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Physical Activity and Knee Joint Injuries - Risk Factors, Management and Prognosis

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ABSTRACT

Introduction and Aim: Physical activity is one of the main risk factors for knee joint injuries, and the risk depends on the specific sport. Each part of the knee joint can be at different risk of injury. Diagnosis, treatment and rehabilitation are key to returning to full mobility, but vary depending on the type of injury. The purpose of this article is to present risk factors, diagnosis, treatment and prognosis in the most common knee joint injuries.

Review Methods: 35 studies from PubMed and Google Scholar were analyzed to examine the relationship between physical activity and knee joint injuries. Joint anatomy, diagnosis, treatment and rehabilitation in the context of amateur and professional sports were considered.

State of Knowledge: Knee joint injuries often result from sudden movements. ACL rupture is the most common injury, often non-contact. Diagnosis is based on history and imaging studies, such as magnetic resonance imaging (MRI) to evaluate soft structures and X-rays for

bone injuries. Treatment depends on the type of injury: in mild cases rehabilitation is sufficient, in more serious cases surgery.

Summary: Physical activity is a major risk factor for knee injuries, and the most common injury is an ACL injury. The risk depends on the mechanism of injury, age, weight and previous injuries. It is crucial to take a history, do a physical examination and perform imaging to make a diagnosis. Proper diagnosis allows for the selection of the appropriate treatment and rehabilitation method, which affects the patient's prognosis and return to full physical activity.

Keywords: knee joint, physical activity, injury, imaging diagnosis, treatment, rehabilitation

1. Introduction:

Knee joint injuries are among the most common in orthopedics and traumatology, especially in physically active individuals. [1] Injury to the knee joint can involve various structures. These include ligaments, meniscus, patella, bones that form the joint, and articular cartilage. The main symptoms of damage to the knee joint, depending on which part sustained the injury, are pain, swelling, restriction of joint mobility, impaired loading of the lower limb, and blocking of the joint during movement.[2] Depending on the damage to the specific structure of the knee, symptoms may be different. In order to make a correct diagnosis and apply appropriate treatment to the patient, it is necessary to take a thorough history, perform a detailed examination of the patient starting with a physical and then perform appropriate symptom-dependent imaging studies of the knee joint. [2] Imaging studies make it possible to make a diagnosis and then apply appropriate treatment and rehabilitation methods to patients. Important risk factors for knee joint injury are age, previous knee injuries, obesity and work that overloads the knee. [3]

The purpose of this article is to present the relationship of the most common knee joint injuries to physical activity in both professionals and amateurs, as well as further management and prognosis.

2. Anatomy and function of the knee joint

In order to show the relationship between physical activity and injuries to the knee joint, it is necessary to study the anatomy to better understand the differences shown by imaging studies and to match the symptoms to the function of a particular part of the joint . The knee joint is a modified hinge type joint - it allows bending and straightening but also internal and external rotation. The knee can be considered as two separate joints - the tibiofemoral joint and the patellofemoral joint. The condyles of the femur form the articular head of the joint, while the acetabulum is formed by the upper surfaces of the tibial condyles deepened by the medial and lateral meniscus, divided by the intercondylar prominence. [4]

2.1.The ligaments of the knee increase the stability of the knee and limit excessive movement within the joint. The two main groups of ligaments are the collateral ligaments of the knee and the cruciate ligaments.

Of the cruciate ligaments, we recognize the anterior (ACL) and posterior (PCL). The ACL prevents anterior displacement of the tibia onto the femur when the knee is bent, and protects against valgus deviation and internal rotation of the tibia. Its damage is the most common acute knee injury during physical activity.
The PCL prevents posterior displacement of the tibia onto the femur.

The collateral ligaments of the knee are divided into lateral (LCL) and medial (MCL).
The medial ligament prevents deviation of the knee during valgus stress and external rotation.
The lateral prevents deviation in talus, as well as excessive internal rotation of the knee.

