiopsy of lesion sites is often necessary.

**Tuberculosis of the spine** is the most frequent and severe disease among all specific lesions of the skeleton.

Clinical signs of spinal tuberculosis depend on a number of factors, in particular, on the phase of development of the inflammatory process (fig. 9.17).

The duration of the latent period of development of the tuberculous process in the spine is 1–2 years. Therefore, its recognition in the initial (pre-spondylitic) stage is rare. In most cases, the disease is diagnosed with the most pronounced and persistent clinical signs, that is, in the spondylitis stage.

One of the earliest symptoms of tuberculosis spondylitis is pain. At first it can manifest itself in the form of physical fatigue or repetitive, sometimes short-term, painful sensations in one specific site. This pain can be exacerbated by prolonged standing and walking.

The pain in the lesion area is blunt, of piercing character, sometimes “gnawing” like a tooth disease.

The clinical picture is usually more clearly manifested in the next, spondylitic phase. Its symptomatology differs constancy, and the pathological process proceeds cyclically, with the stages of the onset, high point and fading. In active stages, general malaise, subfebrile temperature, local and circular pain, restriction, stiffness, soreness of movements in the spine, standing of the spinous processes, the symptom of the “reins” of P.G. Kornev appear to the forefront.

In the symptomatology of spinal tuberculosis, a large part is occupied by neurologic disorders, which, manifested in the initial stage by local pain, can then acquire a clear segmental character with irradiation in the limbs, pelvis, abdomen, thorax. The most severe neurological disorders occur when the tubercular focus destroys the posterior closure plate of the vertebral body and breaks into the vertebral canal. The accumulation of purulent-caseous masses creates pressure on the spinal cord, thus causing conductive disorders that are manifested by spastic paresis and plegias.

A very important symptom of tuberculosis of the spine is a stifling abscess, which can be located pre- and paravertebrally, that is locally, according to the affected area, or migrate and be
identified elsewhere. Thus, with tuberculosis of the cervical region, the abscess is often located on the lateral surface of the neck, i.e. prevertebrally, with tuberculosis of the thoracic region it is paravertebrally, often over a large extent (fig. 9.18); tuberculosis of the thoracic-lumbar and lumbar regions is characterized by the location of the abscess in the ileum in the lumbar region or on the anterior-internal surface of the upper third of the femur, where it descends along the m. psos major, with lesions of the lumbosacral region, the abscess descends between the anterior surface of the sacrum and the posterior wall of the rectum, and then spreads to the sides and find a way out of the small pelvis in the gluteal region and settle in the area of the large trochanter (fig. 9.19).

No less important has the pathology and symptoms of tuberculosis of the spine are external fistulas. Their occurrence is associated with a breakthrough through the skin or an artificial dissection of the abscess. The appearance of internal or external fistula leads to the inevitable penetration into the cavity of the abscess and the bone focus of the secondary pus-forming microflora, which sharply worsens the patient’s condition and often forms doubtful predictions of the disease.

Fig. 9.17. Scheme of development of tuberculous spondylitis according to P.G. Kornev: 1, 2, 3 – localization of primary lesions of vertebral bodies; A, B, C – phase of the subsequent development of the process – the spread and destruction

9. Inflammatory, tumorous and tumor-like diseases of the musculoskeletal system
Fig. 9.18. Tuberculous spondylitis Th₁₀–Th₁₁ (frontal survey X-ray). Visualization of the paravertebral infiltrative abscess, contact destruction of the bodies Th₁₀–Th₁₁.

Fig. 9.19. Tuberculous spondylitis L₄–L₅ (CT). Visualization of destruction in the body of L₄ with bilateral congestive abscesses.

Fig. 9.20. Tuberculous spondylitis L₂–L₃:
A – fistulography. Visualization of fistulous passages, penetration of X-ray contrast into the destruction zone;
B – lateral survey X-ray. Visualization of contact destruction of segments L₂–L₃.

Long, sinuous fistulous passages make particular danger, which usually create in their path a network of branches and purulent clusters (fig. 9.20). The constant retention of pus in them causes an intoxication of the body, which, with the prolonged existence of the fistula, can cause amyloidosis of the internal organs.

