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Radiation Diagnostics of Changes in the Hip Joint

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Abstract: In recent years, there has been a significant increase in rates of damage to the osteoarticular system, rising from 10.9 to 16.9 per 100 thousand adults. The share of diseases and injuries affecting the hip joint is 8.1%. According to WHO forecasts, the number of patients with this pathology is expected to rise, correlating with an increase in the average life expectancy of the population. The challenge of treating patients with these diseases and injuries is not only medical but also socio-economic. In 60.0-64.0% of cases, it leads to a decrease in the quality of life and ability to work, and in 11.5% of cases, it results in disability among persons of working age.

Keywords: X-ray, multislice computed tomography, endoprosthesis, hip joint.

Introduction. In modern traumatology and orthopedics, great importance is attached to the pathology of large joints, in particular the hip. According to WHO forecasts, the number of patients with this pathology will increase, which is associated with an increase in the average life expectancy of the population. The problem of treating patients with diseases and injuries is not only medical, but also socio-economic in nature, since in 60.0-64.0% of cases it leads to a decrease in the quality of life, ability to work, and in 11.5% - to disability among persons of working age. Therefore, optimization of methods for diagnosing and treating pathology of the hip joint is one of the most important tasks of modern medicine [2,13,18,19,27]. An analysis of the literature shows that traditional radiographic examination has not lost its importance in the present time. According to radiography, more than 80.0% of pathological changes in bones and joints are established, and correct interpretation of the data obtained is possible in almost 70.0% of cases [1,25,27,35].

However, when choosing an X-ray examination technique, it is necessary to take into account that when assessing structures that are complex in their anatomical structure, which include the hip joint, it is necessary to select and standardize radiography techniques in various clinical situations. In most cases, this makes it possible to limit the number of studies performed and reduce radiation exposure to the patient and staff.

Diagnostic capabilities have significantly increased with the integration of high-tech techniques into clinical practice, such as spiral computed tomography (MSCT), magnetic resonance imaging (MRI), and high-resolution ultrasound (US) [3,24, 26,53].

The expansion of the diagnostic algorithm is advisable when clarification of data obtained during traditional radiography is necessary or when they do not align with the results of a clinical examination. The use of MSCT, MRI, and ultrasound enables non-invasive visualization of bone tissue, bone marrow, assessment of cartilage and para-articular tissues, and determination of the nature of the blood supply to the extremities, both in normal and pathological conditions [19,40,49].

A number of authors believe that one cannot stop at just one method; an integrated approach is needed to identify diseases and injuries of the joints and to assess the effectiveness of treatment measures [3,26,50].

However, to date, a generally accepted systematic approach to the selection of radiological diagnostic methods in assessing changes in the hip joint, planning and monitoring the results of conservative and surgical treatment for various pathological conditions has not been developed [10].

Degenerative changes of the hip joint. Chronic degenerative diseases of the musculoskeletal system - a widespread pathology - occur in 63.4-85.2% of the adult population. Degenerative changes are the most common lesion of the hip joint. The most common include arthrosis, aseptic necrosis, and cystic restructuring. The causes of degenerative processes are different [6,21,37,42,51].

For a long time, arthrosis of the hip joint was associated with aging of the body or the consequence of injury. According to a group of authors, coxarthrosis develops most often in elderly and middle-aged people. There is idiopathic primary deforming arthrosis of the joints, which occurs in adolescence and in the vast majority of cases is a consequence of dysplastic changes [1,9,16,26,37,44].

However, regardless of the patient's age and the reasons that caused changes in the joint, the main pathomorphological substrate of coxarthrosis is degeneration of articular cartilage. Its structural restructuring is caused by metabolic disorders. In cartilage tissue, quantitative and qualitative changes in proteoglycans occur, ensuring the stability of the structure of the collagen network, which can be considered as the basis of the cartilage matrix [4,23,31,53]. The altered cartilage loses moisture and shock-absorbing ability, which leads to an increase in the load on the articular surfaces of the bones, promotes their compaction, deformation and the growth of marginal osteophytes. All this leads to deformation of the joint and the axis of the limb.

However, an X-ray examination cannot detect early manifestations of arthrosis - initial changes in cartilage tissue - since the cartilage is not visualized on an X-ray and its damage can only be judged by indirect indicators.

