# ANTERIOR KNEE PAIN SYNDROME


## Abstract

Many diseases and types of injuries of the knee joint take a lot of time for diagnosis and the elimination of all nosologies that may cause pain. The complexity of the anatomical device of the knee joint makes it possible to isolate from the general concept of pain in the knee joint of this pathogenetically grounded syndrome. The review gives an idea of a significant number of types of knee joint pathology, which, due to the structural features and similarity of the clinical picture, can be combined into anterior knee joint pain syndrome.



**Key words:** knee joint, syndrome, pain, pathology.


## INTRODUCTION

Pain is interpreted as subjective sensory and emotional experiences associated with actual or potential tissue damage. Nociceptive somatic pain associated with irritation of peripheral nerve endings, damage to cell membranes and release of pain and inflammation mediators occurs in bones, joints, muscles, skin and connective tissue. The knee joint with a complex structural architectonics, with the presence of structures with rich vascularization and innervation, and sometimes subjected to excessive loads, compared with other joints of the musculoskeletal system, is the most common reason for seeking a specialist [1]. The presence of many types of injuries and diseases of the knee joint, until recently, took away the efforts to exclude all nosologies that may cause pain, thereby increasing the duration of disability of the patient. The complexity of the device and the presence of both intra-articular and extra-articular components of the knee joint allows us to introduce the anterior pain syndrome of the knee joint. Isolation from the general concept of pain in the knee joint of this syndrome is pathogenetically justified, because will allow the specialist to reduce the time spent on search, differential diagnosis and treatment of the patient [2].

The knee joint with complex biomechanics is often subjected to loads that exceed the functionality of the latter. Consequently, the main group of patients seeking help are athletes. Knee anterior pain syndrome in athletes is a difficult problem in terms of diagnosis and treatment. The nature of injuries of the knee joint, leading to the development of anterior pain, can be divided into acute and chronic injuries caused by prolonged excessive exercise. The main cause of acute injuries is sports, especially contact sports, such as football, basketball, while non-contact sports, such as athletics, often lead to chronic injuries [3]. The concept of anterior pain in the knee joint is far from the old understanding of the structural etiological causes in the development of pathological processes, including both

bone and soft tissue structures, a significant violation of homeostasis, as the main cause in the genesis of patellofemoral pain [4].

There is a division of the causes of this syndrome into those in which focal lesions can be diagnosed clinically and radiologically, and the causes of "unclear" genesis, for example, the syndrome of lateral hyperpressure of the patella [5]. It was also proposed to narrow down the causes of potential diagnoses depending on the time and persistence of pain: constant pain, pain associated with physical activity, acute and remitting pain [6]. Christian (2006) with co-workers added anatomically isolated points, dividing into pain the causes of which are the patellar tendon ligament [PTL], the patella, intra-articular pathology and bursitis [7]. We, in turn, cannot fail to note such etiological causes of this syndrome as manifestations of systemic diseases of the connective tissue, bone tissue tumors, pathology of the synovial membrane, chondromatosis, exostotic disease.

This article is intended to highlight the anatomical separation of the causes of anterior knee pain syndrome, although all structures of the knee joint are closely interrelated and should be considered as a single mechanism.

We would like to note the importance of the patellofemoral joint (PFJ) in the genesis of anterior pain, as an important functional structure of the knee joint with complex biomechanics [8]. In the case of superphysiological loads that exceed the allowable, the homeostasis of the PFJ, which leads to increased injury and pain. The ability to transfer loads depends on many factors: the correctness of the trajectory of movement, neuromuscular tone and control, absolute loads for a long time, etc. [9]. Peripeptral soft tissues, in particular the peripipellar synovial folds, the fatty body of Hoff also contribute to the appearance of patellofemoral pain. Any PFJ structure can be a potential cause of knee anterior pain syndrome. Nerve endings are concentrated in the PTL, in the tissues of the retinaculum, in the "goose foot", and especially in the synovial folds and the fat body. Articular surfaces, menisci and ligaments are less sensitive. The articular cartilage has no innervation, the nasubchondral bone can be the cause of pain in case of severe overload and damage to the articular cartilage [10].

