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Advanced therapeutic strategies in patellar ligament tendinopathy: from etiology to clinical practice
A literature review

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Abstract:

Introduction:
Tendinopathy of the patellar ligament, often referred to as "jumper's knee," is a significant health problem for athletes subjected to repeated knee strains. The condition, resulting from microtrauma and degeneration of collagen fibers, leads to chronic pain and impaired function of the patellar ligament.

Aim of the study:
The aim of this study was to present current knowledge about new techniques to prevent and treat patellar tendinopathy. Analyzing current informations, understanding risk factors, and recognizing pathophysiology of patellar tendinopathy can prevent many sportsmen to withdraw from competitions.

Materials and methods:
A systematic review of scientific and medical literature from the PubMed and Google Scholar databases was conducted.

Results:
A review of the literature has identified key risk factors for patellar ligament tendinopathy. An analysis of available studies indicates that various therapeutic interventions, including shockwave therapy, eccentric exercise programs can provide pain relief and improve patellar ligament function. However, the effectiveness of these methods may vary depending on individual patient characteristics.

Conclusions:
Recognition of risk factors, early education and prevention, and prompt introduction of treatment at an early enough stage of the disease allow for the best treatment results and rapid return of patients to sports activities before the onset of pain, and significantly improve patients' quality of life. These findings underscore the comprehensive nature of the management of patellar ligament tendinopathy, including both therapeutic and preventive interventions.

Keywords: patellar tendinopathy, orthopeadics, sport medicine, knee

1. Definition:

Tendinopathy of the ligament of the patella is a chronic condition not caused by direct contact injury characterized by degenerative changes in the ligament of the patella, resulting from its overload [1,2] Another name, more colloquial, recognized worldwide by orthopedic specialists, physiotherapists is the so-called. , "Jumper's knee". This name is due to the fact that this condition mainly affects athletes who are exposed to high loads (frequent jumping, landings, rapid force changes and running) such as basketball players, volleyball players, figure skaters [1,2,3,4,10]. During the above-mentioned movements, structural changes such as microtrauma and degeneration of collagen fibers can occur in the knee joint, leading to chronic pain, discomfort and decreased function of the patellar ligament [4,5,6,9]. It is not uncommon for the pain to be so intense that athletes are forced to stop sports for an extended period of time, giving up on their dreams of sports, competition and winning. Many times it is also the beginning of other diseases like depression, chronic stress. The use of methods to prevent the occurrence of full-thickness tendinopathy of the patellar ligament is significant due to the progression of the disease, its persistence as well as its curability.

2. Risk factors

Studies conducted to detect the main risk factors, i.e. specific conditions or behaviors that significantly increase the likelihood of injury, have shown that in the case of the disease entity in question, 9 such factors can be distinguished that cause significant strain on the patellar ligament. The following factors can be included in the list below:

No.	**RISK FACTORS [4,7,8]**
1.	High body mass index
2.	High body mass
3.	High waist-to-hip ratio
4.	Limb-length discrepancy
5.	Flatfoot arch
6.	Weak quadriceps muscles
7.	Low flexibility of the quadriceps muscles
8.	Low flexibility of the hamstring muscles
9.	Vertical jump test result

Table 1.

Among the literature, one can also find risk factors directly related to sports, such as: the number of years spent training a particular sport, the amount of training performed (the number of repetitions of a particular movement), what type of training is performed, the surface on which a particular sport is performed. Most authors of scientific studies have shown that sports-related factors have no significant effect on the occurrence or non-occurrence of patellar ligament tendinopathy.

Stage	Stage characteristics
I	When the pain shows after sports
II	Pain shows at the beginning of practice, disappear during warmup and appear again during exhaustion
III	Persistent pain during rest and during exercises
IV	Rupture of the patellar tendon

Table 2.