MSCT is also a non-informative method in the initial stages of disease development. In the early stages, arthrosis can be detected using MRI, which has a clear advantage in studying the joint capsule, bone marrow, and cartilage. In stage II of deforming arthrosis, MSCT, as well as radiography, can reveal an uneven decrease in the height of the joint space, subchondral osteosclerosis, deformation of the articular surfaces, and marginal bone growths. On MP tomograms at this stage of the disease development, compaction and changes in the configuration of the articular ends, usuration of hyaline cartilage, local calcification of the ligamentous-capsular apparatus, and accumulation of fluid in the joint cavity are determined.

According to A.V. Bryukhanov and A.Yu. Vasiliev (2001), MRI makes it possible with a high degree of probability to determine the pathomorphological basis of changes in the soft tissue, fibrous, cartilaginous structures and bone marrow of the epiphyses that make up the joints at various stages of the pathological process. At the same time, the symptoms of joint diseases on MRI scans are nonspecific, but each pathological process is characterized by some more characteristic MRI signs. This allows the use of this method for the differential diagnosis of degenerative and inflammatory diseases.

It is important to be able to study articular cartilage and bone marrow at the articular ends of bones, and therefore MRI is the method of choice for diagnosing joint diseases of various etiologies [5,33,39,48].

Injuries to the hip joint and their consequences. Damage to bones and joints is the most common indication for radiation examination of the musculoskeletal system.

Fractures of the acetabulum and femur are among the most severe injuries, accompanied by significant changes in soft tissues, blood vessels, massive blood loss, and are often complicated by traumatic shock and profound disorders of the general condition of the victim. Fractures of the proximal end of the femur (neck and head) account for approximately half of these injuries. Fractures of the femoral head are quite rare (4.0%) and are always part of a combined injury to the hip joint [7,15,37,41,49].

(The information content of SCT in stage III deforming arthrosis is not superior to classical radiography and is usually not performed due to the increased dose load on the patient.

However, MSCT makes it possible to more clearly identify cystic restructuring of the epiphyses of bones. MRI shows, in addition to gross deformation of the articular surfaces and restructuring of the

spongy substance, pronounced calcification of the ligamentous-capsular apparatus, and an excess amount of fluid in the joint cavity.

Diagnosis of false joints usually does not cause difficulties. X-ray examination reveals a gap between fragments, atrophy of fragments and their sclerosis, formation of an endplate, and regional osteoporosis. The space between fragments in false joints is filled with scar tissue, which prevents fusion. With a long-standing pseudarthrosis, neoarthrosis forms - typical articular surfaces are formed, covered with cartilage, surrounded by fibrous-modified tissues (pseudocapsule).

An MRI examination of the hip joint with a pseudoarthrosis of the femoral neck clearly shows the presence of different tissues at the level of the neck. The method is effective in the differential diagnosis of non-union fractures and false joints of the femoral neck. MPT also makes it possible to detect changes in the bone, which can be important for making tactical decisions about the nature of surgical intervention [3,8,34,40].

The role of the ultrasound method in the diagnosis of false joints is insignificant, because It is not possible to judge the condition of the bone tissue in the central parts of the pseudarthrosis. Only the interrupted hyperechoic contour of the femoral neck and altered soft tissues are visible [3,19,36,43].

A.K. Morozov, V.V. Banakov, M.A. Sinitsky et al. (2005), in order to clarify the indications for the use of modern methods of radiation diagnostics in traumatology and orthopedics, analyzed the results of examination of 360 patients based on digital technologies. Classical radiography is the main and most common. MSCT is the method of choice in diagnosing injuries and diseases of areas of complex anatomical structure; its role in planning surgical interventions is great. In addition, in the diagnosis of injuries and diseases, the MRI method provides the greatest clarifying information. Ultrasound can be used as an auxiliary method in determining the condition of cartilage, capsular ligamentous apparatus, tendons and muscles.

Aseptic necrosis. Among degenerative processes in joints, various types of aseptic osteonecrosis occupy a significant place in terms of severity and prevalence.