Since the perception of pain is a function of the central nervous system, in addition to direct nociception from PFJ structures, pain in the knee joint can be provoked by the pathology of the hip joint. The hip joint extensors play an important role in the movements of the lower limb and contribute to the absorption of up to 25% of the load when walking. When the muscles of the hip joint do not absorb their share of the load, this should be compensated by other structures, in particular the knee joint. For example, children with hip joint pathology, such as femoral head epiphysiolysis, and adults with varying degrees of osteoarthritis may complain of pain in the knee joint, although there is no pathology in the latter. The lack of changes in the knee joint should suggest a thorough examination of the hip

joint [11]. Pathological movement of the lower extremities is observed in rotational deformities in young patients: increased femoral anteversion, internal orientation of the patella, external rotation of the tibia, pronation of the foot, causing pain in the front of the knee joint.

Anterior pain syndrome of the knee joint may be caused by trauma to the intra-articular structures. Damage to the anterior cruciate ligament (ACL) leads to rotational instability and overload of the medial part of the knee joint. The most common damage to the articular surface of the medial condyle of the femur in ACL injuries. Damage to the posterior cruciate ligament (PCL) leads to the posterior displacement of the tibia and overloading of the anteromedial part of the knee joint. Syndrome of anterior pain of the knee joint with a decrease in the range of movements occurs after the reconstruction of the ACL and is a consequence of the development of the following complications: arthrofibrosis, cyclop syndrome and syndrome of infrapractical contracture [12].

Patellar trauma is a direct cause of anterior pain syndrome, and may be due to a fracture or a patellar contusion. In children, tear-off fractures of the lower pole of the patella are rare, but there may be tearing of the articular cartilage or periosteum. In children and adolescents, Osgud-Schlätter or Larsen-Johansen syndrome may be a likely cause of anterior pain. Pain in the distal pole of the patella or above the tibial tuberosity, are characteristic clinical signs. Radiographically, ossification or fragmentation due to partial separation of bone-cartilage fragments will be determined, magnetic resonance imaging (MRI) will determine the presence of ossification, thickening of the PTL and swelling of the near-tempering tissues [13, 14]. Osgood-Schlatter disease can be a predisposing factor for the development of stress fracture tibial tuberosity [15]. Early diagnosis of stress fractures of the patella, occurring predominantly at the junction of the middle and distal third of the patella, is important for ensuring adequate conservative treatment before separation of fragments occurs [16]. Violations of the ossification of the patella in 1-2% of cases is the cause of the development of the lobed patella. In rare cases, after physical exertion and acute injury, the lobed patella can cause anterior pain of the knee joint. Differential diagnosis should be carried out with Larsen-Johansen syndrome, a detachable fracture of the distal pole of the patella and a stress fracture when finding a fragment from the lateral side [16, 17, 18].

The consequences of acute dislocation of the patella, whether as a result of an acute injury or rotational tension of the extensor apparatus, can also be the cause of anterior pain syndrome. The impact on the outer surface of the knee joint can result in injury to the medial structures of the knee joint, which is often found in young athletes [19]. MRI is the method of choice for diagnosing the effects of patellar dislocation such as hemarthrosis; rupture of the medial retinaculum and the

capsule of the knee joint, with the formation of hematoma, edema, partial rupture of fibers; contusion of the lateral condyle of the femur and medial facet of the knee joint, trabecular microcracks; damage to the articular cartilage of the lateral condyle of the femur and the medial facet of the patella, and the associated finding of osteochondral free bodies [20].

