MANAGING PATELLAR TENDINOPATHY IN-SEASON

WHAT ELSE CAN I DO?

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Patellar Tendinopathy (PT) in court-based sports is a condition in which athletes often try to 'get comfortable with being uncomfortable'. This condition mainly affects athletes involved in repetitive movements involving the stretch-shortening cycle such as jumping and landing, making it also known as 'jumper's knee'[1]. A review by Nutarelli et al., which included 8684 athletes from a variety of sports demonstrated that around 1589 (18.3%) suffered from PT. Of these symptomatic athletes, about 731 (46%) were playing a court-based sport. In running based sports, such as football, where jumping demands are much lower, only 95 athletes experienced similar complaints[2]. PT issues are common in handball players due to the nature of the game requiring numerous accelerations/decelerations, changes of direction and jumping and landing activities involving one or both lower limbs.

Physiotherapists understand that rest can help reduce symptoms, but this often comes with the cost of missing game time. The return to play time for court-based athletes suffering from PT has been shown to be on average 60 days, greatly varying depending on the severity of symptoms[3].

This often leads to difficult discussions with team managers who understand players missing game time can have an impact on overall team standings[4]. In these situations, clinical reasoning serves as a crucial skill to differentiate between athletes who should continue their training routine with the appropriate adjustments and those who should take a step back. Appropriate rest and rehabilitation strategies are necessary when the player is unable to perform due to pain. For example, in cases of paratenonitis and tendinitis, a short period of rest is important to decrease the acute inflammatory response[5]. On the other hand, 'true tendinopathies' are characterized by structural changes to the tendon's collagen matrix because of chronic overload[5]. In these situations, load is beneficial for the tendon regeneration[1]. Thus, rather than simply taking rest, management of symptoms through load modifications and a targeted rehabilitation protocol that allows the player to perform are crucial[1].

It is hoped that this article can support clinicians in taking some simple key steps to safely reason and implement management strategies to maintain, support and in some cases diminish pain affected by PT.

IDENTIFYING PATELLAR TENDINOPATHY

There are various possible differential diagnoses related to anterior knee pain. Identifying the source of pain (ex. patellar tendon, paratenon or Hoffa's fat pad) should be the first step in our process to guide our clinical reasoning (See Figures 2 and 3). When available, imaging via ultrasonography has been reported to be helpful in the diagnosis of PT[6,7]. However, clinical assessment and a thorough history taking is a crucial piece of the pathway[8].

PT is characterized by pain that is commonly located at the inferior pole of the patella but can also present in the

Figure 1: In-season patellar tendinopathy checklist.

Figure 2a and b: Royal London Hospital Test for diagnosis of Patellar tendinopathy.

mid or distal portions of the tendon[8]. This can usually be palpated upon clinical examination (See Figure 2)[1]. Athletes usually complain of an uncomfortable sensation at the front of the knee that can 'warm-up' and allow the player to compete. The pain and stiffness can commonly return or may even increase when the player 'cools down' or upon taking the first few steps the morning after a provocative training[1]. The symptoms of PT may be mild to begin with but may progress into pain and sensitivity that take longer to reduce between trainings/games, and it may also take longer for tendons to 'warm up' when the athlete returns to the court. Over time this can spiral to a difficult stage where the athlete is inhibited to perform[8]. It can be difficult as clinicians to see players returning to play and manage these tendons repeatedly until they get sufficient time during the off-season to rehabilitate. Implementing key loading and biomechanical strategies to support tendon health is imperative to support athletes in-season.

TARGETING THE PATHOLOGY THROUGH ISOMETRICS

The pathogenesis of tendinopathy is multi-factorial with a variety of intrinsic and extrinsic risk factors. Intrinsic risk factors include anthropometric measures such as BMI and quadriceps strength[9]. One important extrinsic risk factor is excessive or poorly managed repetitive energy storage and release and compression of the tendon[8]. This was described by Cook and colleagues as the 'continuum of tendon pathology' whereby an initial acute overload causes the onset of a 'reactive tendinopathy'. In this stage, collagen integrity is preserved and a reversal to a homeostatic state of the tendon is possible. However, if excessive loading continues, the tendon matrix begins to disorganize

Figure 3a and b: Hoffa's Test for diagnosis of Infrapatellar Fat Pad Syndrome.

