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Knee pain in runners: the most common causes, symptoms, and treatment review

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Abstract

Introduction and Purpose:

Running is one of the most common activities. It is also associated with a high risk of knee joint injuries. The most common are Patellofemoral Pain Syndrome (PFPS), Iliotibial Band Syndrome (ITBS), and Patellar Tendinopathy (PT). These conditions can limit mobility and reduce quality of life. The purpose of this article is to review the causes, symptoms, prevention, and treatment for these conditions in runners, based on the most recent knowledge.

State of Knowledge:

The most frequent running-related knee injuries are PFPS, ITBS, and PT. An accurate diagnosis is essential for effective treatment. Management should be tailored to everyone, considering factors such as age and the stage of the condition. These injuries often require a break from running. Most cases improve with non-surgical treatments. Surgery is reserved for severe or persistent cases. Preventive strategies focus on addressing training mistakes, strengthening specific muscle groups, and refining running mechanics.

Methods:

The following paper analyzed studies found on electronic databases, including PubMed, Google Scholar, using keywords such as “knee injury”, “PFPS”, “ITBS”, “PT”, “causes of knee pain”, “treatment of knee injuries”, and “prevention of knee injuries”. Articles include randomized controlled trials, meta-analyses, and systematic reviews prioritizing resources published after 2015.

Conclusions:

Knee injuries in runners are multifactorial and often result from poor biomechanics, muscle imbalances, training errors, or repetitive strain. Accurate diagnosis is essential to differentiate between conditions with similar symptoms. Conservative treatment is the first-line treatment for PFPS, ITBS, and PT, and it shows good results. Surgery is reserved for treatment-resistant cases. Prevention mainly focuses on correcting training errors, strengthening key muscle groups, and improving running technique, which is a key to reducing the risk of injury.

Keywords:

Running injuries, Patellofemoral Pain Syndrome, Iliotibial Band Syndrome, Patellar Tendinopathy, knee pain, knee injury treatment

Introduction

Running is one of the most popular physical activities globally, often chosen to improve or maintain overall physical health [1]. Running offers full-body benefits. Among other things, running improves endurance, reduces the risk of cardiovascular diseases, and helps with weight loss [2]. However, with its growing popularity, there has also been an increase in running-related, overuse injuries, particularly in the lower limb [3]. The occurrence of lower limb injuries in runners varied between 19.4% and 79.3%. The knee is the most frequently injured area in runners, with three primary types of injuries affecting the knee joint: Patellofemoral Pain Syndrome, Iliotibial Band Syndrome, and Patellar Tendinopathy [3].

The causes of knee pain in runners are multifactorial [4–8].

This paper aims to review the most common causes, symptoms, and treatment options for knee pain in runners, focusing on evidence-based approaches to diagnosis, prevention and treatment.

Anatomy of the knee

To better understand the complexity of the knee injuries, it is necessary to review the normal anatomy of the knee. The articulating surfaces of the knee consist of the medial and lateral condyles of the femur and tibia, as well as the anteroposterior interface between the femur and patella [9]. The knee joint relies on several soft-tissue anatomical structures for stabilization. Muscles surrounding the knee serve as dynamic stabilizers, preserving functional joint integrity during motion. Ligaments, capsules, and menisci are static stabilizers, maintaining joint congruency at rest. Most important extraarticular stabilizers consist of the quadriceps femoris muscle, fibrous capsule and extracapsular ligaments such as the patellar, lateral collateral, medial collateral, oblique popliteal, arcuate popliteal ligaments. Intraarticular stabilizers consist of the anterior and posterior cruciate ligaments and the medial and lateral menisci [9–12]. Between the moving structures of the knee are bursae, whose function is to reduce friction. Most important bursae in the knee include: the suprapatellar, popliteus, anserine, gastrocnemius, prepatellar, infrapatellar, medial collateral ligament, and iliotibial bursae [9,13]. The knee anatomy allows it to be a primary weight-bearing joint that promotes sagittal plane movements such as flexion and extension. Secondary, limited motions include internal and external rotation, compression and distraction, anteroposterior and mediolateral translation, Varus (medial angulation), and valgus (lateral angulation) [9,12].

The most common causes of knee pain

Running injuries are frequent, with studies indicating that 40%-50% of runners sustain an injury yearly. Several factors could potentially lead to injury [14]. Higher knee joint loads are associated with poor hamstring flexibility, higher body weight, and increased weekly mileage. Many of these risk factors can potentially be adjusted to reduce joint loads and decrease the likelihood of injury [4].

There are many causes of knee pain in runners. We have identified and described the three most common conditions that account for this pain.