The most common causes of cartilage damage are injuries, physical overload and loss of stability of the joint. It can occur both in isolation and in combination with damage to other intra-articular structures, PTL, Goff's fatty body, instability of the patella. Bohndorf indicated arthroscopic and MRI signs of cartilage damage, divided injuries into concomitant, with and without cartilage lesions [21]. MRI as a diagnostic method perfectly differentiates the structure of cartilage and other soft tissues, thinning or surface defects are clearly visible in FSEPD-mode. Perspective methods for physiological visualization of cartilage damage, such as T2 images, diffuse weighted images, and dGEMRIC (delayed gadolinium enhanced imaging) mode, are promising [22]. Damage can be divided into subchondral injuries, osteochondral fractures and exclusively cartilage damage. The term “dissecting osteochondrosis or osteochondritis” is described as bone-cartilaginous pathology found in young athletes. The most frequent localization in the femoral sulcus, on the inner surface of the medial condyle of the femur. Defect can be detected on the patella. MRI allows you to diagnose, determine the stability of the fragment [23, 24].

Injuries to the knee joint extensor apparatus (KJEA) are the main cause of anterior knee pain in professional athletes. In recent years, the role of PTL tendinopathy in pathology has increased, due to the increase in the duration and intensity of training and competition [25]. Periods of relative inactivity and active physical activity in professional athletes, during irregular sports competitions, as well as “athletes of the day off” allow us to add them to the risk group. Injecting steroids, taking systemic corticosteroids, fluoroquinolones increases the risk of tendon rupture [26]. PTL tendon is 25-30% thinner than the quadriceps tendon and therefore increases the risk of injury during sports [27]. KJEA performs 2 important functions, the function of strengthening with concentric contraction (jumps, hitting the ball) and the deceleration function during eccentric contraction (landing after the jump, descending the stairs). The braking mechanism is able to overload the PTL above possible strengths. KJEA also plays an important role in regulating the external and internal rotation of the tibia [28]. Due to the unique anatomical properties and structure of the tendon, the forces generated during its movement are usually insufficient for its rupture, only regular excessive physical exertion of KJEA can cause damage and, as a result, anterior pain of the knee joint. Degenerative changes, as compared to inflammatory changes, are more often found at tendon ruptures, which indicate the presence of a pre-rupture phase or a predisposition to rupture. In addition to external causes of PTL tendinopathy,

which include repetitive mechanical loads, internal factors include instability of the patella, high standing of the patella, impingement of the lower patella pole, increased muscle tone [29]. After recent scientific studies in which no inflammatory cells were found , the question of diagnosis of tendinitis sportsmen with pain and weakness in the area of PTL should be questioned [30, 31]. Loss of normal structure microscopically tears of collagen fibers, necrotic modified fibers, as well as mucoid degeneration with different fibrosis and neovascularization are detected macroscopically. For the first time, PTL tendinopathy was described in jumpers, and the disease was called the jumper's knee [32]. We must take into account that morphological changes do not always correlate with the clinical picture, and specific signs can be found in asymptomatic athletes. Patients with asymptomatic signs found by radiological methods (MRI) should be under the supervision of a specialist, because increases the risk of disease. In addition, characteristic signs of tendinopathy of PTL are local or diffuse hypoechoicity, tendon thickening, and uneven contours, swelling of the parastemal tissues and structures, and increased vascularization on color Doppler. Hyperachogenic areas that are pockets of dystrophic ossification can also be detected [33, 34]. Increased strength, biomechanical features, and enhanced vascularization of the quadriceps femoris tendon (QFT) are the causes of the rarer cases of PTL tendinopathy, compared with tendinopathy of PTL. Adolescent fractures of the proximal patella pole are more common in adolescents compared with tendinopathy. In elderly patients, degenerative changes, such as calcifications and spurs of the upper patella pole, can be observed and cause anterior pain of the knee joint.

Violation of the normal positioning of the patella relative to the block of the femur can also be the cause of the syndrome of anterior pain of the knee joint, and in severe cases, the cause of instability of the patella. Decentration of the patella, disruption of its normal movement results in excessive stresses and shear forces exceeding physiologically acceptable thresholds, and as a result, tendons, ligaments, cartilage and bone injuries develop. The fact that an abnormal structure can occur in people who do not complain, that differences can occur at different angles of flexion in the knee joint, is the reason for the difficult diagnosis of the pathology of PFJ [35, 36, 37]. The lateral inclination of the patella, as the most common cause, as well as the high or low standing of the patella, the anomaly of the position of the tibial tuberosity (TT) are variants of the PFJ pathology. Q-angle is an angle showing the magnitude of the varus deformity of the knee joint. The normal angle is 15 degrees. The TT-TG index determined in CT images can replace the definition of a Q-angle in clinical diagnostics. An indicator of 1.8-2.0 cm is specific for a violation in the PFJ, namely for the decentered position of the patella [38, 39]. The furrow angle, congruence angle, lateral patellofemoral angle, and lateral displacement of the patella are used more frequently [40, 41].