2.2 There are two meniscuses - lateral and medial. These are fibrocartilaginous structures that are located between the condyles of the femur and the articular surface of the tibia. Their main functions are cushioning and stabilization of the knee. The medial meniscus is up to three times more susceptible to injury.

2.3 At the front of the knee joint is the patella - the largest sesamoid bone in the human body. It protects the knee joint from the front, the quadriceps tendon is attached to it from above, the patellar ligament from below and the patellofemoral joint from within, and supplies nutrients to the knee joint.

The above structures are dependent on each other. The functions of the knee joint are to perform lower limb movements and stabilization during standing, walking and other physical activities. Proper knowledge of the anatomy and function of specific structures of the knee joint allows us to better understand the mechanisms of injury during physical activity and adjust the appropriate diagnosis and treatment. [4] [5] [6]

3. Physical activity and the risk of knee joint injuries

In athletes, knee joint injuries can account for as many as ⅓ of all injuries. Up to 50% of patients are young, under the age of 30. The most commonly documented injuries are anterior cruciate ligament (ACL) damage of 20%, medial meniscus damage of about 10%, tibial collateral ligament damage of about 8%, lateral meniscus damage of about 4, fibular collateral ligament damage of about 1.1% and posterior cruciate ligament damage of about 0.5%. [7] The patella is also vulnerable to injury in people with active lifestyles, with patellar tendinopathy more common. [8]

Physical activity significantly increases the risk of knee joint injuries. In recent years, the number of injuries has increased due to more and more people leading healthy and active lifestyles. The greatest risk of knee joint injury is associated with contact sports such as soccer, basketball and combat sports, but also sports in which the knee joint is loaded continuously, such as running and volleyball.

Depending on the type of sport practiced, a different part of the knee joint is more exposed. This is due to the mechanisms performed in a particular sport, which expose a specific part to injury.

The most common knee injury in athletes is ACL rupture. This is the most common injury to the knee joint in people who play soccer but also handball or practice combat sports like judo or jiu-jitsu. The mechanism of ACL rupture is complex. ACL rupture occurs in athletes in non-contact mechanisms, a non-contact rotational injury in which the tibia moves forward while the knee is slightly bent. Symptoms of ACL rupture include sudden pain in the knee,

swelling, and instability of the joint. The patient often describes a sudden feeling of "cracking" inside the knee. ACL rupture makes walking and standing very difficult, often even impossible. ACL rupture can indirectly negatively affect other components of the knee joint and lead to their damage. An example is the medial meniscus. [9][10][11][12][13]

The meniscus is also often injured during physical activity. More often the medial meniscus is injured. This is due to its anatomy and mechanism of injury. It is closely associated with the joint capsule and ACL, making its mobility limited and more easily damaged, most often due to rapid rotation of the tibia when the joint is flexed. Meniscus injury can occur in any type of sport, but a high percentage of cases have been reported in running or climbing sports. In contact sports like soccer, these injuries occur less frequently than ACL ruptures. This is due to the fact that sports like soccer have more frequent torsional mechanisms, which are much less common in sports like running or mountaineering which increases the percentage of ACL ruptures by far and this results in their prevalence over meniscus injuries. [9][14]

In jumping sports patellar tendinopathy otherwise known as jumper's knee is much more common. The basic mechanism involves microtrauma to the ligament connecting the patella to the tibia. These result from repetitive extension mechanisms that stress the knee, such as jumping or landing. This leads to overloading. The main symptoms are pain and tenderness of the knee, especially in the area of the lower edge of the patella. Increased tension is also felt in this area, occurring when the knee is straight and less when it is bent. [9][15]

4. Imaging studies in the diagnosis of knee joint injuries

A presumed knee joint injury requires both a thorough history, physical examination and detailed imaging studies to properly visualize all structures, make a diagnosis and assess the severity of the injury. It is also crucial for choosing the correct treatment and rehabilitation of patients. Of the imaging methods of examination, we distinguish ultrasound, X-ray, MRI and CT. A method also helpful is knee arthroscopy, which in itself is not a classic imaging method because it allows imaging of knee structures from the inside, as well as performing procedures on the knee joint. [16,17]