During tuberculous spondylitis, which develops in adults, 2, less often 3 vertebrae are usually involved in contact destruction, and therefore the kyphotic deformation of the spine is poorly expressed, sometimes in the form of a "buttoned" spacing of one or two spinous processes. Even with
the involvement of more vertebrae, the deformation has the character of a "round back". Rough kyphotic deformations, sometimes acute angles, are the result of tuberculous spondylitis, which occurred in early childhood.

Activity of the pathological process, i.e. the stage of highest point, can proceed for a long time, then its acuteness gradually decreases, the stage of remission comes. It is characterized by an improvement in the general condition, a significant decrease in local symptoms of inflammation, normalization of biological indicators.

Tuberculosis of the hip joint (tuberculous coxitis) is a serious disease of the musculoskeletal system, which often leads to significant anatomical and functional disorders in the joint, which entails the social and domestic inferiority of the patient.

In the clinical course of tuberculosis coxitis, three phases are distinguished: preartritic, arthritic and postartritic, each with its own manifestations and features of symptoms.

The development of tuberculous osteitis in the preartic phase is initially accompanied by local discomfort, followed by light, unstable and intensifying pain in the area of lesion. Often, the pain syndrome is characterized by irradiation into the thigh and knee area.

The arthritic phase is characterized by the progression of soreness in the inflamed joint. In this phase, three stages are distinguished: the beginning, the highest point and the fading. Three symptoms are inherent in active coxitis: pain, impaired function and muscular atrophy.

The inflammatory changes in the area of the affected joint are determined to varying degrees: increased local temperature, paraarticular infiltration, restriction or loss of active movements, vicious limb positions, contractures, abscesses and fistulas. Congestive abscesses usually manifest as an asymmetrically located protrusion or as a more diffuse fluctuating tumor. Congestive abscesses are often located in front of a large trochanter, on the anterior-external surface of the thigh, less often they are behind the large trochanter in the gluteal region, as well as in front under the Poupart's ligament, and in the region of the adductor muscles. When perforating the medial wall of the acetabulum, an intrapelvic location of abscesses is observed.

The acuteness and severity of the inflammatory phenomena associated with the appearance of tension in the joint, after the formation of a congestive abscess, is reduced, which is associated with the release of cold pus from the joint into the soft tissues.

However, fistulas, often arising from tuberculous coxites on the basis of congestive abscesses, lead to increased inflammatory changes, worsening of the general condition and can be the cause of amyloidosis of internal organs.

All these changes develop gradually, progress slowly, reaching the greatest intensity in the stage of swelling. The spread of the tuberculous process to the joint by the type of sudden burst of purulent-caseous masses into its cavity is rarely observed and proceeds in the form of acute arthritis.

X-ray changes in the active phase are manifested by narrowing and then disappearance of the joint gap, the appearance and progression of secondary destruction of articular surfaces, osteoporosis, densification and enlargement of the contours of the joint bag, and expansion of the intercellular space between the joint bag and the gluteus muscles (fig. 9.21).

In the stage of remission, a decrease in the activity of the pathological process occurs with a decrease in pain and decline of local inflammatory manifestations with maintaining the anatomical and functional insufficiency of the joint.

Tuberculosis of the knee joint (tuberculosis gonitis) is one of the leading in the frequency of lesion among other osteoarticular localizations and is about 20%.

The occurrence of tuberculosis in most cases is due to the formation of the primary ostitis at the joint ends of the femur and tibia. The ostitis in its development, as a rule, involves the synovial membrane in a specific inflammatory process.
The initial stage of a specific inflammation of the knee joint is characterized by three main symptoms: pain, restriction of movements in the joint and early muscle atrophy.

The height of the disease is associated with the subsequent progression of inflammatory phenomena and the development of a well-known pattern of tuberculosis gonitis. Clinically, this is manifested in a significant increase in the above symptoms, especially pain and movement limitation, with the formation of muscle contractures. Then clear anatomical changes occur. The joint increases in size, its contours are smoothed out, which together with progressive muscular atrophy gives it a spherical shape. The increase in the volume of the joint depends on both the effusion and the thickening of the capsule. The effusion to the joint gradually decreases and eventually ceases to be determined, and the thickening of the capsule, on the contrary, increases, and the joint acquires a spindle shape with swollen, pale, sometimes wax-like skin, which to some point confirms the old name "white tumor" (tumor albus). At the height of the flush of the process, often there are congestive abscesses in the form of fluctuating, asymmetrically located swellings; sometimes they extend far beyond the joint capsule proximally, under the quadriceps muscle of the thigh, or distally to the lower leg or the popliteal fossa. The closer to the surface there is the abscess, the sooner it can break out and form a fistula. Finally, the destruction of the ligamentous apparatus leads to the displacement of the ends, the subluxation of the tibia posteriorly and its valgus deviation outside, the destruction of the articular ends also leads to a shortening of the limb.