The syndrome of the orio-tibial tract ("runner's knee") is also a cause of pain in the knee joint. Occurs as a result of constant friction between the orothibial tract (OTT) and the lateral epicondyle of the femur. This syndrome is more common in long-distance runners, cyclists, as well as military personnel, i.e. in any activity that requires repeated flexion-extension movements in the knee joint. Barrel deformity, excessive pronation with internal rotation of the leg, spur of the lateral condyle, as well as different length of the lower extremities, all this can increase the tension of OTT and create friction on the lateral epicondyle. Other potential factors for the development of OTT syndrome: large weekly runs, or cycle load with weakness of the extensor muscles of the knee joint, flexor muscles, hip abductors. The weakness of the hip abductors leads to an increase in hip adduction and an increase in tension over OTT [42, 43].

Goff's adipose tissue is an intraarticular, but extrasynovial structure, rich in vascularization and innervated. Often, the pathology of this structure is found together with other problems of the knee joint, such as PTL tendinopathy, conditions after PCA reconstruction, at meniscus ruptures, instability of the knee. Direct injury can also be the cause of this pathology. Different variants of Goff's fatty body edema can occur in various pathologies, maybe in the form of 2 variants: infra-infraredular impingement syndrome and impinging of the upper lateral angle of Hoff's body. It is believed that hypertrophy and inflammation of the fatty body of Hoff is secondary after compression between the femoral condyles and the tibial plate during extension of the knee joint. Symptoms include pain in the anterior region of the knee joint, below the top of the patella. The pain is exacerbated by extension in the knee joint [18]. MRI scans show increased intensity at T2W, as well as a small effusion. In the subacute and chronic stages, due to hemosiderin and fibrin deposits, a low signal is detected in the T1W and T2W modes. Deviation of the patellar tendon may be due to a mass effect. Fibrous tissue can be gradually organized into a fibrocartilaginous fibroid, in rare cases, Hoff schismatization may occur [26]. Upper-lateral and pre-femoral swelling of the fatty body of Hoff is often associated with patellar chondromalacia, dysplasia of the femoral block, improper position of the patella, pathology of PTL and patellata.

Synovial folds in rare cases can cause anterior knee pain in adolescents, although the relationship between the crease and anterior pain is controversial. The syndrome of the medial fold is a combination of clinical symptoms with the presence of a pathological fold. Usually found in young athletes, with such repetitive movements as flexion-extension, for example, rowing, swimming, cycling, basketball. The large fold that covers the medial condyle of the femur may be damaged when squeezed between the femoral condyle and the patella. Due to the regular repetition of this movement, damage to the cartilage may be caused [5, 22, 40]. The suprapatellar fold is located on the border between the suprapatellar sac and the cavity of the knee joint. Recently, it has been suggested that it may be

the cause of the anterior pain of the knee joint, especially with full separation of the suprapatellar pocket from the joint cavity. The infrapipellary fold is the most frequent fold in the knee joint. On MRI, it is detected as a low intensity signal in front and parallel to the anterior cruciate ligament ACL in sagittal images. Traditionally, the infrapatellar fold was thought to be a random discovery and not associated with clinical symptoms. However, some studies describe it as a rare cause of anterior pain in the knee joint, which can be thought of in the absence of other pathological causes; it can mimic the rupture of ACL [11].