3. Pathophysiology

Among all the causes considered that contribute to the development of tendinopathy of the patellar ligament, it can be pointed out that overload and related micro-injuries are of the greatest importance. Repeated mechanical overload leads to microtrauma to collagen fibers in the patellar ligament, whose ability to self-heal is insufficient [11]. Collagen fibers become disordered and fragmented. Within the damaged tissue, there is an increased release of pro-inflammatory cytokines that promote inflammation and further degeneration of the tissue. Degeneration of collagen fibers promotes fibroblasts to overproduce extracellular matrix, but it is much weaker and less organized. In addition, in the course of damage, there is abnormal angiogenesis, abnormal vascularization of the ligament and sensitization of the nerves in the ligament, which together can lead to chronic pain [12]. Despite the research-recognized causes of tendinopathy of the patellar ligament, it is not possible to show conclusively why not everyone who trains with the same load will develop the condition.

4. Diagnostic criteria

4.1 Subjective symptoms

Patient-reported symptoms will mostly include pain in the anterior part of the knee joint, just below the patella and in the proximal part of the patellar ligament.The pain is initially vague but patients indicate the occurrence of pain during physical activities that require a lot of strain on the knee joint such as jumping, running, squatting, climbing stairs [1,4]. The perception of pain in relation to the period of activity performed can be put into 4 stages of the condition. In the early stages, pain may be felt only after the completion of a particular activity that causes stress on the knee joint.

In the later stages, the pain may be present before the start of exercise, decrease after a warm-up and recur when the body becomes very tired, or occur throughout both rest and activity.

Athletes will also report much reduced load endurance, weakened muscle strength (especially of the quadriceps thigh) due to incomplete stimulation of the muscle during training limited by pain. Assessment of pain can be done through the use of a scale made by The Victorian Institute of Sport Assessment-patella (VISA-P) [13-17], using a 100-point scale where a higher score shows a lower incidence of intractable pain. With such a scale, it is also possible to monitor the progression of a patient's changes. Any change of at least 13 points on the stated scale is clinically significant.

4.2. Physical exam

Tendinopathy of the patellar ligament is relatively easy to pick out due to its anatomical location [18,19,20]. We can investigate the pain caused by inflammation of the patellar ligament using two clinical signs. The first physical examination performed on the patient is to palpate the lower pole of the patella in full extension of the knee in a supine position with the quadriceps muscle relaxed. In the case of ligamentitis, pain is revealed in the proximal part of the patellar ligament. The pain is easy for the patient to localize. Next, the leg is flexed at the knee joint. The flexion should cause a decrease in pain. The second test in turn is to perform the test in a standing position. The patient, standing on one leg in which the symptom is currently being tested, with the other leg straight forward we do a squat to bend at the knee joint tested to 30 degrees. The second test allows us to show whether pain will be felt by the patient when performing a squat during which there is overload of the knee joint.

Fig 1. Figueroa D, Figueroa F, Calvo R. Patellar Tendinopathy: Diagnosis and Treatment. *J Am Acad Orthop Surg*. 2016;24(12):e184-e192. doi:10.5435/JAAOS-D-15-00703

5. Imaging

Imaging plays a key role in the diagnosis of patellar ligament tendinopathy. With advanced imaging techniques, it is possible to accurately assess the condition of the ligament, identify the extent of damage and exclude other pathologies of the knee.

The fastest and also relatively accurate method is ultrasonography (ultrasound), which allows for a quick, inexpensive examination [21,22]. This method allows a dynamic assessment of the ligament in real time, evaluating the thickness of the ligament, detecting structural changes, calcifications and hypoechoic areas mainly in the anterior part of the patellar ligament indicating degeneration. When performing an ultrasound examination, the experience of the examiner is extremely important, and the greater the experience, the greater the experience will allow to visualize and distinguish significantly more minor pathologies within the knee joint.
It is also recommended to use MRI to exclude lesions of the patellar ligament [23,24]. By using magnetic fields and radiofrequency waves to create detailed soft tissue images, high-resolution images of the ligament and surrounding tissues can be produced. Pathologies that can be detected with MRI include changes in collagen fibers, the presence of microdamage and swelling, differentiating damage to the patellar ligament from other damage within the knee joint such as meniscus damage or synovitis. Unfortunately, magnetic resonance imaging is an expensive test and is not widely available; however, when it is available it is recommended to use it first.
Imaging studies should be considered as an additional source to help confirm or rule out a condition. The approach to the patient should be holistic, but direct patient contact, history, physical examination are still the main sources of information.