On X-ray, the stage of the highest point of the disease is characterized by increased osteoporosis and the appearance of a significant destruction of the articular ends of the bones. The joint gap tends to narrow, the contours of the articular surfaces become indistinct, intermittent. Irregularities, serrations and a different degree of bone destruction appear (fig. 9.22).

The stage of decline of the process is characterized by a decrease in the clinical signs of inflammation in the knee joint. The pain, local heat and swelling of the joint disappear, abscesses and fistulas disappear. The joint becomes "cold" and "dry". According to X-ray data, bone destruction cease at the moment and signs of repair are growing, the sharpness of contours of articular surfaces and bone density increases, a coarse beam network appears along the force lines. Simultaneously, the general condition of the body is equalized, the temperature and biological reactions are normalized. However, in the majority of patients, trophic and anatomical-functional disorders are retained, which are expressed in muscle atrophy, restriction of movements, contractures, displacement of the joint ends and shortening of the limb. In rare cases, bone ankylosis becomes the outcome of the disease, but incomplete fibrous fusion occurs and limited mobility with a vicious position of the limb persists.  

Treatment of patients with osteoarticular tuberculosis. At the present time, at the basis of the modern rational system of treatment of the OAT is a combination of three principles: planning, complexity and activity.

The principle of planning implies carrying out extensive organizational activities aimed primarily at timely detection of initial forms of bone and joint lesions and as early as possible treatment that ensures the greatest effectiveness of therapeutic activities.

The principle of complexity is provided by a harmonious combination of methods of general and local treatment in one common dynamic system.
Fig. 9.22. Right-sided tuberculous gonitis. Destructive changes in the joint.

The general influence is achieved by sanatorium and climatic and antibacterial treatment, local – by orthopedic measures.

Sanatorium and climatic treatment provides for the use of three factors: a strict regime, a rational diet and aerosol therapy. Sanatorium and climatic treatment should be carried out, mainly, in local sanatoriums using local climatic factors, to which the patient is well adapted.

Specific antibiotic therapy, which is carried out in accordance with standards accepted in phthisiology, is an important therapeutic factor. Antibiotics and chemotherapy of specific action contribute to the rapid fibrotic restriction of cellules and the cessation of inflammatory processes.

The principle of activity is realized through the wide involvement of planned surgical interventions in the general treatment system.

The main task of surgical treatment is to remove all caseous masses, necrotic tissues and specific tubercular granulations. Thus the main attention should be paid to the elimination of primary ostitis, i.e. bone pathological focus, which is the root cause of the disease.

Timely removal of bone foci prevents the spread of the process to soft tissues and joints. This is the basis for the idea of radical preventive interventions.

All modern surgical interventions are conditionally divided into 5 groups:
1. Treatment and diagnostic surgeries – joint puncture, abscess, biopsy of joint tissues, fistula, arthroscopy.
2. Radical-prophylactic operations – extraarticular necrectomy with plastics of defects and without it.
3. Radical surgery is a radical-recovery mobilizing operation (trans-articular necrectomy) with plastics of defects and without it, a typical saving and atypical reconstructive joint resection with arthrodesis graft and without it, arthrodesis of the joint.
4. Reconstructive and recovery mobilizing operations are reconstructive-recovery surgery without the plastics of defects (arthrolysis, modeling marginal resection of articular ends, cheilotomy, etc.), reconstructive-recovery plastic surgery and arthroplastics.
5. Treatment-auxiliary operations – corrective (length and axis of extremity) osteotomy, tenotomy, abscessotomy, abscessectomy, fistulotomy, arthroplasty, synovectomy.
TASK #1

A 22-year-old patient applied to the orthopedic clinic with complaints of pain in the spine, a periodic increase in temperature. Recently, he suffers from eye diseases, radiculitis. On the X-rays, osteoporosis of vertebral bodies, spondylitis, and scoliosis are determined. Ankylosing spondylitis is suspected. What are the early signs of this disease?

