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Patellar Tendinopathy: Pathomechanics and a Modern Approach to Treatment

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Patellar tendinopathy, a common condition in sport, can be recurrent and resistant to treatment. Risk factors include the level of training, biomechanics, and genetic factors. This review discusses several programs based on eccentric exercise and suggests principles for nonoperative treatment including improving shock absorption, load modification, and adaptation of the tendon to sporting stress. The level of pain that patients are asked to tolerate during tendon-exercise programs varies among programs, and it is unclear what level is optimal to stimulate tendon recovery. Rehabilitation presents several challenges: It can take a long time (3–12 months), exercise prescription in an athlete who is continuing to compete is not straightforward, and guidelines for treatment progression are poor. Nonoperative treatment can fail because of inappropriate exercise prescription and poor athlete compliance. If this occurs and surgical intervention is required, the athlete might still have an unpredictable outcome. Solutions to these problems require additional clinical research.

Key Words: nonoperative management, risk factors, rehabilitation

Key Points:
- Patellar tendinopathy is a recurrent and resistant condition.
- Nonoperative treatment might require more than 3 months rehabilitation.
- Nonoperative treatment requires individually tailored programs.

Introduction

Patellar tendinopathy is a pathological condition of the tendon similar to that found in other tendons susceptible to overuse (e.g., Achilles, supraspinatus). Although originally considered inflammatory in nature, overuse tendon injury is better considered a failed healing response. This is evident from the hypercellular, blastic process evident in histopathological specimens. Degeneration is associated with cell atrophy, and this is not the case in overuse tendinopathy. Thus, the term degeneration is not as accurate as is failed healing.

The histopathology of tendinopathy is documented elsewhere. From a clinical perspective, the important pathological process is the failure of the collagen to align or cross-link that decreases load-bearing capacity and impairs tendon function.

Although patellar tendinopathy is deemed a tendon injury, it is a true enthesopathy. The role of enthesopathy in the symptomatology and the
Genetic Factors

Activation of the vasospasm mechanism appears to be promoted by genetics and by a variety of factors, including stress, fatigue, and current stress levels. The vasospasm mechanism appears to be more pronounced in men than in women, and may be more pronounced in women who have experienced more stress. Genetic factors may play a role in the development of tendon injury, particularly in athletes. Although many biological factors have been identified as predisposing to tendon injury, few have been studied in detail. Although many biological factors have been identified as predisposing to tendon injury, few have been studied in detail.

Biomechanics

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Training Schedule

Risk Factors

Parallel tendons, which are located parallel to each other, can be associated with symptoms of tendon injury. Parallel tendons appear to be more prone to injury when subjected to stress and fatigue. Injury to parallel tendons appears to be more common in athletes and in individuals who engage in high-impact activities. The injury occurs when the tendons are subjected to mechanical stress, which results in microtears and irritation. The injury is often accompanied by pain and swelling, and may be accompanied by a reduced range of motion.

Pathomechanics

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Kannus and Jozsa\textsuperscript{21} have shown that subjects with blood-group type O were more likely to sustain tendon ruptures than those with other ABO groups. Similarly, subjects with type A blood were less likely to sustain tendon ruptures. This association was not shown in Maffulli's study of tendon ruptures in Scotland.\textsuperscript{22} Nevertheless, several studies suggest that genetic factors might cause susceptibility to tendinopathy.\textsuperscript{23,24}

**Aims of Treatment**

Well-researched nonoperative and surgical treatment options for patellar tendinopathy are limited. Nonoperative treatment is therefore based on clinical experience, and surgical techniques vary widely.\textsuperscript{25}

Tendon rehabilitation seeks to improve the pain-free load-bearing capacity of the musculotendinous unit (MTU). It is unknown which part of the MTU is affected by rehabilitation, and there is no evidence to show that it improves tendon structure. Symptomatic relief should occur after rehabilitation. However, tendon morphology on ultrasound might not change.\textsuperscript{26} See Figures 1 and 2 for ultrasound images of patellar tendinopathy.

![Image](image-url)

**Figure 1** A classic sagittal ultrasound of patellar tendinopathy, with the swollen, hypoechoic area adjacent to the patella.

Clinical Rehabilitation

Nonoperative Treatment

The proximal, hypotenar area in the center of the lesion.

An ultrascan of the same lesion as in Figure 1, in the axial plane, with...
damage. Simply put, load should be reduced to a level that is symptomatically appropriate and to a point at which the MTU can function satisfactorily.

Load Adaptation. Adapting the MTU to tolerate increased load without symptoms is central to a rehabilitation program. This is achieved by a progressive increase in musculotendinous load. Adding weight, speed, height, and endurance or combinations of these can increase load. Specific programs emphasize different aspects of load, although there is no evidence that any one offers superior results. Curwin and Stanish\textsuperscript{38} emphasized speed, whereas Alfredson et al\textsuperscript{34} advocate weight increments. Nirschl\textsuperscript{34} stresses endurance for rehabilitation of the extensor tendons of the elbow.

It is essential to assess which of these aspects of tendon function is lacking in each patient so that exercise prescription can be tailored appropriately. Rehabilitation must address the strength and function of the whole limb, and lumbopelvic stability must be emphasized.