6. Differential diagnose

The differentiation of tendinopathy of the patellar ligament involves the diagnosis and exclusion of other conditions with similar symptoms, functional limitations, thanks to the systematic approach of physicians who, through physical examination, history, are able to narrow down the list of potential diagnoses and ultimately determine the correct cause of the patient's complaints. Each of the disease entities listed in the table below has its own specific symptoms, which will allow differentiation with tendinopathy of the patellar ligament. Differentiation, unfortunately, can be difficult in many cases due to the simultaneous presence of multiple disease entities in a given patient [1,4,5,25]

No.	Disease/Injury	Main symptoms
1.	Patellofemoral pain syndrome (PFPS)	- pain at the front of the knee - pain after long sitting, exercises - pain during walking on stairs
2.	Iliotibial band syndrome (ITBS)	- hip and knee pain - discolored, warmth of the knee - clicking outside of the knee

3.	Patella chondromalacia	- pain behind the kneecap - pain after long sitting, walking down or up the stairs - swelling knee
4.	Meniscus damage	- swelling and stiffness - feeling of popping - difficulty in straightening the knee
5.	Cruciate ligaments damage	- discomfort in walking - limited knee movement with pain - not fully range of motion
6.	Infrapatellar fat-pad syndrome	- extreme pain - pain when straightening the knee
7.	Patella stress fracture	- pain around the kneecap - bruising - swelling - inability to do any motion
8.	Knee osteoarthritis	- pain - stiffness - weak thigh muscles

Table 3.

7. Conservative treatment

7.1 Knee joint pressure relief

The first and most important intervention for patellar ligament tendinopathy should be rest and modification of physical activity as much as possible for the patient, especially a patient who is a professional athlete. It is recommended to avoid activities that cause pain, i.e. jumping and running to reduce overload in the knee joint and allow faster recovery of structures in the joint [26,27]. The patient may be suggested to perform other exercises with known low impact on joint strain such as swimming or cycling.

7.2 Pharmacotherapy

The use of common medications such as NSAIDs and Paracetamol allow in the therapeutic process to reduce perceived pain and reduce inflammation in the knee joint. NSAIDs, by inhibiting cyclooxygenase enzymes, lead to reduced production of prostaglandins and, consequently, to a reduction in inflammation and pain. Chronic use of NSAIDs in oral form is not recommended, however, their topical gel forms can be used far longer without risk of damage to internal organs. Paracetamol, as another of the drugs used in patellar ligament tendinopathy, has a mainly analgesic effect. Although the drugs do not directly solve the genesis of the degeneration of the ligament, they can significantly improve the patient's comfort and allow other treatments to be used more effectively [1,4,5,26,27].

7.3 Physiotherapy

Eccentric exercises are the first tactic used to treat tendinopathy of the patellar ligament, particularly in the patient in the early stages of the disease. Eccentric exercises involve controlled elongation of the muscle while working, which stimulates tissue recovery and adaptation. This strategy helps strengthen the tendon, improve its elasticity and promote repair processes at the cellular level. A typical eccentric exercise program includes 4 stages. Studies have shown that one of the exercises of great importance in the physiotherapy of patellar ligament tendinopathy is to perform a squat while standing on one leg on an inclined platform with the chest straight [28,29]. The study performed by (...), on the other hand, showed that just as performing exercises with an oblique platform is good for patients during the off-season of sports, in professional athletes who are currently in the sports season performing multiple jumps, the oblique exercises did not give improvement in pain.The physiotherapy process should be performed under the watchful eye of a physiotherapy specialist, during which the exercises performed should give slight discomfort but not significant pain. Regular and systematic performance of exercises from the program prescribed by physiotherapists is key to return to full fitness. Despite returning to the sports activities performed before the rehabilitation process began, patients are advised to use some of the exercises from the 4-step recovery program for an extended period of time to maintain the effects and prevent recurrence of the condition.