Ultrasound in the examination of the knee joint is one of the basic imaging tests, fast and easy to perform but with limitations in imaging individual structures. It allows detection of joint effusion (e.g., as a result of trauma, infection or inflammation), diagnosis of ligament damage, such as ACL rupture, assessment of the condition of tendons, examination of the presence of cysts or subcutaneous cysts and other changes in the joint. In addition to acute conditions seen in athletes, it can also be used to assess the severity of osteoarthritis and perform fluid aspiration procedures. Depending on diagnostic needs, examinations are performed on a person in a lying or standing position. Ultrasound, due to its limitations in accurate imaging, may be insufficient and further diagnostic work-up is needed, for example, by MRI of the knee. As a non-invasive, rapid, inexpensive and radiation-free imaging modality, ultrasound has the potential to be used in initial defect screening evaluations of patients presenting for the first time with a primary symptom of knee pain or disability. [17]

X-ray of the knee joint is also one of the first tests used in the diagnosis of knee injury. The X-ray allows visualization of the bones - the condyles of the femur, the proximal end of the tibia, the fibula and the patella. X-ray allows assessment of fractures, dislocations, features of degeneration of the joint in different compartments of the joint, assessment of joint space narrowing and the presence of osteophytes. In the evaluation of degenerative changes, there are many scales. with the most widely known and still used today being the Kellgren-Lawrence Grading Scale. Measuring the width of the joint space on radiographs of the knee joint in standing and flexed positions, performed according to established positioning rules and imaging protocols, has a high degree of precision, making it an effective tool for monitoring the progression of degeneration in long-term studies. [18]

MRI of the knee is a common diagnostic test that is performed to detect and evaluate acute and chronic internal injuries of the knee joint. It is the gold standard for diagnosing knee injuries.[17][19][21] It provides accurate imaging of the bones, ligaments, meniscus, articular cartilage, tendons, synovial membrane and periarticular soft tissues of the knee joint and aids in treatment planning. [23] The disadvantages of MRI are its high cost and limited availability. Importantly, MRI should only be used when necessary. If the injury is not

advanced and less accurate imaging studies like X-rays or ultrasound are sufficient for diagnosis, then there is no need for MRI.

CT can be used as an alternative to MRI when X-ray is inadequate because it is less expensive and more widely available in medical facilities. [25]

Arthroscopy is a minimally invasive diagnostic and treatment method for the knee. The advantages of this method are minimally invasive, faster recovery time and reduced complications. [26] The disadvantages of arthroscopy are limited access and necessary operator experience.

As noted above, the gold standard in the diagnosis of knee injuries is MRI, as it allows accurate imaging of all structures and this increases the likelihood of a correct diagnosis. Ultrasound and X-ray should be the initial examination. An MRI scan, alternatively a CT scan, should be used to deepen the diagnosis.

5. Treatment - current guidelines

Treatment of the knee joint must be preceded by correct diagnosis without which it is not possible to choose the best method. The choice should be guided by the patient's well-being, individual approach and offer the least invasive method, allowing the fastest possible return to health and physical activity. Depending on the damaged structure of the knee, the choice of treatment method is different. [27]

Treatment of knee ligament injuries, depending on the severity of the damage, can be conservative and surgical. The decision is made based on the level of physical activity, goals and expectations of the patient. According to the recommendations, in physically active patients who want to return to full function after injury, surgical treatment is more often recommended, e.g. in the case of ACL rupture, it is anatomical reconstruction of the ligament. In patients with mild injuries, surgical treatment can be delayed or conservative treatment consisting of rehabilitation, pain management, orthoses and restriction of physical activity can be opted for. The disadvantage of conservative treatment is the increased risk of new injury to

the joint due to instability. Importantly, in jumping sports athletes, surgical ligament reconstruction is a strong recommendation, when in other sports conservative treatment is often a choice on equal footing with surgical treatment. [28]