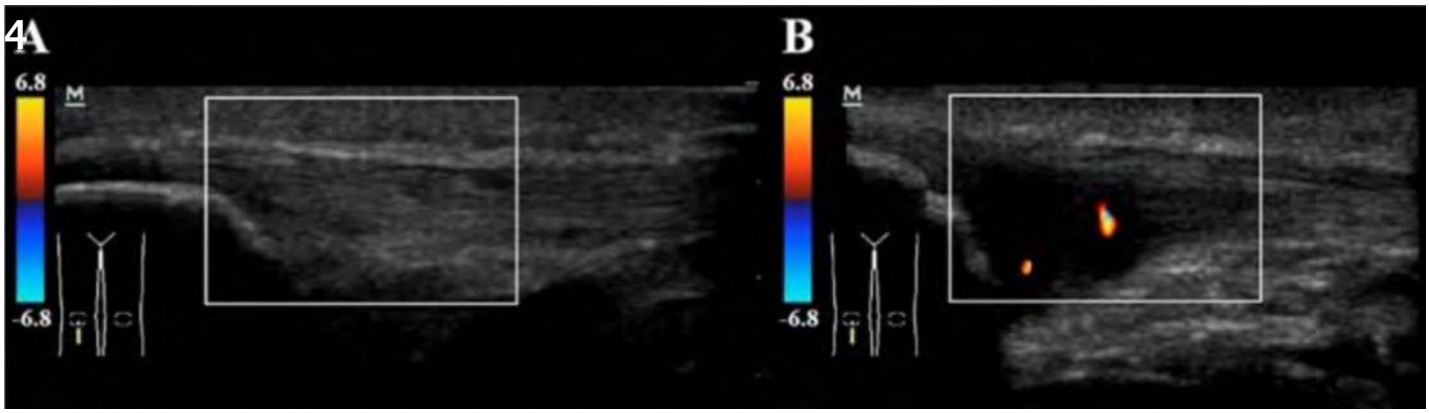

Figure 4: Taken from Arias-Buría et al., 2020. 'A' shows a normal tendon. In image 'B' the dark discoloration or 'hole' indicates thickening of the tendon and the orange coloration indicates increased vascularization within the tendon.

leading to a pathological response of increased vascularity and innervation[8]. In tendinopathy, doppler ultrasonography features may display a darkened 'hole' like shape within the tendon, which indicates a localized thickening. Furthermore, the imaging can give insight into possible neovascularization within the tendon[10] (See Figure 4). It has been previously suggested that mechanical loading, regardless of the contraction type, supports the tendon matrix and tensile strength of the healthy tissue in a tendinopathy[11]. Recently there has been more focus on isometric training which has been proposed to target the "hole" or disorganized tendon matrix[12].

It has been suggested that 'stress shielding' occurs when loads are put through a tendon e.g. jumping / isotonic strength training. In this case, the healthy tissue protects the disorganized proportion of the tendon by withstanding the load or force put through the tendon (See Figure 5). This load would theoretically support tendon regeneration and increase tensile strength of the disarranged tendon fibrils[8]. However, because of this 'stress shielding' effect, the disorganized portion of the tendon is not loaded, thus, further breakdown may continue to take place[12].

Interestingly, long isometric contractions are proposed to induce a 'stress relaxation' effect[13]. This is when a tendon is under a sustained load for a long period of time and the forces within the tendon reduce, causing the tendon fibers to relax. As these fibers relax the force disperses across all regions of the tendon and counteracts the 'stress shielding' effect previously described. This allows the load to run through the disorganized tissue of the tendon and effectively support tendon regeneration (See Figure 5)[12].

As professionals, we know that isotonic training for developing muscle mass and strength is crucial for athletes and should be utilized for performance and injury prevention. However, as explained above, isometric exercise may be more efficient at targeting 'the hole' in the disorganized and symptomatic tendon[12,13]. Furthermore, if performed at reasonable intensities, isometric actions appear to be less taxing on the muscles and energy system, allowing for quicker recovery between sessions and could be a great 'warm-up' / pre-conditioning tool[14].

