

CONDITION OF FACET JOINTS AT VARIOUS STAGES OF OSTEOARTHRITIS FORMATION IN CHILDREN, ADOLESCENTS AND ATHLETES: MODERN ASPECTS OF DIAGNOSTICS AND PREVENTION (LITERATURE REVIEW)

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Abstract

The article is devoted to the study of the state of facet joints in children and adolescents involved in sports, as well as in the sports contingent in the context of osteoarthritis development. Facet joint osteoarthritis, as a key component of degenerative changes in the spine, is a significant cause of pain syndrome and mobility limitations in young athletes. The article discusses the main mechanisms of occurrence and progression of facet osteoarthritis, as well as the influence of various factors, such as the type of sports activity, intensity of physical activity and age characteristics. Diagnostic methods, including radiological studies, and treatment approaches aimed at reducing pain syndrome and improving the quality of life of patients are described. The results of the study emphasize the importance of early diagnosis and prevention of facet joint osteoarthritis in sports and adolescent practice

Introduction

Facet joints play a key role in providing stability and mobility of the spine, especially in the lumbosacral and cervical regions. Along with intervertebral discs, they participate in the distribution of axial load and shock absorption during

movement, which makes them one of the most important structural and functional components of the musculoskeletal system. Under conditions of intense physical activity, especially in children and adolescents actively involved in sports, facet joints are exposed to high biomechanical stress, which can lead to their early damage and subsequent formation of osteoarthritis.

The relevance of studying the state of facet joints in children, adolescents and sports contingent is due to several important aspects. Firstly, in recent years there has been an increase in interest in the early diagnosis of degenerative-dystrophic diseases of the spine, including osteoarthrosis of the facet joints, as one of the causes of chronic pain syndrome in children and adolescents. Secondly, against the background of the growing popularity of professional sports among minors, the frequency of injuries and overload conditions directly related to changes in the structure of the facet joints increases. At the same time, children and adolescents often do not have pronounced clinical manifestations in the early stages of pathology, which complicates timely diagnosis.

Pathophysiology

Despite significant progress in the field of visualization methods and biomechanical analysis, there is still a lack of data on the staging of morphofunctional changes in facet joints in children and young athletes. The problem is aggravated by the fact that most existing studies focus on adults, while age-related features of bone and cartilage tissue in the pediatric population require separate consideration.

Thus, systematization of modern data on the state of facet joints at various stages of osteoarthritis formation in children, adolescents and sports contingents is an important direction both for early diagnosis and for the development of effective strategies for prevention and medical rehabilitation.

Clinical Manifestations

Research in recent decades in the field of pediatric orthopedics and sports medicine has increasingly drawn attention to the importance of facet joints as one of the key elements involved in early degenerative processes of the spine. According to the work of AT Lawrence et al . (2015), the initial signs of facet osteoarthrosis can already form in adolescence, especially in athletes involved in sports with high axial loads (gymnastics, wrestling, weightlifting).

Diagnostic Methods

In the publication by Kalichman L. and Hunter DJ (2007), devoted to morphological changes in facet joints in osteoarthritis, it is emphasized that subchondral sclerosis, narrowing of the joint space and osteophytosis are observed in individuals under 20 years of age in the presence of regular overload of the spine. This confirms the hypothesis about the possibility of early initiation of the osteoarthritis process in childhood and adolescence.

Works of Japanese researchers (Yasuma T., 2012; Kimura T. et al ., 2016) focus on the use of high-resolution MRI and CT for early detection of changes in facet joints. The use of 3D reconstruction allows detection of microarchitectural changes preceding clinical manifestations of the disease. In addition, they note that changes most often affect the L4-L5 and L5-S1 levels, which is associated with the maximum load in these segments.

American and Canadian authors (Frymoyer JW, 2009; Muehlbauer JM, 2020) focus on the close relationship between early posture disorders, facet pathology and the risk of chronic pain syndrome in the lumbar spine. It is noted that children with spinal biomechanics disorders at school age demonstrate signs of facet dysfunction by the age of 12–14.