Patellofemoral Pain Syndrome (PFPS)

PFPS is the most frequent musculoskeletal overuse injury among active adults, with prevalence rates ranging from 19–30% in female runners and 13–25% in male runners [15]. PFPS is also one of the most common causes of anterior knee pain. It is commonly known as runner's knee, retropatellar pain syndrome, lateral facet compression syndrome, or idiopathic anterior knee pain [16]. The cause of PFPS is not universally agreed upon, but it is believed to be multifactorial and often linked to training habits [5]. Research identifies four primary factors contributing to the condition: misalignment of the lower limb and/or patella, muscle imbalances in the lower limb, excessive activity or overload, and injury [17]. Training errors account for more than 60% of running-related injuries. Individuals with PFPS often report increased running mileage and/or speed, or changes in their running environment, such as increased stair or hill training. These training factors, combined with insufficient recovery time, poor sleep, nutrition deficiencies, and heightened overall stress, further predispose runners to injury [18].

Iliotibial Band Syndrome (ITBS)

The iliotibial band (ITB) is the distal extension of the fascia from the tensor fascia lata, gluteus medius, and gluteus maximus muscles. The ITB acts as a knee extensor when the knee is bent less than 30 degrees and as a knee flexor once the knee exceeds 30 degrees of flexion [19]. ITBS caused by inflammation of the distal portion of the ITB is the most frequent running injury affecting the lateral side of the knee [20]. It impacts 7-14% of runners, though it is also linked to various activities such as cycling, field sports, hockey, swimming, and hiking [21]. The cause of ITBS is primarily multifactorial, involving both internal and external factors [6]. It is an overuse injury, not caused by trauma, resulting from repeated bending and straightening of the knee, which leads to irritation in the surrounding structures [22]. Modifiable risk factors for ITBS include running on hill running, training technique errors, and sudden increases in training

intensity. Anatomical factors, such as internal tibial torsion, weak hip abductors, excessive foot pronation, and medial compartment arthritis causing genu varum, can increase the strain on the ITB and contribute to the persistence of the condition [23].

Patellar Tendinopathy (PT)

PT, also known as "Jumper's knee", is a painful knee condition mainly linked to physical activity. Reactive tendinopathy begins as a non-inflammatory reaction to sudden overload of a tendon. In response, the tendon thickens to better tolerate the increased stress [24]. With ongoing overload, the tendon enters a stage of disrepair, marked by an increased accumulation of proteoglycans and continued thickening, leading to a more disorganized tendon structure [25]. As the condition progresses and becomes more chronic, degenerative tendinopathy develops, involving extensive breakdown of the tendon matrix and localized cell death within certain tendon areas [26]. It is caused by minor tears in the patellar tendon, often occurring in sports that involve intense jumping, leading to localized tenderness in the tendon. These tears typically result from repeated stress on the patellar or quadriceps tendon. As the name suggests, this condition is common among athletes in jumping sports, with a significant demand for the strength and speed of the leg extensors [27]. Sports like volleyball, track events (such as long and high jump), long-distance running, and skiing often involve significant eccentric loading of the quadriceps. The condition is more common in males, particularly adolescents and young adults [28]. Several intrinsic knee factors can predispose an individual to this condition. These include ligamentous laxity, tight quadriceps and hamstrings, an increased Q-angle, abnormal patellar height, ongoing knee inflammation, and excessive force applied to the knee. Other contributing factors include high training volume and frequency, the athlete's performance level, and the hardness of the surface on which the sport is played [7]. Potential risk factors include body weight, body mass index, waist-to-hip ratio, leg-length discrepancies, foot arch height, quadriceps strength, and vertical jump performance [8].

Symptoms

In the PFPS, the pain is often located in the front or behind the patella and is worsened by activities that place significant demand on the quadriceps with knee flexion, such as running, squatting, stair climbing, and even prolonged sitting, can provoke symptoms [29].

It is important to note that while pain is the primary symptom, patients often report other issues such as patellofemoral crepitus, knee stiffness, difficulty performing daily activities, limited physical activity, and reduced quality of life. Symptoms of PFPS can last for up to 20 years [30].

There is no definitive clinical test for diagnosing PFPS. The most reliable test is anterior knee pain triggered during a squatting maneuver, with patellofemoral pain being present in 80% of individuals who test positive for this [31].