Single-leg work is important because pain and weakness cause unloading of an affected leg, hence allowing the unaffected leg to dominate the exercise. Similarly, squats place limited load on the quadriceps mechanism because both the calf complex and the gluteal muscles contribute significantly to the exercise. Recent work has indicated that the use of a 25° decline board limits the work of the calf muscle and can increase load on the patellar tendon.\textsuperscript{36-38}

Improving the Shock-Absorbing Capacity of the Limb. Because patellar tendinopathy occurs mostly in athletes in jumping sports, improving shock absorption on landing is critical in the rehabilitation process. Enhancing shock absorption below the knee (foot function, calf-muscle strength, and ankle dorsiflexion) will decrease the amount that occurs at the knee.

Poor foot mechanics and structure should be addressed with either shoe and/or orthotic intervention. Calf-muscle strength and endurance are also critical, because repeated landings will induce fatigue, so a comprehensive calf-muscle-strengthening program is essential.

A large range of ankle dorsiflexion allows maximal shock absorption. Because jumping athletes are often afflicted with ankle-joint degeneration or impingement, rehabilitation must include the ankle joint.

For maximal shock absorption, the gluteal muscles must have good function. Although the gluteus medius is very often adequately rehabilitated, the gluteus maximus is not and should be included in a rehabilitation program.

Rehabilitation Program

The program should include parts of the following components; however, this is not an exclusive list of appropriate exercises.

Initial strength should include weight work such as leg press and leg extension, as well as simple weight-bearing activities such as lunges, calf raises, and step-ups. As the program progresses, speed is added, and
weight-bearing exercises should include incremental speed increases. Activities such as skipping and running should be included toward the end of the program. The final aspect needed to complete rehabilitation is sport-specific strength training and running, sprinting, and change-of-direction exercises. It is important to note that each athlete should perform different exercises as part of the rehabilitation program. Appropriate exercise progression is essential for pain production in the rehabilitation process.

Once one could argue that pain is not essential for pain production in the rehabilitation process. Pain will inhibit muscular function. Therefore, the clinician should not be advising the patient to continue to exercise in pain. The goal of therapy is to return the athlete to normal activity levels as quickly as possible. In this manner, rehabilitation will never end. If collagen synthesis is the goal, then a prolonged recovery time is also indicated. Similarly, pain relief is an important measure of tendon recovery because it is needed for increasing the load adaptation of the MTU.

The best guide to recovery is the ability of the MTU to bear appropriate load. It is rare for athletes to return to competition before the decline in muscle function. Therefore, the ability of the MTU to complete training loads week after week means that the repair of the MTU is complete.

Rehabilitation becomes problematic when an athlete's performance continues to decline. Further training should be administered only if the athlete's performance improves. This is a condition that allows for extended periods and appears not to reflect the current or future symptomatic status. A specific load may not be included in the training program of an athlete who is not symptomatic over the decline.
tendon maximally and perhaps provocatively in training and competition. Adding rehabilitative load to these athletes might increase symptoms. Hence, some of the training load should be replaced by appropriate rehabilitation. Nursing the player through to the end of the season and then starting aggressive rehabilitation in the off-season has proven successful.

Failure to Respond

Nonoperative tendon rehabilitation might fail to improve symptoms, and the reasons can be athlete- or practitioner-centered. Tendon rehabilitation requires excellent compliance from both the athlete and the clinician over an extended period.

Many athletes find long-term compliance difficult, especially if their symptoms are minimal. This compliance must extend to maintaining strength after their return to sport. Recurrence is a common problem in patellar tendinopathy,41 and the athlete should never allow the MTU to weaken.

Failure can arise from clinicians prescribing programs that lack eccentric exercises or adequate load increases. Similarly, failure to rehabilitate the whole limb can adversely affect rehabilitation. Of course, differential diagnosis is critical, and patellofemoral pathology and fat-pad impingement45,46 can mimic tendinopathy.

There is a group of athletes who fail to respond despite what appears to be an appropriate program undertaken with full compliance. These patients usually cannot progress far into a program and fail in the early stages. Some athletes can progress fully through rehabilitation but are unable to return to their previous competitive levels. Other interventions might be indicated for these athletes (eg, corticosteroids, aprotinin, prolotherapy), but surgical intervention probably remains the best option for them.

Surgical Treatment

Surgery on the patellar tendon was described in 1973.47 Since that time, many different techniques have been reported.55 Open patellar tenotomy is the most common surgical procedure. Other techniques include surgery directed at the enthesis (drilling, scarification),34,68 extensor-mechanism surgery,30-32 and longitudinal tenotomy.59 Less invasive procedures such as dry needleing and percutaneous tenotomy might offer “interim” management between nonoperative and surgical treatment, although the few investigations into these procedures have not indicated that they are more or less successful than standard surgical treatment.53

Good and excellent outcomes vary from 100%,54,55 to 50%.51 Coleman et al68 have separated symptomatic recovery from return to sport, reporting that 90% have relief of symptoms but that only about 60% ever return to their previous level of activity. Surgery should only be considered when an

References

Conclusion