Aseptic necrosis of the articular ends in adults was described as an independent disease several decades ago. It is known that aseptic necrosis can be caused by various reasons: violation of the integrity of the arteries, embolism, arterial spasm, venous stasis, as a result of joint damage, surgery, etc. [11,29].

Traumatic and vascular points of view are equally widely represented in the literature. Revealing the essence of the traumatic theory of the occurrence of aseptic bone necrosis, much attention is paid to both single significant damage and microtraumatization, often chronic.

The literature describes more than 30 classifications of aseptic necrosis of the femoral head as the most common localization of the process. Most of them are based on radiological changes in the proximal femoral epiphysis.

Currently, a 5-stage characterization of pathological changes in aseptic necrosis of the femoral head is generally accepted [3,17,32].

Stage I - pre-X-ray. X-ray examination does not give positive results. The head of the femur retains its inherent shape, size and structure.

Stage II - the stage of impression fracture, characterized by many microscopic fractures against the background of necrotic bone tissue. X-ray at this stage, the head of the femur is homogeneously darkened and there is no structural pattern, its height is reduced compared to the healthy side, the surface in some places has the appearance of compacted facets, the joint space is widened.

Stage III - stage of sequestration. The head flattens even more and consists of separate structureless isolated fragments of irregular shape and size, the joint space widens even more. The neck of the femur is shortened and thickened.

Stage IV is the stage of repair. The cancellous bone substance of the head is restored. Radiologically, sequestration-like areas are no longer visible, the shadow of the femoral head is outlined, but the structure of the bone is not yet visible; rounded cyst-like clearings can be observed for a long time.

Stage V is the stage of secondary deforming arthrosis. It is characterized by a number of secondary changes such as deforming arthrosis. The bone structure of the head at this stage can be traced, but its shape is significantly changed, it is flattened, expanded in diameter, the articular cavity does not cover it, and the congruence of the articular surfaces is disrupted. Marginal bone growths and secondary dystrophic cysts are visible.

Radiography allows one to determine the late stages of avascular necrosis of the femoral head, as does MSCT. However, MSCT facilitates a more detailed study of the internal structure of the femoral head and acetabulum due to the transverse orientation of the slices of the layer-by-layer study [5,26,45].

Early diagnosis of aseptic necrosis of the femoral head is possible only with the use of MRI. According to the literature, it is a method for early diagnosis of aseptic necrosis, allowing one to determine and measure the size of the affected area, display the structure of the hip joints at an early stage of the disease, note the presence of effusion and a decrease in signal intensity in the subchondral zone of the femoral head without signs of changes in the shape of bone structures [5, 12.30].

Total hip replacement. At the present stage of development of traumatology and orthopedics in the treatment of injuries and diseases of the hip joint, endoprosthetics is given very great importance [24, 26,30,38,46].

Endoprosthetics is a complex, high-tech surgical intervention that is performed due to the ineffectiveness of other treatment methods [5,14,28,]

It allows you to restore mobility in the hip joint, ensure supportability of the limb and eliminate pain. The need for this method of treatment is constantly growing throughout the world, and the indications for surgery are expanding. One of the advantages of endoprosthetics is the improvement in the quality of life of patients. Surgical treatment of degenerative diseases in 85.5% of cases provides a positive result, in 75.5% - restoration of working capacity, which indicates the high effectiveness of this method [11,38].

A large number of scientific works are devoted to endoprosthetics, in which indications for this surgical intervention have been developed and clarified [12,23,44].

To ensure a positive therapeutic effect, it is necessary to identify structural changes in bone tissue at the pre- and postoperative stages. According to V.P. Novikov (1981), the leading method of radiation diagnostics in traumatology and orthopedics is radiography, which is fundamental in monitoring the condition of the joint after endoprosthetics [3,6,43].

K. M. Sherepo (1990) attaches great importance to the X-ray method of examination in endoprosthetics. The author clearly formulated the radiological signs of the technical execution of total prosthetics. According to the author, this method also makes it possible to document errors and complications of endoprosthetics.

When directly preparing a patient for endoprosthetics, preference should be given to radiographic data. MSCT is of a clarifying nature, allowing one to assess the depth of changes in the head of the femur and the supra-acetabular region of the body of the ilium. These data are important for planning surgical intervention.

Determining the geometric features of the entire proximal femur is necessary to select the type of endoprosthesis size.

