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Is proprioception diminished in patients with patellar tendinopathy?

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ABSTRACT

Purpose: Patellar tendinopathy is a highly prevalent overuse injury, and most treatments are only effective to some extent. This persistence of complaints could be linked to changed proprioception. One study showed diminished proprioception in athletes with lateral epicondylitis. Aim of this study was to determine differences in proprioception, by measuring threshold to detect passive motion (TTDPM) between recreational athletes diagnosed with patellar tendinopathy and healthy controls.

Method: The TTDPM as measure of proprioception was determined in 22 recreational athletes with patellar tendinopathy and 22 healthy recreational athletes using a validated instrument. Amount of knee flexion and extension before the movement was noticed by the subject was determined. 80 measurements per athlete (left and right leg, towards extension and flexion and with two starting angles of 20° and 40° flexion) were performed. Mean TTDPM was compared between groups and among the injured recreational athletes between the affected and unaffected knee.

Results: No significant difference in TTDPM was found between recreational athletes with patellar tendinopathy and healthy controls. We did find a significant difference between the injured and non-injured knee in recreational athletes with patellar tendinopathy; mean TTDPM was 0.02° higher in the injured knee ($p = 0.044$).

Conclusion: No difference was found in proprioception between recreational athletes with patellar tendinopathy and healthy recreational athletes. It is unclear whether such a small difference in TTDPM between affected and unaffected knee is important in clinical setting.

1. Introduction

Patellar tendinopathy (PT) is characterized by activity-related knee pain and tendon dysfunction. The pain can be located proximally in the tendon just below the patella (in the vast majority of cases), distally in the tendon, or in the main body of the patellar tendon [1]. PT is a common injury among jumping athletes, elite as well as recreational. Prevalence of PT ranges between 14% (in nonelite volleyball players) and 45% (in elite volleyball players) [2,3]. As a consequence of PT, athletes are impaired in sports participation and suffer from long-lasting symptoms of this overuse injury [4]. Effectiveness of the currently available treatment options is quite variable [5]. It is thus important to prevent PT in athletes and to develop better injury treatment options [2,6].

Proprioception is the perception of movement and position of body segments in relation to each other when out of view [7]. This ability to sense the position of limb segments constitutes the proprioceptive function, which is important for the establishment and maintenance of functional joint stability [8]. Different modalities of proprioception are described, such as sense of tension, joint position sense (JPS) and kinesthesia (perception of motion) [9]. In general, measurements of the threshold to detect passive motion (TTDPM) are more reliable than measurements of JPS [10]. Sources of conscious proprioceptive information potentially include joint, muscle and cutaneous mechanoreceptors. Slow speeds, ranging from 0.5 to 2°/s, are used to target the Golgi tendon organs or Ruffini endings [9]. Macefield et al. reported that Golgi tendon organs could encode the forces developed by the contracting muscle fibres, where muscle spindles are sensitive to length changes within the muscle [11].

Previous research suggests that proprioception could play a role in the development of PT [12]. It is thought that proprioception is affected by chronic overuse, which could diminish the ability of sensory nerve endings to register angle changes. Earlier research

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pointed out that proprioception of athletes with lateral epicondylitis (tennis elbow) is diminished compared to that of healthy athletes [12]. As PT and lateral epicondylitis have common characteristics (such as chronic overload), proprioception of the knee in athletes with PT could also be diminished compared to healthy athletes. If that is the case, it might be important for prevention as well as treatment of PT, as proprioceptive balance training could reduce PT injury rates as well as rehabilitation time [13]. The exact mechanism is still speculated upon, but it is thought that sensory input is higher in proprioceptive-trained individuals, and that might enhance muscle-tendon unit function and integration [13].

The aim of this study was to investigate whether proprioception, by measuring TTDPM, is decreased in recreational athletes with PT by comparing the proprioception of an injured knee to the proprioception of a knee of age- and gender-matched healthy recreational athletes and to a non-injured knee of recreational athletes with PT.