BIOMECHANICAL DEFICITS

Biomechanical strength deficits etc. can often be found at the hip, knee and ankle leading to increased valgus and anterior tibial translation positions increasing loads across the anterior knee[15] (See Figure 6). This possibly contributes to the development of PT and places the knee joint in a 'vulnerable' dynamic position that may increase its susceptibility to other injuries such as ACL rupture[15]. Below we outline the three main areas where bio-mechanical deficits can be identified and suggest exercises we

have found to be helpful in targeting these strength deficits.

A) Poor Hip strength and control

Poor biomechanical control has been documented as a possible provocation of anterior knee pain[16]. If there is reduced abductor and external rotation strength of the hip, the knee tends to have increased valgus moments which increases the shear and load across the anterior knee and tendon during landing and change of direction[16]. As the external rotators of the hip reduce valgus positions on landings and deceleration, targeting lateral hip strength may reduce tortional load across the anterior knee and reduce anterior translation. (See Figure 7).

It is important to look at the players' abduction and external rotation strength and review if it is adequate to sustain the loads during jumping and landings. If it's possible for a clinician to easily resist abduction and external rotation, there is a possibility that there will be reduced hip control during high force functional tasks.

B) Quadriceps Strength and Eccentric Absorption

Limited quadriceps strength can be a common reason for anterior patellar tendinopathy[9,17]. It's important to test quadriceps strength of the affected limb compared to the unaffected leg. This can be done through isometric (knee extensions tasks) and/or isoinertial (horizontal or 45 degrees leg press) and isokinetic testing[18] or functional tasks such as SL squat tests[19]. A deficit in absolute strength might increase the loads on the tendon[9] and be one of the causes of PT. Athletes suffering from PT due to reduced quadriceps strength could benefit from a targeted lower limb strength program as this may support tendon healing and regeneration[1]. However, implementing heavy strength exercises during a busy competition schedule may be difficult to achieve without overloading the athlete. This would need to be carefully planned into the athletes' training week to avoid excessive fatigue and allow for sufficient recovery.

Eccentric absorption

There may be a common deficit seen when the quadricep muscles do not absorb load on landing known as reduced 'eccentric absorption'. This is often secondary to reduced quadriceps' eccentric strength