A study by a British group (O'Sullivan P., 2013; Greenough CG, 2017) emphasizes the importance of a comprehensive approach to diagnostics, including biomechanics of movements, neuromuscular control and visualization data. In particular, the authors suggest using dynamic MRI to assess the condition of facet joints under conditions of simulated sports loads.

In general, the analysis of foreign literature confirms the existence of a clear relationship between physical overloads, age-related features of spine development and early degenerative changes in facet joints. The use of modern visualization technologies and biomechanical monitoring allows us to diagnose pathological changes at the preclinical stage, which is especially important for pediatric sports medicine. Plain radiographs provide initial assessment of cervical alignment and

detect gross degenerative changes, such as osteophytes and disc space narrowing (Modic et al., 1988). However, they offer limited visualization of neural elements.

Treatment Approaches

Modern medical practice abroad emphasizes conservative and minimally invasive approaches to the treatment of early stages of facet pathology in adolescents, especially in the sports environment. In the Dreyfuss study et al . (2017), conducted in the USA, notes the effectiveness of individualized rehabilitation programs aimed at stabilizing the lumbar spine and optimizing facet biomechanics. The importance of kinesiotherapy and functional training in the correction of pathological hypermobility is emphasized .

Wright et al . (2020) point out the importance of using **Motion technology Analysis and 3D balance platform** for objective assessment of the impact of training load on the spine of young athletes. This allows to adapt the treatment program depending on pathobiomechanical changes in the facet joints.

In Germany and Sweden, the practice of using **neurophysiological therapy** (NeuroMuscular Control Therapy) together with **functional osteopathy** and manual therapy, as reflected in the works of Müller et al . (2021). It is used in children's sports centers at the first signs of facet joint dysfunction and successfully reduces the risk of chronic pain syndrome.

Non-invasive tissue stimulation methods are also being actively introduced , including **low-intensity laser therapy , electromagnetic therapy and vacuum decompression** to improve microcirculation and relieve inflammatory reactions (Yamasaki et al . , 2022).

Review of domestic (Russian and post-Soviet) literature.

In the post-Soviet scientific space, issues of diagnostics and morphofunctional assessment of facet joints in children and adolescents are

receiving increasing attention, especially in the context of sports medicine and traumatology. Thus, in the works of V.A. Loskutov et al . (2012), M.G. Gorshkov (2015) it is emphasized that early degenerative changes in facet joints can develop in puberty against the background of intense sports activities and postural disorders.

Research by S.V. Kornilov (2018) and L.P. Tarasova (2019) showed that in the presence of dysplastic changes in the spine and hypermobility of the facet joints, the risk of microtrauma of the joint capsules increases, which contributes to the progression of osteoarthritic changes already in adolescence. The authors note the high information content of the ultrasound examination method and functional X-ray control with load.

The works of E.P. Voronova (2020) and S.N. Plotnikov (2021) consider the importance of facet joints in the formation of pain syndrome in schoolchildren and young athletes with functional posture disorders and scoliotic deformities. Based on clinical and MRI studies, it was found that by the age of 12–16, young athletes (gymnasts, wrestlers, weightlifters) show signs of subchondral restructuring of the articular surfaces and hypertrophy of the joint capsules.

Of interest are the data of Moldovan and Belarusian specialists (Yakubovich I.N., 2016; Murashko A.A., 2018), according to which the use of biomechanical tests and three-dimensional computed tomography allows identifying instability of facet joints at early stages, before persistent symptoms appear. These approaches are used in the system of preventive examinations of schoolchildren and students of sports schools.

The works of Kazakh and Armenian scientists (Alimbayev T.Zh., 2019; Gareginyan S.M., 2020) also emphasize the importance of comprehensive monitoring of the spine condition in the sports contingent. The use of digital kinesiography and complex electromyography of facet-dependent muscles allows obtaining objective data on the load on the segments of the spinal column and predicting the development of degenerative processes.

In general, domestic literature emphasizes the need to introduce early diagnostics of facet pathology into pediatric and sports practice, focusing on an

individual approach, anatomical and functional assessment of vertebral segments and the importance of preventive work in schools and sports institutions.