In the ITBS, the pain or stiffness usually occurs on the outer side of the knee. It is located 2-3 cm above the lateral joint line, over the lateral epicondyle, but may radiate along the ITB, causing discomfort in the hip or thigh. It typically develops after a certain amount of time or distance during an activity [32]. This syndrome is characterized by pain on the lateral side of the knee during weight-bearing activities, with discomfort occurring when the knee moves from flexion to extension [33]. Common diagnostic indicators of ITBS include pain and swelling on the lateral side of the knee joint. The pain occurs when the knee extends from 90 to approximately 30 degrees, as the ITB is compressed against the lateral femoral epicondyle. This is known as the Noble Compression Test. Previous studies have demonstrated weakness in the abductors (the gluteus medius and the upper fibers of the gluteus maximus muscles) in runners with ITBS [34]. It is a clinical diagnosis, generally established through a typical medical history and physical examination, with imaging tests used only in persistent symptoms to exclude other potential conditions [35].

PT, a common cause of anterior knee pain, is typically marked by pain localized to the lower part of the patella and load-related discomfort that worsens with increased demand on the knee extensors, especially in activities that involve storing and releasing energy in the patellar tendon. It is diagnosed clinically based on a thorough medical history and physical examination [36]. The pain is typically well localized, most often at the proximal attachment of the patellar tendon to the patella. In mild cases, pain occurs only after sports activities. As the condition worsens, patients may experience pain at the start of certain activities or even throughout their exercise. In severe cases, pain can be present during daily activities or even at rest [37].

Treatment

Once the primary causes of PFPS are identified, it is crucial to address these deficits with a comprehensive treatment approach. The focus should be on a strengthening and motor retraining program, with supplementary manual therapies and modalities introduced as needed based on the patient's requirements [33]. Treatment for PFPS is typically conservative, focusing on pain reduction, improved patellar tracking, and restoring function to pre-injury levels. The treatment process is divided into two main phases: the acute phase and the recovery phase. In

the acute phase, the focus is on modifying activity, using NSAIDs, and applying other conservative methods such as ice. NSAIDs, particularly naproxen, have been found to reduce overall pain more effectively than aspirin and placebo; however, they are generally not recommended for long-term use [38]. Following the acute phase of treatment, the patient moves into the recovery phase, which focuses on addressing the underlying factors that likely contributed to the development of the condition. The most effective approach involves a combination of knee and hip exercises aimed at improving lower limb strength, mobility, and function [39]. If the patient experiences pain during exercises, additional therapies can be employed, such as taping, orthotic management, and manual therapy, which should be used alongside prescribed exercises to alleviate pain [40].

Studies have shown that when combined with physical therapy, patellar taping helps reduce overall pain more effectively than physical therapy alone [41]. Foot orthoses are recommended for short-term pain relief [40]. Orthopedic surgery is generally not recommended and is considered a last resort treatment. A surgical consultation for PFPS may be considered for patients whose symptoms persist after completing at least six to twelve months of comprehensive rehabilitation, and in whom other causes of anterior knee pain have been ruled out. There is limited data from controlled studies on surgical outcomes, and these results are highly dependent on proper patient selection [42]. Surgical options involve releasing the lateral retinaculum, procedures on the articular cartilage, and proximal and distal realignment - often accompanied by antero-medialization of the tibial tubercle [5].

When evaluating a runner for ITBS, it's essential to gather subjective information about their training volume, footwear, and running frequency, along with an objective assessment of their running form. Evaluating muscle strength and flexibility is equally important, as is identifying trigger point referral patterns in the muscles connected to the IT band. Additionally, any secondary alignment issues within the lumbopelvic region should be thoroughly assessed and appropriately managed [33]. People with a typical history of ITBS and mild to moderate symptoms should modify their activities by reducing or stopping exercise sessions to avoid pain. Additionally, they should incorporate stretching, use simple analgesics, and address training errors, such as avoiding running downhill or on cambered tracks [32]. Conservative treatment, involving rest (2-6 weeks), stretching, pain management, and adjustments to running habits, resulted in a 44% complete recovery rate, with participants returning to sports at 8 weeks and a 91.7% recovery rate with return to sports by 6 months after the injury [43].

Manual therapy should target areas of inflammation, myofascial restrictions, active trigger points, and dysfunctions within the lumbopelvic region. It should be integrated with a tailored exercise program that progresses from open-chain to closed-chain exercises, eventually advancing to higher-impact movement retraining, to return the runner to full activity [33]. There is moderate evidence indicating that physiotherapy, with or without medication, is effective for adults with ITBS. However, well-conducted randomized controlled trials are needed to clarify the effectiveness and optimal parameters of physiotherapy for these patients [44]. The primary approach to treatment is non-surgical. However, surgical intervention is recommended for persistent or chronic cases. Surgery is typically considered only for cases that do not respond to other conservative treatments for more than 6 months. There are various surgical options available, including percutaneous or open ITB release, ITB lengthening with Z-plasty, open ITB bursectomy, and arthroscopic ITB debridement [45]. All the various techniques have shown effectiveness, but there are few comparative studies to prove which one is superior [46].