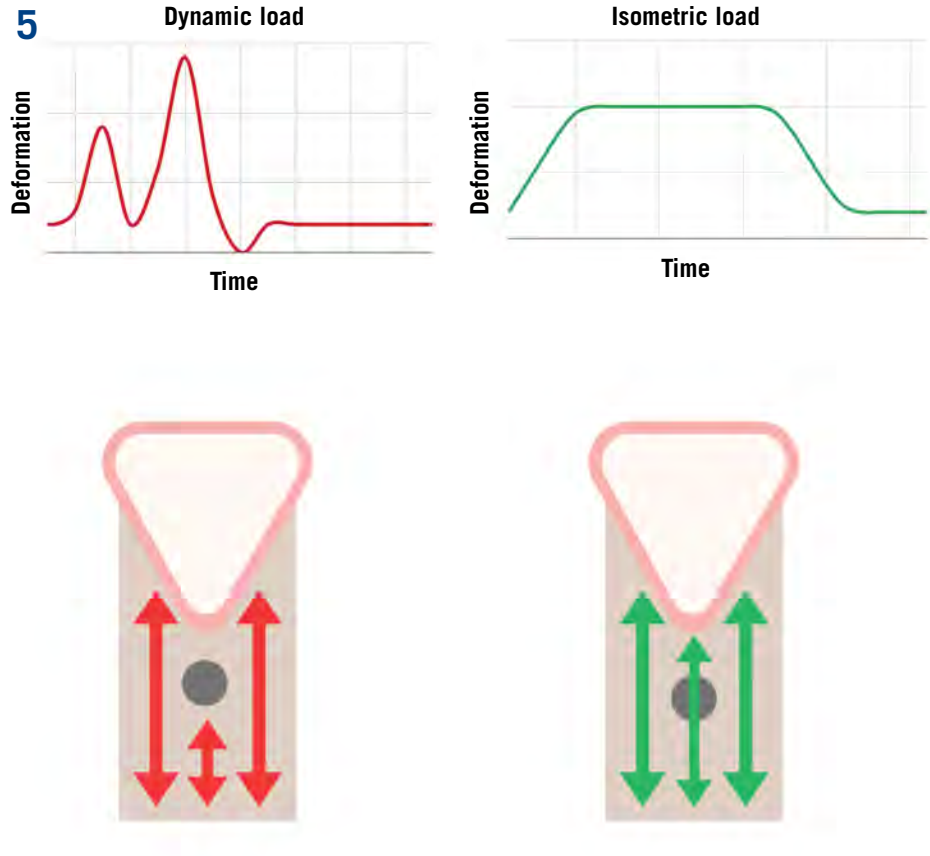

Figure 5: Re-interpretation from Steffen et al., 2022. Explains the 'stress shielding' and 'stress relaxation' phenomena related to different strategies of tendon loading.

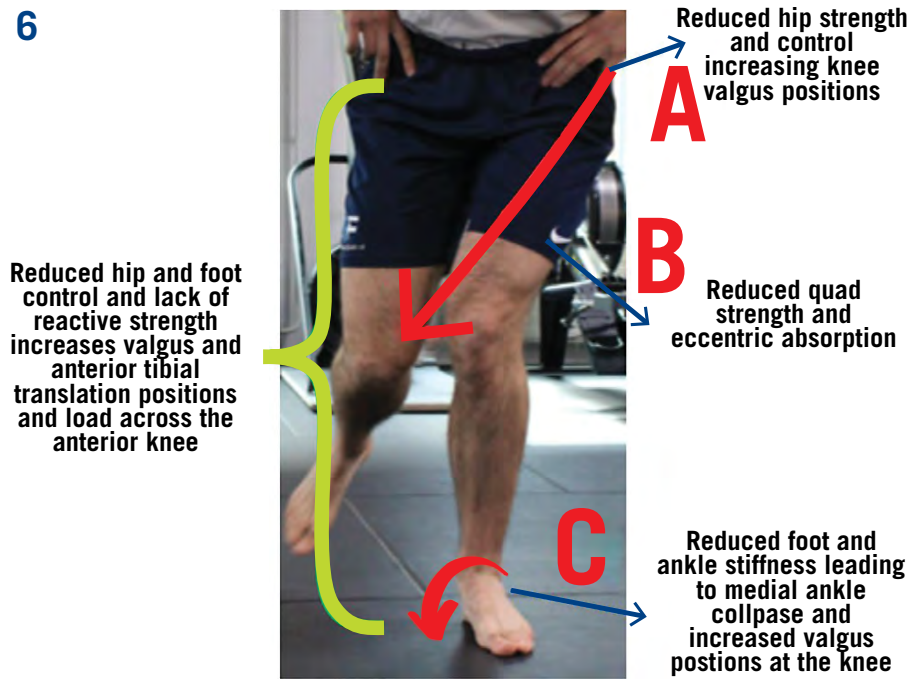

Figure 6: A combination of poor hip strength and control (A), reduced quadricep strength and absorption (B), and reduced foot control and ankle stiffness.

