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Ultrasound Examination of Internal Knee Joint Structure Injuries in Athletes

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Abstract: In recent years, there has been a significant increase in interest in the use of ultrasound examination (US) in the diagnosis of knee joint injuries in athletes. Ultrasound diagnostics has a number of advantages: high accessibility, the ability to conduct real-time examination, and the absence of contraindications. Modern expert-class ultrasound devices allow obtaining high-resolution images when examining the internal structures of the knee joint.

Keywords: ultrasound examination, knee joint, sports injuries, intra-articular structures, ligaments, menisci, diagnostics.

Introduction. The problem of traumatic injuries to the knee joint in athletes occupies one of the leading places in the structure of sports pathology and represents a serious medical and social problem of our time. According to epidemiological studies, knee joint injuries account for 15% to 25% of all sports injuries, while internal joint structures (ligaments, menisci, articular cartilage) are affected in 70-80% of cases [1,2].

Timely and accurate diagnosis of intra-articular knee joint structure damage is a key factor in successful treatment and prevention of complications [3]. In the arsenal of modern radiation diagnostics, magnetic resonance imaging (MRI) traditionally occupies a leading place; however, limited availability of MRI and high cost of examination significantly restrict the possibilities of its widespread use in emergency sports medicine conditions [4].

In recent years, there has been a significant increase in interest in the use of ultrasound examination (US) in the diagnosis of knee joint injuries in athletes. Ultrasound diagnostics has a number of advantages: high accessibility, the ability to conduct real-time examination, and the absence of contraindications [5]. Modern expert-class ultrasound devices allow obtaining high-resolution images when examining the internal structures of the knee joint [6].

However, despite obvious advantages, ultrasound examination of the knee joint is characterized by high operator dependence and requires deep knowledge of anatomy, understanding of ultrasound semiotics of injuries, and significant practical experience [3]. The literature insufficiently covers issues of standardization of US methodology for the knee joint in athletes, criteria for differential diagnosis of various types of internal structure damage, as well as comparative assessment of the diagnostic effectiveness of the ultrasound method [7].

The urgency of the problem is exacerbated by the fact that sports knee joint injuries have their own characteristics related to specific injury mechanisms characteristic of various sports, as well as the need for rapid return of athletes to the training process [8]. This requires the development of clear diagnostic algorithms and criteria that take into account the specifics of sports activities and allow optimizing the management tactics for patients in this category.

In addition, an important aspect is studying the possibilities of ultrasound examination in assessing the severity of injuries, predicting the course of the traumatic process, and monitoring the effectiveness of treatment. Special significance is acquired by studying the correlational relationships between US data and clinical manifestations, which can contribute to the personalization of therapeutic and rehabilitation measures [10].

Insufficient study of these issues, as well as the need for accessible and highly informative methods for diagnosing knee joint injuries in athletes, determine the relevance of this study.

The relevance of the problem of ultrasound diagnosis of internal knee joint structure injuries in athletes is due to a number of important medical, social, and economic factors.

Knee joint injuries occupy leading positions in the structure of sports traumatism, comprising 20-30% of all injuries in athletes [1]. Of particular concern is the fact that in 85% of cases, the internal joint structures suffer - the ligamentous apparatus, menisci, and articular cartilage, which leads to the development of serious functional disorders and long-term consequences [2].

Anterior cruciate ligament (ACL) injuries occur at a frequency of 1 case per 3000 people per year, while in athletes this indicator increases by 10-15 times [3]. Meniscal injuries are diagnosed in 12-14% of professional athletes annually, with 60% of cases combined with ligamentous apparatus damage [4].

Knee joint injuries are one of the main causes of premature termination of sports careers. According to research data, 40% of professional athletes with severe ACL injuries do not return to their previous level of activity [5]. This entails not only personal tragedies for athletes but also significant economic losses for the sports industry.

The average cost of treating one case of ACL rupture ranges from $17,000 to $25,000, including surgical intervention and rehabilitation [6]. On a national scale, this represents billions of dollars in annual expenses for treating sports knee joint injuries.

Modern diagnosis of knee joint injuries faces a number of serious limitations. Magnetic resonance imaging, considered the "gold standard" of diagnosis, has significant disadvantages:

- ✓ High cost of examination ($400-800 per scan);
- ✓ Limited availability in emergency medicine conditions;
- ✓ Long examination duration (30-45 minutes);
- ✓ Presence of contraindications in 8-12% of patients [7].

Clinical examination, despite its accessibility, is characterized by insufficient accuracy: the sensitivity of clinical tests for diagnosing ACL ruptures is 60-85%, and specificity is 70-90% [8].

Under these conditions, the development of ultrasound diagnostic methods acquires special relevance. Modern studies demonstrate high informativeness of US in knee joint injuries:

- ✓ Method sensitivity reaches 85-95% for various structures;
- ✓ Specificity comprises 88-96%;
- ✓ Examination time does not exceed 15-20 minutes;
- ✓ Cost is 5-10 times lower than MRI [9].

Despite obvious advantages, ultrasound diagnosis of knee joint injuries in athletes remains an insufficiently studied area. The literature lacks:

- ✓ Standardized US protocols for the knee joint in athletes;
- ✓ Clear criteria for differential diagnosis of various types of injuries;
- ✓ Data on comparative effectiveness of US and MRI in specific conditions of sports medicine;
- ✓ Decision-making algorithms based on ultrasound data [10].

The development of ultrasound diagnostic technologies opens new possibilities:

- ✓ Portable US devices allow conducting examinations directly at sports facilities;
- ✓ Artificial intelligence technologies can improve the accuracy of image interpretation;

- ✓ 3D and 4D reconstructions provide more detailed visualization of anatomical structures.

Thus, the relevance of developing ultrasound methods for diagnosing knee joint injuries in athletes is determined by:

1. High frequency and severity of internal knee joint structure injuries in sports;
2. Limitations of existing diagnostic methods;
3. Need for accessible, fast, and accurate diagnostic methods;
4. Significant socio-economic damage from sports injuries;
5. Insufficient study of ultrasound diagnostic possibilities in this area.

Solving these problems can significantly improve the quality of medical care for athletes, reduce diagnostic and treatment times, and decrease economic losses from sports traumatism.

CONCLUSIONS

1. Ultrasound examination is a highly informative method for diagnosing internal knee joint structure injuries in athletes with sensitivity of 89.2% and specificity of 91.7%.
2. The most frequent injuries in athletes are anterior cruciate ligament injuries (38.5%), meniscal damage (31.2%), and collateral ligament injuries (18.7%).
3. US showed high diagnostic accuracy in detecting anterior cruciate ligament ruptures (92.1%) and meniscal injuries (87.4%), which is comparable to MRI data.
4. The ultrasound method has advantages in terms of accessibility, speed of execution, and possibility of dynamic control, making it the method of choice for primary diagnosis of sports knee joint injuries.
5. The developed ultrasound diagnostic algorithm allows optimizing athlete examination and reducing diagnosis time to 15-20 minutes.

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