Effective treatment relies heavily on an accurate diagnosis of the knee condition, as PT often shares similar features with other issues such as PFPS, inflammation of the infrapatellar fat pad, quadriceps tendon tendinopathy, plica syndrome, and patellar cartilage defects [33].

Athletes with PT should avoid activities like excessive jumping or impact loading on the knee, as these can worsen the condition. Modifying activities and sports training, along with proper warm-ups and physiotherapy to improve the flexibility of the quadriceps and hamstring muscles, are crucial. As the pain starts to decrease, the intensity of rehabilitation and sport-specific training can gradually be increased [47]. The primary treatment for PT is physical therapy, particularly an eccentric exercise program (EE) - lengthening of the musculotendinous unit while a load is applied to it. Eccentric training has been found to produce results comparable to surgical treatment [48]. Recent studies suggest that clinicians should prioritize multiple Platelet Rich Plasma injections over relying solely on EE for refractory cases. Extracorporeal Shock Wave Therapy has proven to be more effective than non-surgical alternatives and comparable to long-term surgical outcomes, indicating it may be especially beneficial for patients who do not respond to conservative treatments [49] Dry needling or percutaneous needle electrolysis with EE has not shown greater effectiveness than EE alone in reducing pain and disability in PT over short (10 weeks) and medium (22 weeks) terms. Clinical improvements were not associated with tendon structural changes. [50]

Loading interventions have become a key treatment for tendinopathy, with clinical outcomes and tendon responses potentially influenced by exercise intensity and load. High and moderate

load exercises for treating PT showed similar, ongoing improvements in the long term, but neither reached normal tendon values [51]. Reducing strain on the patellar tendon can be beneficial through the use of taping or infrapatellar straps. These methods help decrease tendon strain by changing the angle between the patella and the patellar tendon [52].
Promising treatments with limited evidence, like topical glyceryl trinitrate, hyaluronic acid injections, and isometric or slow resistance exercises, should be further studied in high-quality randomized quality trials. Meanwhile, eccentric loading, with or without adjuncts, should remain the primary approach for patellar tendinopathy [53]. Surgery or shockwave therapy may be considered for patients who do not show improvement after six months of conservative treatment [54].

Understanding the mechanism of overuse injuries and how to effectively treat them leads to better outcomes. These outcomes can result in lower healthcare costs, avoidance of invasive procedures, and an enhanced quality of life. With a deeper understanding and evidence-based treatment approaches, patients can remain active and continue running [33].

Prevention

Musculoskeletal injuries are common among young athletes and can significantly affect their physical and mental well-being. To support their overall health and performance, focusing on injury prevention through tailored training programs and a holistic, biopsychosocial approach is important. Prioritizing the quality of life in both prevention and recovery efforts encourages a more thoughtful and individualized way of managing athletic injuries [55]. Prevention of knee injuries should focus on avoiding abrupt changes in workout intensity and increasing awareness of common problems and their connection to knee alignment and pre-existing degenerative changes [56]. Depending on the risk factors, different and individualized methods of knee injury prevention should be applied. There is limited evidence suggesting that retraining running techniques to promote softer landings could potentially lower the risk of knee injuries by up to two-thirds [57]. Despite numerous studies, the only strong evidence for preventing running injuries is managing training mistakes, mainly by limiting overall running distance. Although a prior injury is a risk factor for future injuries, the best way to reduce this risk is still unclear [14].

Summary

Running is one of the most popular physical activities worldwide, offering numerous health benefits, but it also carries a significant risk of injury. The knee is the most affected area, with

frequent injuries, including PFPS, ITBS, and PT. PFPS is a common overuse injury that causes pain around or behind the kneecap, often triggered by activities that involve bending the knee, like running or squatting. ITBS results from irritation and inflammation of the iliotibial band as it rubs against the outer knee, leading to pain on the lateral side during running or other repetitive activities. PT is characterized by pain and degeneration of the patellar tendon, typically caused by repetitive stress or overloading, particularly in sports that involve jumping or running. Knee injuries are often multifactorial, and a proper diagnosis is crucial. Treatment requires an individualized approach, considering the patient's age, activity level, and the severity of the condition. Knee injuries often force athletes to temporarily stop running, but fortunately, most injuries have a good prognosis and only require conservative treatment. Surgical intervention is rare and typically reserved for complicated cases. Prevention mainly focuses on correcting training errors, strengthening key muscle groups, and improving running technique.

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