In addition to the above-described diseases and conditions in violation of the biomechanics of the knee joint, benign and malignant tumors can be one of the causes of pain in the anterior section of the knee joint. Vaginal-nodular pigmented synovitis (VNPS) and a giant tumor of tendinous vaginal cells, terms often used interchangeably to describe predominantly benign conditions, with proliferations of synovial cells of the joints, tendons and synovial bags. A tumor of giant cells of diffuse type is defined as destructive proliferation of mononuclear cells of the synovial type with an admixture of multinucleated giant, foamy, inflammatory cells and siderophages [14]. This form affects joints more often, but there can be a lesion of extra-articular soft tissues, characterized by infiltrative growth. The localized type, which can be found in tendon sheaths, bursa, is characterized by the same cellular composition as the diffuse type, but as a rule, it is smaller, well limited and less destructive growth. The intra-articular form of VNPS is a rare disease with a frequency of 1.8:1,000,000, usually occurs in the fourth decade of life without sex. It is the knee joint that is most often affected, and the lack of physical examination data, and such nonspecific symptoms as sudden pain, the appearance of edema and restriction of movements, makes it difficult to diagnose [6, 31, 36-37].

Synovial chondromatosis is a rare benign condition characterized by the presence of cartilaginous nodules in the synovial membrane of the joints, tendon sheaths and synovial bags, which are often found without prior injury and inflammation [27]. As the disease progresses, free bodies may be ossified [42]. The condition is generally considered monoarticular and more than 50% of reported cases are described with lesions of the knee joint [28]. The extra-articular form is rare, but with an X-ray picture with the presence of large extra-articular calcinates, it is necessary to carry out differential diagnostics with idiopathic tumor scinosis, which occurs in people of Africa and the Caribbean in the second decade of life [9]. Extra-marginal lesions can be classified as tenosynovial chondromatosis or chondromatosis synovial bags depending on localization [41]. It is believed that the exact etiology of synovial chondromatosis is unknown. Milgram, in 1977, divided the development of the disease into 3 separate phases. In phase I, metaplasia of the synovial membrane occurs, synovitis develops and nodules are formed, without calcification. In phase II, nodular synovitis and free bodies of

cartilaginous origin in the joint are observed. In phase III, free bodies remain, but synovitis is permitted. Free bodies tend to merge and calcify [35]. There is no histological evidence of metaplasia in the third stage, but there are concerns about a possible conversion to synovial chondrosarcoma.

The defeat of such a richly innervated structure, such as the synovial membrane, can also be a direct cause of the pain syndrome, in particular, anterior pain syndrome in the knee joint. Chronic inflammation of the synovial membrane (synovitis) is a fairly common pathology, with a large variability of etiological causes and the complexity of the differential diagnosis. The following groups of etiological causes of chronic synovitis of the knee can be distinguished: non-inflammatory (for example, in osteoarthritis, gout, accumulation diseases), inflammatory (in rheumatoid arthritis, reactive arthritis, acute rheumatic fever), septic in nature (purulent bacterial and septic arthritis) and hemorrhagic in nature (arthritis associated with trauma, tumor, coagulopathy) [1]. An important role in the development of chronic synovitis is played by disturbances in local disturbances of homeostasis, disturbances in the antioxidant system and activation of lipid peroxidation, contributing to the development of membrane-destructive or inflammatory-dystrophic changes, which determine the degree of pathological changes in the knee joint. "Diagnostics of the possible causes of chronic synovitis are histopathological analysis of the synovial membrane and biochemical research with commercial fluid. Given the evidence that reactive arthritis is detected in 10% of patients with rheumatologic hospitals, and the proportion of urogenic patients accounts for up to 50-75% [2], a necessary mandatory study on the polymerase chain reaction of synovial fluid.

## CONCLUSION

Our review shows that there are a large number of diseases and nosologies of the knee joint, which, due to the structural features and similarity of the clinical picture, can be combined into anterior pain syndrome of the knee joint. Anterior pain syndrome of the knee joint has the prospect of further study, because The education of young specialists and the sharing of our observations with experienced doctors will lead to a regular optimization of differential diagnosis and multimodal treatment of pain in the knee joint.

## CONSENT

It is not applicable.

## ETHICAL APPROVAL

It is not applicable.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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