2. Methods

2.1. Study design and participants

The study had a cross-sectional design. Knee proprioception was determined in recreational athletes with PT and healthy controls. Inclusion criteria for the PT group were age between 18 and 50 years, current symptoms of knee pain in the patellar tendon or its patellar or tibial insertion in connection with training and competitive sports in one knee, symptoms for over three months excluding acute inflammatory tendon problems and de novo partial ruptures, and a Victorian Institute of Sport Assessment scale in athletes with patellar tendinopathy (VISA-P) score < 80. The VISA-P is a self-administered outcome measure to assess the severity of symptoms in athletes with patellar tendinopathy. The score ranges between 0 and 100, with 100 corresponding to an asymptomatic athlete [14,15]. Exclusion criteria for the PT group were neurologic or neuromuscular disorders and other lower extremity injuries or diseases that might interfere with the measurements. Inclusion criteria for the healthy group were age between 18 and 50 years and VISA-P score ≥ 80. Exclusion criteria for the healthy group were knee injuries in the medical history, neurologic or neuromuscular disorder, and current symptoms of knee pain.

2.2. Recruitment

Recreational athletes under treatment at the Center for Sports Medicine of University Medical Center Groningen, the Netherlands, with symptomatic PT as diagnosed by a sports physician and who complied with the inclusion and exclusion criteria were asked to participate in this study. Healthy recreational athletes were recruited through social media and e-mail and were from the local community. All participants gave written informed consent. The study was approved by the medical ethics committee of University Medical Center Groningen (Number 2011/075).

2.3. Proprioception measurement system

The instrument that measured the TTDPM was build based on the prototype of Fridén and Roberts (University of Lund, Sweden) and validated in a previous study [10]. On a hospital bed a platform was mounted with a revolving sled that is driven by an electric stepper motor (Fig. 1). A splint for positioning and fixation of the distal limb, including the foot, was attached to the sled. The sled could be moved in either direction like the hand of a clock along the natural arc of extension or flexion of the knee.

2.4. Test protocol

Participants had to fill in an informed consent form, a general questionnaire about their injury and the VISA-P questionnaire. Before the tests started, participants became familiarized with the test protocol, whereafter they were asked if everything was clear to them.

Participants were positioned on their side, with the lower leg placed in the splint. The underlying leg was measured while the other leg was laid upon a second platform (Fig. 1). The centre of sagittal rotation of the knee joint was carefully positioned above the axis of the apparatus. A potentiometer was tightly fixed on the knee. The trunk of the participants was stabilized by a vacuum mattress, which impeded motion of the pelvis and reduced measurement error to 0.03°. With the participant in the desired position only motion of the knee in the sagittal plane was possible. Participants were not able to see their own leg and auditory cues were eliminated. They were encouraged to immediately press a button to stop the motion of the apparatus the moment they could sense motion of their knee. Proprioception was quantified by digitally measuring the TTDPM, in this case the angle (in degrees) at which the machine was halted.

We tested the participants following a standard protocol (start with the right leg, starting positions 20° then 40° flexion, repeat with left leg). To avoid influences of learning and loss of concentration, the leg with which the tests were started (right leg or left leg) was randomized. For each test 10 measurements towards flexion (TF) and 10 towards extension (TE) were executed at random. In total, 80 measurements per participant were performed. The leg was moved with an angular velocity of 0.5°/s. This velocity was chosen based on the investigations of Roberts and Fridén, and Boerboom et al. [10]. After each measurement the leg was repositioned and the starting position was automatically checked or corrected. To avoid participants' guessing, the onset of the rotation had a random delay, varying between 5 and 15 s, after the participants were told to be ready. If a person reacted within 0.1 s after the onset of the motion (i.e. TTDPM $< 0.05^{\circ}$), this was considered a guess because a physiological reaction time was defined to be at least 0.1 s [12]; such results were excluded from the analyses. Although reaction times over 0.1 s can also be the result of a guess, these trials were all included in the analysis as there is no way to distinguish them from those that were not the result of a guess.

2.5. Statistical analysis

Continuous variables were summarized as mean $\pm$ standard deviation or median and interquartile range if distribution was skewed. Discrete variables were presented as counts and percentages.

Fig. 1. Demonstration of positioning the subject on the Prosys. The right knee is tested while the left knee is held away at a second level.