Treatment of patella injuries - in injuries like tendinopathy begins with conservative treatment consisting, for example, of massage, taping or orthoses. As a rule, such treatment is sufficient. Operative treatment is used when there is no improvement after conservative treatment. Both arthroscopy and open surgery are commonly used. At the same time, the time to return to sports activity is longer i.e. about 8 months for open surgery, compared to arthroscopy of about 4 months. The average rate of return to sports is similar in both surgical methods. [29]

The meniscus can be treated in three ways. Treatment options fall into three main categories: conservative treatment, meniscectomy or meniscus surgery. Choosing the most appropriate treatment for a given patient depends on both patient-related factors (e.g., age, comorbidities, patient cooperation) and the characteristics of the injury, i.e., location of the injury, age, ability to reduce the injury [30]. Conservative treatment of meniscus injuries has been well documented. Its main application is in damage caused by degeneration rather than acute trauma. Exercise has been shown to improve meniscus function and reduce joint pain.
The indication for meniscectomy is when conservative treatment has not had the desired effect or when the lesions are too extensive that regeneration is impossible.
Surgical treatment is associated with greater complications, longer rehabilitation times and a later return to full physical activity, but it allows for a full recovery and reduces the risk of new injury due to the strain of instability on other knee structures. The choice should always be up to the patient and each must be approached on an individual basis.

6. Rehabilitation and return to health and physical activity

As with medical treatment, rehabilitation varies depending on the damaged structure. For severe and acute injuries like ACL rupture, rehabilitation takes longer and requires more work from the patient compared to more chronic conditions like patellar tendinopathy.

Knee ligament rehabilitation, for example, for the most common acute knee injury like ACL rupture, is long and not all patients return to full physical activity. Many experience deterioration in long-term knee-related quality of life, while nearly 35% develop symptomatic osteoarthritis. About 80% of patients return to some type of sports activity after ACL reconstruction, 65% return to pre-injury levels, and 55% return to competitive sports. Poorly prepared rehabilitation can limit subsequent sports performance and predispose to re-injury. Returning to competitive sports after ACL reconstruction is associated with a more than fourfold increase in re-injury rates within 2 years, and 20% experience a second ACL injury. [34]

Meniscus rehabilitation is not entirely clear-cut, and no real improvement in the postoperative period has been proven. Rehabilitation may be effective in selected patients. Rehabilitation depends on the type of injury and the treatment method used. Early initiation of physiotherapy, gradual introduction of load and exercise, and customization of the program to the individual patient's needs are crucial. Longer rehabilitation occurs after surgical treatment of the meniscus, such as arthroscopy or transplantation, than conservative treatment. [32]

Rehabilitation of patellar injuries such as patellar tendinopathy involves applying controlled eccentric and isometric resistance to the patellar ligament. In a study, it was shown that such exercises serve both those who participate in sports and those who do not regularly engage in physical activity. Rehabilitation can improve treatment outcomes in up to 75% of patients with patella injuries. In rehabilitation, a 3-step protocol is proposed consisting of pain and load modulation, followed by strengthening exercises and load progression, and finally a slow return to full physical activity. [33]
The return to physical activity depends on factors such as the type of injury, its severity, the speed and type of medical intervention taken or the age of the patient. After severe injuries such as ACL rupture, return to full function can be lengthy even in professional athletes. Approximately 80% of patients after anterior cruciate ligament reconstruction return to some type of sports activity, but only 65% return to pre-injury levels, and 55% return to sports at a competitive level [34,35] Inadequate rehabilitation combined with too rapid a return to sports can limit subsequent activity and predispose to injury recurrence. It has been shown that a faster and full return to full physical activity prior to injury is predisposed by young age, male

gender, being a professional athlete, and good mental status. [35] Return to full physical activity after a knee injury is not always possible, so each patient should be approached individually and comprehensively.

7. Conclusion

Physical activity significantly increases the risk of knee joint injury. It is important to carry out a complete diagnosis, choose the appropriate treatment and rehabilitation depending on the damaged structure. This will make the return to full fitness faster, more reliable and reduce the risk of secondary knee injuries.

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