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Lower limb strength and flexibility in athletes with and without patellar tendinopathy

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ABSTRACT

Objectives: To compare the hip, knee and ankle torques, as well as knee and ankle flexibility between athletes with patellar tendinopathy and asymptomatic controls.
Design: Cross-sectional study.
Setting: Laboratory setting.
Participants: Fourteen male volleyball, basketball or handball athletes, divided into 2 groups, patellar tendinopathy group (TG; $n = 7$) and asymptomatic control group (CG; $n = 7$).
Main outcome measures: Hip, knee and ankle isometric torques were measured with a handheld dynamometer. Weight-bearing ankle dorsiflexion, hamstring and quadriceps flexibility were measured with a gravity inclinometer.
Results: The TG had 27% lower hip extensor torque when compared to the CG ($P = 0.031$), with no group differences in knee and ankle torques ($P > 0.05$). Also, the TG had smaller weight-bearing ankle dorsiflexion ($P = 0.038$) and hamstring flexibility ($P = 0.006$) when compared to the CG. Regarding quadriceps flexibility, no group differences were found ($P = 0.828$).
Conclusions: Strength and flexibility deficits might contribute to a greater overload on the knee extensor mechanism, possibly contributing to the origin/perpetuation of patellar tendinopathy. Interventions aiming at increasing hip extensors strength as well as ankle and knee flexibility might be important for the rehabilitation of athletes with patellar tendinopathy.

1. Introduction

Patellar tendinopathy is a common musculoskeletal dysfunction in athletes and it is considered an important cause of physical disability. The prevalence of patellar tendinopathy in non-elite athletes of basketball, handball and volleyball ranges from 11.8 to 14.4% (Zwerver, Bredeweg, & van den Akker-Scheek, 2011). Chronic symptoms from patellar tendinopathy can last for decades and it has been shown that 53% of athletes quit their sports career because of knee pain (Kettunen, Kvist, Alanen, & Kujala, 2002). Still, little is known about the factors associated with this condition, which complicates the effective management of patellar tendinopathy.

Decreased knee extensor torque has been previously associated with patellar tendinopathy in athletes (Crossley et al., 2007). Impairments in the strength of the knee extensor muscles may cause tendon overload due to a decrease in the energy-absorption capacity of the muscle–tendon complex (Kannus, 1997). It is also worth noting that the hip and ankle joints are important contributors for the dissipation of the ground reaction forces during weight-bearing activities such as jump-landings (DeVita & Skelly, 1992; Zhang, Bates, & Dufek, 2000). Thus, weakness of the muscles surrounding these joints might result in excessive overload of the knee extensor mechanism in jumping athletes, possibly contributing to patellar tendinopathy. However, to our knowledge, no study evaluated the torque generation capacity of the hip and ankle joints of athletes with patellar tendinopathy.

Flexibility deficits, local and distal to the knee joint, have been previously observed in athletes with patellar tendinopathy. Locally,

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some studies have found quadriceps (Witvrouw, Bellemans, Lysens, Danneels, & Cambier, 2001) and hamstring flexibility impairments (Cook, Kiss, Khan, Purdam, & Webster, 2004; Witvrouw et al., 2001) in athletes with patellar tendinopathy. Conversely, other studies have shown that athletes with patellar tendinopathy have greater hamstring flexibility than asymptomatic controls (Crossley et al., 2007) or showed no difference in flexibility between athletes with tendinopathy and healthy controls (Gaida, Cook, Bass, Austen, & Kiss, 2004; Malliaras, Cook, & Kent, 2006). Distally, previous studies have shown that athletes with patellar tendinopathy have reduced weight-bearing dorsiflexion range of motion compared to asymptomatic athletes (Backman & Danielson, 2011; Malliaras et al., 2006). However, Crossley et al. (2007) found no difference in weight-bearing dorsiflexion range of motion between athletes with and without patellar tendinopathy. Therefore, more research is necessary in order to establish whether these flexibility impairments are present in athletes with patellar tendinopathy.

Despite the high incidence of patellar tendinopathy in the athletic population, at present we lack an obvious “treatment of choice” for this condition (Riley, 2008). A recent tendinopathy management guideline recommends that contributing issues throughout the kinetic chain should be considered in the rehabilitation of athletes with tendon disorders (Cook & Purdam, 2014). However, research is necessary to clarify whether proximal, local and distal strength and flexibility impairments are present in athletes with patellar tendinopathy. The identification of lower limb strength and/or flexibility impairments in athletes with patellar tendinopathy is important for the establishment of effective interventions to treat this condition. The purpose of this study was to compare the hip, knee and ankle isometric torques, as well as dorsiflexion range of motion, hamstring and quadriceps flexibility between athletes with patellar tendinopathy and asymptomatic controls.