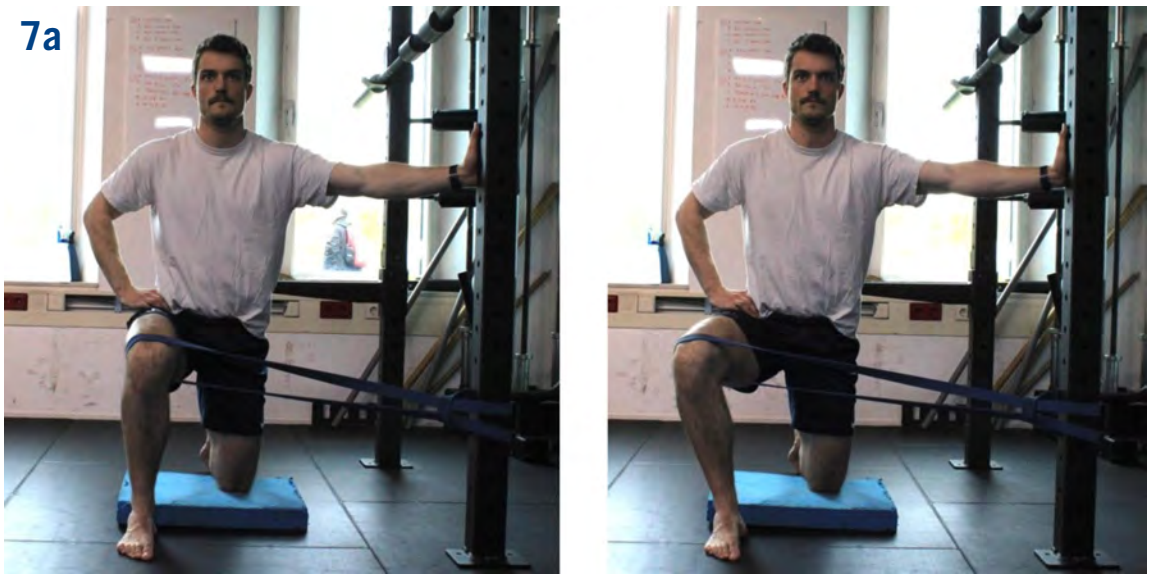

Figure 7: Lateral hip pull to target hip abductors and external rotators.