A. Kifosis formation of the lumbar spine.
B. Impairment of the function of external respiration.
C. Lumbalgia, lumboischialgia, which pass after a warm-up.
D. Pain increase after dynamic load.
E. Changes in the zone of sacroiliac joints.

TASK #2

A 56-year-old patient was admitted to the orthopedic clinic complaining of pain in her left hip joint, an increase in temperature. At the examination tuberculosis coxitis was revealed. What is the characteristic localization of the lesion in this disease?

A. The head of the femur.
B. The acetabulum, less often the head and neck of the femur.
C. Neck of femur.
D. Synovial sac.
E. Bones of the acetabulum.

TASK #3

A 28-year-old patient entered the orthopedic clinic for examination. Bechterew's disease was diagnosed. What are the late signs of this disease?

A. Ankylosis of the fingers.
B. Atrophy of transverse processes.
C. Ankylosis of the ribs and vertebral joints.
D. Ankylosis of the knee and hip joints.
E. Sacroiliitis.

TASK #4

The patient is 40 years old, complains of pain when moving in the right knee joint, has a difficulty in walking, restriction of movements. The pain appeared 2 weeks ago after the acute tonsillitis.

On examination the joint is thickened, the upper curvature is contoured. Movements in the joint are in full range, painful in extreme positions. At palpation local temperature is increased, paraarticular soft tissues are painless. Ballottement of the patella is defined, moderate soreness during palpation along the joint space is determined. Overall well-being is satisfactory. What is the nature of the disease in this patient?

A. Traumatic.
B. Degenerative and dystrophic.
C. Infectious-allergic.
D. Infectious-specific.
E. Tumor.

TASK #5

Patient V., 18 years old. A year before admission to the hospital he had pains in the left thigh. He was diagnosed with arthritis in outpatient conditions, hydrocortisone injections were carried out. After a year and a half, a swelling appeared on the anterior surface of the thigh, which gradually increased. X-ray: osteogenic sarcoma is present. During examination in hospital: on anterior surface of a femur the tumor is defined 4 × 6 sm, dense,
motionless, morbid, not soldered with a skin. Pulse on the femoral artery has satisfactory properties. Movement in the knee joint is limited. What treatment should be offered to the patient?

A. Preoperative chemotherapy – surgery – postoperative chemotherapy.
B. Preoperative chemotherapy – radiation therapy – postoperative chemotherapy.
C. Radiation therapy – an operation.

**TASK #6**

Patient T., 62 years old was hospitalized with a pathological fracture of the humerus. From the anamnesis: gland the combined treatment was spent 5 years ago in occasion of a cancer of a mammary. During the last 2 years, twice repeated treatment due to local recurrences in the postoperative cicatrix was perfomed. On the X-ray of the diaphysis of the humerus, a solitary metastasis was found, no other metastases were found. What further treatment tactics can be offered?

A. Immobilization + chemoradiotherapy.
B. Segmental resection, bone plastic surgery – chemotherapy.

**TASK #7**

Patient L., 61 years old for 2 years had physiotherapy and spa treatment for radiculitis. During examination the tumor of the proximal part of the left femur with a soft tissue component 4 × 3 cm in size, the threat of pathological fracture is determined. The diagnosis is confirmed morphologically: chondrosarcoma of moderate degree of differentiation. What is the tactic of treating the patient?

A. Intramedullary osteosynthesis.
B. Exarticulation of the limb.
C. Osteosynthesis with apparatus of external fixation.
D. Resection of the femur, hip joint endoprosthetics.

**TASK #8**

Patient D., 31 years old was hospitalized because of a tumor of the left femur. On X-rays: the focus of osteolytic destruction of the proximal metaphysis of the femur with a cellular structure more than 2/3 of the diameter of the bone is defined. The results of trepanobiopsy confirmed the clinical and radiological diagnosis of a benign giant cell tumor. What is the treatment tactic?

A. Polychemotherapy – bone resection, joint endoprosthetics.
B. Resection of the bone, joint endoprosthetics.
C. Radiation therapy.
D. Excocleartation of tumor and plastics by ceramic material.