2. Methods

2.1. Participants

Thirty-four young athletes (22 male), 16–30 years of age, were recruited from local volleyball, basketball and handball professional and university teams. They were submitted to an ultrasonographic evaluation of both patellar tendons by an experienced radiologist. The athletes were considered to have a patellar tendon abnormality if a hypoechoic area was evident in both the longitudinal and transverse scans (Cook, Khan, Kiss, Purdam, & Griffiths, 2000). Females were excluded from this analysis because only 1 female athlete was identified to have patellar tendon abnormalities. The remaining women presented with normal patellar tendon imaging and no knee symptoms or with symptoms consistent with dysfunctions other than patellar tendinopathy. This finding is supported by previous studies that have found that patellar tendinopathy is more prevalent in males in comparison to females (Visnes & Bahr, 2013; Zwerver et al., 2011). Six male athletes with patellar tendon abnormalities but no current symptoms in the knee joint were also excluded. In addition, two male athletes were excluded in this initial screening due to ultrasound imaging consistent with Osgood-Schlatter disease and prepatellar bursitis. Ultimately, seven male athletes with patellar tendinopathy and 7 asymptomatic controls with no patellar tendon abnormalities or knee symptoms were included in this study.

In addition to the presence of patellar tendon abnormalities, clinical criteria to include the athletes in the patellar tendinopathy group (TG) were the following: pain localized in the patellar tendon of insidious onset, confirmed by palpation; and current symptoms in the patellar tendon during tendon-loading tasks (i.e., jumping, squatting) for at least 3 months (Sorenson et al., 2010). Asymptomatic athletes with no patellar tendon abnormalities were included in the control group (CG). The exclusion criteria adopted in this study were the following: history of trauma or surgery in the knee joint; intra-articular pathology; patellofemoral pain; patellar instability; Osgood-Schlatter or Sinding-Larsen-Johansson diseases; and symptom reproduction with palpation of the retinacula, iliotibial band or pes anserinus tendon. The athletes were invited to participate voluntarily in the study and they signed an informed consent form. Parental consent was also obtained in the case of underage athletes. This study was approved by the University's Ethics Committee for Research.

Prior to the strength and flexibility evaluations, the athletes' body mass and height were measured. They were also questioned about the total time of sports practice and their current weekly hours of sports practice. In addition, the athletes filled the Brazilian Portuguese version of the Victorian Institute of Sport Assessment-Patella (VISA-P) questionnaire (Wageck et al., 2013). During the strength and flexibility testing, the athletes were wearing shorts and sports shoes. Only the symptomatic limb of the athletes of the TG was submitted to the strength and flexibility evaluations. In case of bilateral symptoms (1 athlete), the most symptomatic limb was assessed. For the athletes of the CG, the dominant lower limb was assessed. Lower limb dominance was defined as the limb the athlete would use to kick a ball as far as possible. The tests were always conducted under the same conditions, always in the order as described in the article. In order to test the reliability of the primary outcomes of this study, ten healthy active subjects were tested in a pilot study with the procedures described in the following sub-sections on 2 occasions separated by 48–72 h by the same examiner. For each variable, the intraclass correlation coefficient (ICC), standard error of measurement (SEM) and minimal detectable change (MDC) were calculated (Weir, 2005).

2.2. Isometric strength testing

A handheld dynamometer (Lafayette Instruments, IN, USA) was used to measure hip extension, knee extension and ankle plantar flexion torques during maximal isometric contractions. Inelastic straps were used to stabilize the athletes and the handheld dynamometer, to eliminate the effect of tester strength on these measurements (Willson & Davis, 2009).

Hip extensor torque was measured with the athlete in prone-lying with the hips in a neutral position in all 3 planes. The knee of the limb under test was positioned in 90° of flexion (Fukuchi, Stefanyshyn, Stirling, Duarte, & Ferber, 2014). A strap was positioned around the athlete's pelvis and the examination table for stabilization. The athlete was allowed to hold the examination table with the upper extremities for trunk stabilization. The dynamometer was positioned immediately proximal to the popliteal fossa (Fig. 1a). The athlete was asked to ‘push trying to move the foot towards the ceiling’. Reliability of this measurement was found to be excellent in our pilot study, with an $ICC_{3,3} = 0.93$; a SEM = 0.012 N m/kg/m and a MDC = 0.032 N m/kg/m.

Knee extensor torque was measured with the athlete in supine-lying with 30° of knee flexion (Willson & Davis, 2009). This test position was chosen because it more closely resembles the knee flexion angle the athletes have to generate force in during jumps (Willson & Davis, 2009). The dynamometer was positioned immediately proximal to the midpoint between the lateral and medial malleoli (Fig. 1b). The athlete was asked to cross the arms in front of the thorax and to ‘push trying to extend the knee’. This measurement was found to have excellent reliability ($ICC_{3,3} = 0.85$, SEM = 0.026 N m/kg/m, MDC = 0.073 N m/kg/m).