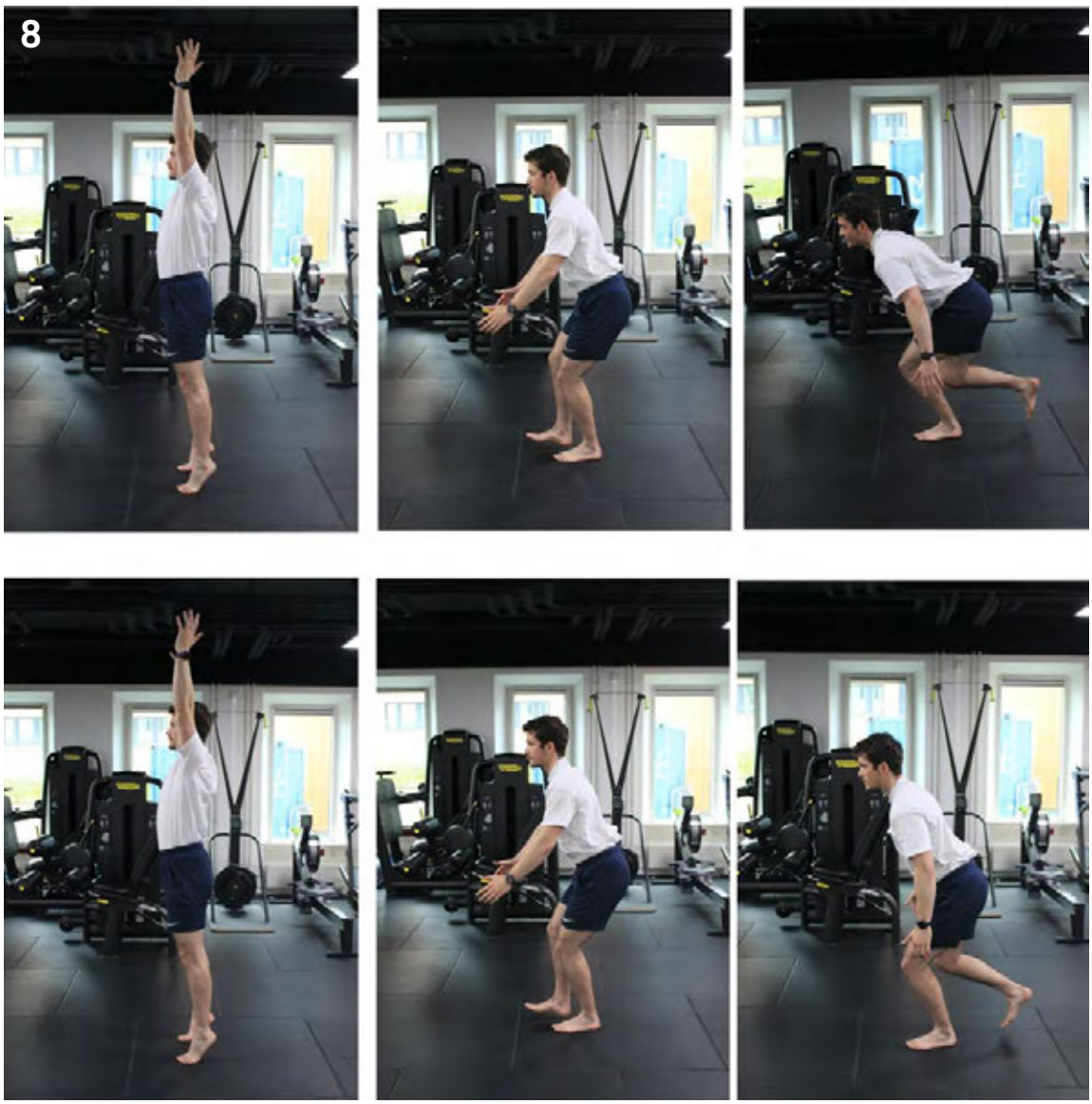

Figure 8: The top row displays a 'good' landing strategy with increased eccentric absorption. The bottom row displays a 'poor' landing strategy with reduced eccentric absorption.

Figure 9: Double leg dropcatch, a controlled landing task that can be utilized to increase quadriceps eccentric absorption.

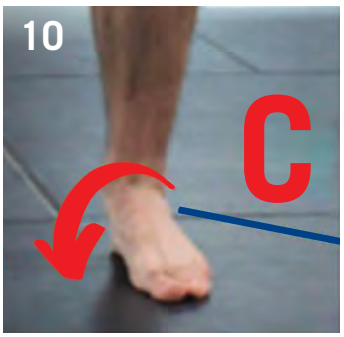

Figure 10: Poor midstance ankle control with medial arch collapse.

Figure 11: Single leg isometric calf raise to target gastrocnemius strength.

where the leg extensors muscles are unable to withstand or absorb the loads. This results in a lack of knee flexion during landing and is termed a 'stiff landing'. This landing strategy increases loads on the anterior surface of the knee[1,17], overloading the patella tendon (See Figure 8).

Performing a similar task as Figure 8 allows the clinician to visually assess the eccentric absorption capabilities of both lower limbs. From this, the clinician is then able to reason whether the quadriceps muscles require more eccentric absorption training such as controlled landing tasks e.g. (Figure 9)

C) Ankle Stiffness and Foot Control

Typically, practitioners tend to focus on the location of the injury and might overlook other joints which may contribute to the injury occurrence. With athletes experiencing PT, commonly overlooked is the importance of foot and ankle strength, control, and plyometric capacity, often referred to as 'ankle stiffness'. Ankle stiffness is commonly used to explain the ability of the ankle to absorb load and transfer energy in a controlled manner[20]. This requires key fundamental properties such as midstance control, strength, and reactive or plyometric strength. Poor ankle control when jumping and landing might affect knee loading and be one of the causes of PT. Therefore, practitioners should focus on the ankle joint also when treating PT patients to restore and enhance function and reduce the risk of re-injuries.

1) Soleus and Gastrocnemius Strength:

The main muscles involved in absorbing impacts and accelerating in the ankle joint are the soleus and the gastrocnemius. The soleus can withstand loads of up to 7- 9 times the persons' body weight[21]. If the soleus does not have adequate strength to absorb and counteract these loads, it's difficult to maintain midstance ankle control and stability. (See Figure 10).

Therefore, ensuring the athlete has adequate strength in the plantar flexors muscles is imperative[22]. Testing the strength through tests such as isometric testing, or calf raise isoinertial protocols of the soleus or gastrocnemius may support clinicians in identifying possible weakness[23,24]. Handball players should perform strength training activities targeting both the gastrocnemius and soleus muscles with a periodized and progressive plan incorporated in their weekly micro-cycle (See Figure 11). It is important to make sure that such activities are carefully planned to avoid unnecessary overload and fatigue in proximity of games.