The combination of traditional radiography and MSCT allows us to study in detail the geometric parameters of the articular ends of bones and their relationships. Such a study seems very promising and is poorly reflected in the modern literature on endoprosthetics.

It is important to study the spatial position of the endoprosthesis in the tissues after implantation, as well as to compare the location of the attachment points of the main muscle groups before and after surgery [9,13,22,36].

During surgery, periprosthetic fractures and dislocation of the prosthetic head from the cup are possible. Identification of possible intraoperative and early postoperative complications is carried out using radiography [2,14,29,42].

The use of ultrasound to monitor the regeneration of a surgical wound during the first two weeks, when hematomas and purulent-inflammatory complications may occur, may be interesting and promising. Under ultrasound control, it is possible to carry out various manipulations aimed at the prevention and treatment of early postoperative complications (puncture, drainage, etc.).

Another important issue that clinicians have to decide at the stage of preoperative planning is the choice of method for fixing endoprostheses. To do this, it is necessary to identify pathomorphological changes in the affected joint [4,8,15,31,41].

Subsequently, after endoprosthesis replacement, the main task is to identify changes in the "bone-endoprosthesis" design at different periods of the patient's life in order to adopt adequate treatment methods.

According to a dynamic clinical and radiological study, it was found that endoprosthetics provides good and excellent results in the coming years in 80.0-90.0% of patients [3,17,38].

However, over time, the proportion of such outcomes decreases mainly due to the development of aseptic instability. Many authors analyzed in detail the causes of various complications: aseptic instability, paraprosthetic fractures, dislocation of the endoprosthesis head, stress reaction, heterotopic ossification, purulent complications. It should be noted that their diagnosis in almost all cases is carried out using X-ray data, since the presence of a massive implant makes it difficult to use other research methods [20,22,45,46].

Aseptic instability was studied in detail by K. M. Sherepo (1990) in 673 patients after surgery for a period of 3 to 16 years. Unsatisfactory outcomes, accounting for 25.1%, are due to instability of the prosthesis. Based on a careful study of radiographs, the author identified 3 stages in the development of instability: initial, severe and advanced [7,18,20,16,32,39].

A.K. Morozov et al. (2005) believe that examination of patients after hip replacement using an orthopedic program, including radiography and X-ray densitometry, allows one to obtain objective data on the stability of the endoprosthesis. Densitometry to determine the mineral density of bone tissue around the femoral component of the endoprosthesis was used by S. S. Rodionova et al. (2000). They found that high dietary calcium intake and drug therapy with complex calcium preparations had a positive effect on bone mass restoration. Late complications include osteomyelitis, periprosthetic fractures, dislocation of the prosthetic head from the cup, and destruction of prosthetic elements.

MSCT of the hip joints after endoprosthesis surgery was used in a small proportion of patients to identify opportunities for assessing the condition of bone tissue around a metal implant [10,25,33].

Tomography above the upper contour of the metal prosthesis provided the usual visualization of bone tissue for this method with all the existing changes before surgery. Somewhat lower into the cut were part of the cup and the head of the rounded prosthesis, which is located in the center of the cup. The tomograms clearly show the structure of the bone tissue and cement. Radiation artifacts were visible around the metal head, interfering with visualization of the bone tissue structure. Tomograms at the level of the prosthesis leg gave the same picture as at the level of the head, i.e. Around the most massive part of the pedicle, a significant number of artifacts were noted, interfering with the assessment of bone tissue. In the presence of two prostheses, the situation was complicated by the fact that the artifacts intensified among themselves and the visualization of bone and soft tissue structures deteriorated even more. These circumstances have significantly limited the use of MSCT after prosthetics [3,25,37].

Conclusion.

Analyzing the literature data, we can conclude that an integrated approach is needed to the selection of radiological diagnostic methods for hip replacement. To determine their role and place in planning surgical intervention and monitoring treatment results in the postoperative period, an assessment of the capabilities and limitations of the methods should be carried out, which will allow:

primary and differential diagnosis of hip joint pathology to a sufficient extent; clearly define indications and contraindications for surgery, carry out preoperative planning; promptly identify possible complications both at the intraoperative stage and in the early and late postoperative period.

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