**TASK #9**

An operation was performed to a patient D., 45 years old, in the orthopedic department – marginal resection of the iliac bone for osteoblastoklastomy. After 4 years, a slight pain occurred. During the examination in the clinical picture a relapse of a benign giant cell tumor with spread to the sacrum (S1-S2) was found. What treatment is supposed for the patient?

A. Operation – radiation therapy.
B. Operation – polychemotherapy.
C. Radiation therapy.
D. Chemoradiotherapy.
Patient R., 22 years old complained of minor pain in the hip. A few months later there was a pathological fracture of the proximal femur, which was treated conservatively with a plaster bandage at home for 4 months. After removal of the plaster bandage on the X-rays a consolidation of the fracture was present. Based on the results of the examination of the patient and evaluation of the X-rays, an outpatient diagnosis was made: fibrotic dysplasia of the proximal femur. The diagnosis is confirmed by biopsy data. What kind of treatment should be offered?

A. Excochleation of the focus of dysplasia.  
B. Resection of the bone, endoprosthesis of the joint.  
C. Radiation therapy.  
D. Excochleation of the focus and plastic with ceramic material.

TESTS

11. In what place, according to statistical data, is the frequency of lesions by osteoarticular tuberculosis among other extrapulmonary forms of tuberculosis in our country?

A. 1st.  
B. 2nd.  
C. 3rd.  
D. 4th.  
E. Other.

12. The total incidence of tuberculosis lesions of the spine, hip and knee joints is:

A. 40 %.  
B. 80 %.  
B. 60 %.  
B. 20 %.  
B. 10 %.

13. Permanent signs of osteoarticular tuberculosis include:

A. Subfebrile body temperature.  
B. Congestive abscess.  
C. Schmorl’s hernia.  
D. Deformation of the spine or joints.  
E. Spinal cord disorder.

14. The main principle of treatment of patients with osteoarticular tuberculosis of all ages is:

A. Combination of conservative and surgical treatment.  
B. Conservative treatment.  
C. Operative treatment.  
D. Tuberculin treatment.  
E. Immunostimulating treatment.

15. Tuberculosis of the joint begins with a lesion:

A. Epiphysis.  
B. Metaphysis.  
C. Diaphysis.  
D. Synovium.  
E. Articular ends of the bone.

16. Which of these bones are more often affected by the chondroma?

A. Skull bones.  
B. Long bones of limbs.  
C. Phalanges of fingers and toes, metatarsal, tarsus and metacarpal bones.  
D. Spine.  
E. Bones of pelvis.
17. Which of the X-ray signs does not apply to Ewing's sarcoma?
   A. Narrowing of the medullary canal.
   B. A destructive focus is identified, which has a fine mesh pattern.
   C. “Bulb periostitis”.
   D. “Needle periostitis”.

18. Name one of the main symptoms of a solitary bone cyst.
   A. Increase in local temperature.
   B. Pathological fracture.
   C. Night pain.
   D. Shortening of the limb.
   E. Contracture of adjacent joints.

19. Clinical symptoms of Ewing's sarcoma often resemble:
   A. Rheumatoid arthritis.
   B. Acute osteomyelitis.
   C. Gout.
   D. Rheumatism.
   E. Acute venous thrombosis.

20. For the development of rheumatoid arthritis, the main thing is:
   A. Genetic predisposition.
   B. Neuroendocrine disorders.
   C. Enzymopathy.
   D. Autoimmune disorders.
   E. Formation of superoxidant anions.

21. X-ray changes in rheumatoid arthritis are primarily detected:
   A. In the elbow joints.
   B. In the shoulder joints.
   C. In proximal interphalangeal or metacarpophalangeal joints.
   D. In the knee joints.
   E. In ankle joints.

22. The criteria of the American Rheumatological Association, in the presence of which the diagnosis of rheumatoid arthritis is reliable, are: 1) morning stiffness for at least 1 hour; 2) arthritis of 3 or more joints; 3) arthritis of the joints of the hand; 4) symmetric arthritis; 5) Raynaud's syndrome; 6) increase of ESR in blood serum; 7) rheumatic nodules.
   A. 1, 5, 6, 7 are correct.
   B. 2, 5, 6, 4 are correct.
   C. 3, 4, 5, 7 are correct.
   D. 1, 2, 3, 4 are correct.
   E. 2, 4, 5, 6 are correct.