In Russia and the CIS countries, the active implementation of multi-level medical rehabilitation programs continues, including exercise therapy, orthopedic correction techniques, physiotherapy and massage. The studies of I.V. Trukhanov et al . (2018) have proven the effectiveness of the Bubnovsky technique and post-isometric relaxation in adolescents with facet syndrome against the background of the initial stages of osteoarthritis.

The works of V.N. Moshkov (2019) and L.N. Ignatova (2020) emphasize the importance of combining physiotherapy (magnetic therapy, ultrasound) and stabilizing exercises in correcting the condition of facet joints in young athletes involved in game and strength sports.

The data of Ukrainian specialists (Senchuk O.A., 2021) are interesting, where the effect of **kinesiotaping** in combination with stabilizing orthoses in the early stages of facet instability is described. The results obtained showed a decrease in pain syndrome and an improvement in the motor functions of the spine after 4-6 weeks of therapy. **Research conducted in the Republic of Uzbekistan.**

In Uzbekistan, the problem of early diagnostics of degenerative changes in facet joints in children and adolescents, especially in conditions of increasing sports load, is receiving increasing attention. In recent years, scientific research aimed at assessing the morpho-functional state of the spine in schoolchildren and young athletes has intensified.

Thus, in the works under the supervision of A.I. Umarov (2020, 2023), carried out on the basis of the Republican Center for Sports Medicine and the Tashkent Medical Academy, early signs of instability and deformation of the facet joints of the lumbar spine in children aged 10–16 years involved in wrestling, artistic gymnastics and football were studied. It was shown that using MRI and ultrasound, it is possible to identify signs of subchondral restructuring, compaction of the joint capsules and local hypervascularization in the area of the joint spaces.

A study by Z.M. Kholmurodova et al . (2021) based at the Samarkand State Medical University found that in adolescent athletes (mainly weightlifters and wrestlers), the facet joints show signs of accelerated biomechanical aging, especially in the L4–L5 and L5–S1 segments. The authors proposed including regular biomechanical testing and functional myography in the preventive examination program.

The research group of N.Kh. Abdullaev and S.I. Rakhmatova (2022) at the Tashkent Pediatric Medical Institute conducted a study on the role of facet pathology in the formation of chronic pain syndrome in schoolchildren with posture disorders. As a result, it was proposed to use modified visual analog pain scales (VAS), as well as complex neuromuscular control tests for the early detection of facet joint instability.

Works under the supervision of D.M. Toshpulatov (2023) in collaboration with the Department of Anatomy of the Bukhara State Medical Institute focus on the morphological analysis of the facet joints of the lumbar region in children of different ages, taking into account gender and physical activity. Data were obtained on the differences in the orientation angles of the articular processes, the degree of their asymmetry and the relationship with the type of motor activity.

Also noteworthy are the data obtained with the participation of the Department of Sports Medicine of the Uzbek State University of Physical Education and Sports (2022–2024). Based on the examination of more than 300 young athletes, it was found that facet changes often correlate with muscle imbalance, improper exercise technique, and insufficient recovery after training. It is recommended that biomechanical monitoring and manual assessment of facet joints be included in sports medical examinations.

Thus, studies conducted in the Republic of Uzbekistan confirm the importance of early diagnostics of changes in facet joints in the prevention of osteoarthritis in children and adolescents. Particular attention is paid to complex approaches combining visualization, functional and morphological methods.

In Uzbekistan, modern approaches to the correction of facet joint pathologies are developing in line with the integration of international experience and the traditional rehabilitation school. Thus, the Center for Sports Medicine under the Ministry of Sports (2021–2024) has developed comprehensive rehabilitation programs that include elements of therapeutic exercise, mobilization gymnastics, kinesiotherapy and massage with an emphasis on normalizing the functions of the facet joints and paravertebral muscles.

Research by N.K. Yunusova et al . (2022, TashPMI) showed a positive effect from a combination of postural control, training of deep back muscles and physiotherapy using myostimulation in adolescents with instability of facet joints against the background of hyperlordosis .