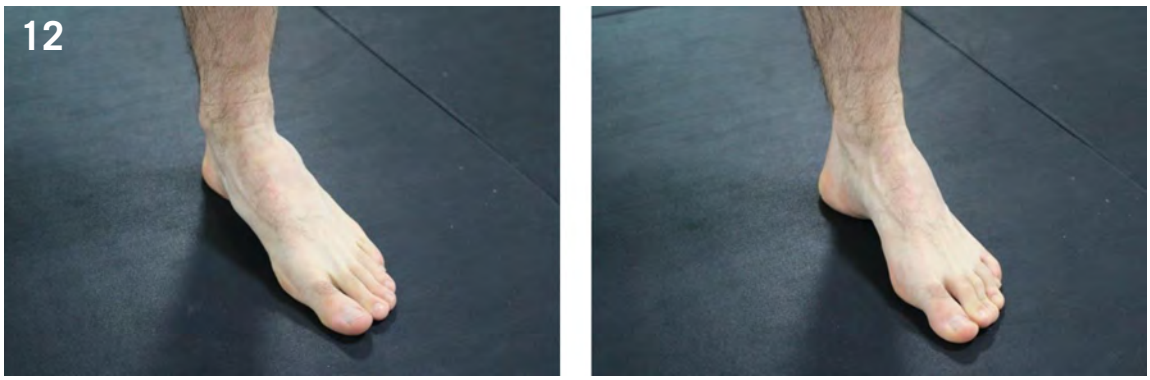

Figure 12: Closed kinetic chain tibialis posterior exercise targeting midstance control.

Figure 13: Open kinetic chain banded inversion for tibialis posterior strengthening.

Figure 14: Alternated pogo jumps with elastic band support.

2) Mid-stance control

Midstance control is the ability of the ankle to maintain a neutral midfoot position during functional tasks such as landing and running. It's important to develop midstance stability because when the ankle has excessive medial arch collapse it tends to pull the tibia medially and increases the valgus position at the knee, thus, increasing load on the anterior knee (See Figure 6)[18].

One of the main drivers to support mid- stance stability can be the posterior tibialis' muscle strength[25]. Exercises that target ankle control and stiffness are shown in Figures 12 and 13. The goal with these exercises is to develop sufficient mid-stance control which would then prevent excessive dynamic knee valgus and decrease load on the anterior knee.

3) Reactive Strength

Reactive strength refers to the elastic properties of tendon and muscle to absorb force during landing and subsequently accelerate to take off or spring forward[22]. Having sufficient lower limb reactive strength can improve midstance and valgus control[20], therefore, reducing excessive anterior tibial translation.

Developing reactive strength can be achieved without putting too much load through the anterior knee when coached correctly and performed with the knee extended. (See Figure 14). Implementing double and single leg jumping and hopping tasks such as 'pogos', supports in developing reactive strength and stiffness. 'Pogos' can be implemented as a 'warm up' before training activities but they can also be incorporated as part of the strength training program.

LOAD MANAGEMENT

Load management is the process of monitoring an athlete's training loads and their ability to sustain the prescribed loads to adjust their training accordingly. This in theory, should maximize their performance, whilst minimizing their injury risk[26]. This is especially important for athletes who have undergone a period of decreased loading due to their injury. These athletes would have a lower 'tolerance' to exercise, their exposure to acute bouts of training loads would exceed their ability to sustain the loads and increase their risk of re-injury[27,28]. This is where the communication between the medical and the coaching staff becomes

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crucial[29]. A collaboration is needed between these two parties, to create an individualized schedule for each athlete managing PT. This plan should be as specific as possible and include things like type of training (court sport-specific training vs. gym training), duration, and intensity. Other factors to take into consideration are the level of fitness of the athlete, their symptomatology and psychological readiness[30]. It is crucial to consistently evaluate the athletes' response to the prescribed training loads to make sure that their symptoms do not increase following a training[30]. In doing so, the athlete has a much higher chance of returning to their previous level of performance and avoiding possible setbacks[31].

CONCLUSION

In conclusion, athletes who suffer from PT can be difficult to manage during a competitive season. Reviewing the athlete's strength and power capabilities, the biomechanical characteristics of specific landing and jumping activities and his/her plyometric capacity should help clinicians identify the possible causes of the PT symptoms. These could then be addressed by implementing one or more of the above-mentioned management strategies that best suits the individual athlete.

References
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