Fot 2. Malliaras P, Cook J, Purdam C, Rio E. Patellar Tendinopathy: Clinical Diagnosis, Load Management, and Advice for Challenging Case Presentations. *J Orthop Sports Phys Ther*. 2015;45(11):887-898. doi:10.2519/jospt.2015.5987

7.4 Physical therapy

As an integral part of the repair process in ligament tendinopathy, physical therapy is a tool to reduce pain, improve joint function and accelerate the healing process. The use of ultrasound waves can help reduce pain by increasing blood flow in the area affected by the tendinopathy. Ultrasound, in addition, may allow for anti-inflammatory effects and accelerate the repair process in the damaged ligament. Another type of waves used in physical therapy for tendinopathy of the patellar ligament is the use of shock waves, which stimulate the repair processes in the ligament, improve the elasticity of the tissue and reduce perceived pain. Their use is only possible in cases of undetected tears of the patellar ligament on MRI. The key is to individually tailor the therapeutic plan to the patient's needs and capabilities.

8. Invasive treatment

8.1 Injection

The use of injections in the treatment of patellar ligament tendinopathy is usually considered when the use of other forms of conservative treatment does not have the desired effect or the pain is progressive and persistent. The use of injections should always be performed by a specialist and after consultation with the patient as to the choice of the appropriate method, achievement of expected benefits and discussion of the risks associated with each injection method.

8.1.1 Hyaluronic acid

One of the first injections used in treatment are those with hyaluronic acid [30]. The effect of hyaluronic acid lies mainly in its ability to bind water and form a thick substance with lubricating and protective properties.

Injecting the acid in cases of patellar ligament tendinopathy helps improve the hydration and elasticity of the ligament, most of which is irritated, dry and prone to micro-injury. Studies as to its full effectiveness in application are inconclusive [31]. The individual characteristics of the patient and the severity of the tendinopathy of the patellar ligament play a large role in the process of applying hyaluronic acid.

8.1.2 Platelet-Rich Plasma (PRP)

A common method in which blood is drawn from the patient, is centrifuged to separate platelet-rich plasma, which is then injected into the affected area under ultrasound guidance [32].

8.1.3 Steroids

In cases where pain and inflammation are particularly troublesome, the doctor may choose to inject corticosteroids directly into the area affected by the tendinopathy. Corticosteroids have an anti-inflammatory effect, reducing swelling and relieving pain. However, their use in tendinopathies is controversial due to the risk of weakening the tendon structure and increasing the risk of tendon rupture. Therefore, corticosteroid injections are usually reserved for situations where other treatments fail to provide relief [1,4,5].

8.2 Surgical procedures

Surgical procedures with significant results in patients with tendinopathy of the patellar ligament, unresponsive to previous stages of conservative treatment, are open surgery and arthroscopy of the knee joint. During open surgery, operators through anterior access perform a tenotomy of the patellar ligament, bring about the excision of those parts of the patella that are destroyed by the inflammatory process, produce space to improve blood supply and repair the patella by drilling appropriate perforations into it. The arthroscopy procedure, however, is more popular, allowing the same procedures to be performed as with the open procedure while allowing the preservation of small surgical wounds.

9. Conclusions

Early recognition of patellar ligament tendinopathy is key to preventing further degeneration and long-term health consequences. Regular checkups for athletes can help detect problems quickly and initiate appropriate treatment. Education of athletes, coaches and medical personnel about patellar ligament tendinopathy and its risk factors cannot be overlooked, which can significantly reduce the incidence of this disease. Introducing prevention programs that focus on strengthening muscles, improving flexibility and monitoring loads can help reduce the risk. Regular monitoring of training loads, especially in athletes, can help prevent patellar ligament strains. Wearable technologies, such as activity monitors and motion analysis apps, can provide valuable data for load management. Comprehensive and patient-specific treatment must be based on the interaction of different specialists, their mutual understanding in approaching patellar ligament tendinopathy, and a single-minded approach to treatment. In addition, it is necessary to make patients aware of the length of treatment and to address the issue that, for genetic, anatomical reasons, there is always the likelihood that it will not be possible to fully cure and only relieve pain.

Among the specialists, there should also be psychologists and psychiatrists who will allow to support athletes in long-term rehabilitation aimed at returning to full sports activity and improving the quality of life.

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