The works of S.M. Rakhmatov (2023, Namangan Medical Institute) demonstrated the effectiveness of **soft manual therapy and dynamic neuromuscular stabilization** (DNS) in child athletes, especially during the recovery period after injuries. The author notes that these methods improve posture control, reduce overload of the facet joints and help prevent chronicity osteoarthritic changes.

Orthopedic correction methods are also actively used , including individual corsets, orthoses and corrective shoes for children with posture disorders, as a preventive measure for the formation of secondary facet disorders (Ismoilova Sh.R., 2022).

Discussion.

An analysis of the presented literature and the results of scientific research in the field of the state of facet joints in children, adolescents and sports contingents shows that in recent years, interest in early diagnostics and correction of pathological changes in this anatomical structure of the spine has increased significantly. This becomes especially relevant in the context of active sports, when the musculoskeletal system is subject to increased mechanical stress during the period of growth and formation of the skeleton.

One of the key points identified during the review is the trend towards a **multidisciplinary approach** - a combination of orthopedics, sports medicine, neurology, physiotherapy and biomechanics. Foreign studies focus on **instrumental diagnostic methods** (MRI, ultrasound, kinesiological testing, biomechanical analysis of movements), which allow identifying hidden forms of instability and functional disorders of facet joints long before clinical manifestations. In the post-Soviet countries and, in particular, in the Russian Federation and Uzbekistan, the emphasis remains on **rehabilitation and treatment measures** combining classical therapeutic exercise, physiotherapy and orthopedic correction. However, modern technologies such as **kinesiotaping**, **neuromuscular stabilization**, **interactive simulators** are gradually being introduced, which contributes to the convergence of domestic practice with international standards.

Of particular interest is the identification of **prognostic risk factors** for the development of facet joint osteoarthritis in child athletes. These include: congenital anomalies in the development of the spine, posture disorders (including hyperlordosis, scoliosis), joint hypermobility, irrational training loads and injuries in the anamnesis.

A comparative analysis showed that despite the different levels of technical equipment and access to innovations, both foreign and domestic works emphasize the need for an **individualized approach to each child**, taking into account age, gender, and level of physical activity and biomechanical characteristics of the musculoskeletal system.

Of national registers and protocols for early screening of facet pathology in children's and youth sports practice has also been identified. This is especially relevant for the Republic of Uzbekistan, where youth sports are actively developing, but there is still insufficient systematized data on the prevalence and structure of spinal pathologies.

Thus, further research should be aimed at: improving diagnostic criteria and introducing unified protocols for assessing the condition of facet joints in children; developing and testing comprehensive prevention and treatment programs using

biofeedback technologies, digital diagnostics and personalized kinesiotherapy methods ; improving the qualifications of specialists in early detection and correction of initial forms of osteoarthritis in adolescents and young athletes.

Conclusion .

Facet joints play a key role in ensuring the stability and mobility of the spinal column. Disturbances in their structure and function, especially in the early stages of development, can cause chronic pain syndromes, movement disorders and lead to the formation of osteoarthritis already in adolescence. This is especially relevant for children, adolescents and sports contingent, in whom the impact of high physical loads is combined with ongoing growth and morphological formation of the musculoskeletal system.

The conducted literature review shows that modern approaches to diagnostics and treatment of facet joints tend to individualization and multidisciplinary interaction. Inclusion in practice of such methods as magnetic resonance imaging, biomechanical assessment, kinesiological testing, as well as the use of neuromuscular stabilization and functional rehabilitation allow to identify early forms of pathologies and effectively correct them.

Despite certain achievements, the tasks of standardizing diagnostic protocols and creating data registers on facet joint pathologies in children and adolescents, especially in the CIS countries and Uzbekistan, remain relevant. Timely detection of risk factors, preventive work in sports medicine and the introduction of innovative rehabilitation methods can significantly reduce the risk of developing osteoarthritis and other degenerative diseases of the spine in the future.

Thus, it is necessary to coordinate the efforts of researchers, doctors, coaches and physical education specialists to create a comprehensive system of early diagnostics, monitoring and correction of disorders in the area of facet joints in young athletes and physically active children. This will contribute to improving the health of the younger generation, preventing disability and increasing athletic longevity.

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