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Original research

The effect of a patellar strap on knee joint proprioception in healthy participants and athletes with patellar tendinopathy

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ABSTRACT

Objectives: The primary aim of this study is to investigate the effect of the use of a patellar strap on knee joint proprioception in both healthy participants and in patients with patellar tendinopathy (PT). Secondary aims are to examine whether there is a difference in effectiveness of the use of a patellar strap between participants with low and high proprioceptive acuity and if possible predictors of effectiveness can be determined.
Design: Case-control.
Methods: The threshold to detect passive motion with and without a patellar strap was assessed in 22 healthy participants and 21 unilateral PT patients.
Results: The results from the mixed model analysis show that in both groups of participants a small but statistically significant improvement in proprioception was found, primarily in those who had low proprioceptive acuity. A notable finding was that in the symptomatic leg of the PT group no improvement in proprioception by wearing a strap could be determined. Male gender and having fewer symptoms were possible predictors of effectiveness in PT patients.
Conclusions: As proprioception plays a role in optimising movements and reducing load to joint-related structures like tendons and ligaments, it is considered an important protection mechanism. Although the improvements in proprioception as a result of wearing the strap are small, it might be that the use of a patellar strap can potentially play a role in injury prevention since poor proprioception can be a risk factor for (re)-injury.

1. Introduction

Proprioception – defined by Lönn as 'the perception of movement and position of body segments in relation to each other without the aid of vision' [1] – is thought to play an important role in optimising movement by controlling muscular actions and to protect from excessive strain.[2] Proprioception even seems to be a more important protective mechanism than pain because proprioceptive signals, initiated by mechanoreceptors, travel faster.[3] As a result, deficits in proprioception may lead to a higher risk of developing injuries, acute as well as chronic. Improvement in proprioception may result in reduced injury occurrence, as was found in several studies,[4–6] and is therefore considered to be very important in primary and secondary injury prevention.

In several studies the potentially positive effect of different orthoses on proprioception was demonstrated, e.g. tapes,[7,8] braces[9–11] and elastic sleeves.[12,13] Callaghan et al. showed, for instance, that the use of patellar taping in patients with patellofemoral pain syndrome is effective in improving proprioception. They did find however that the effect occurred solely in patients who originally had poor proprioception and not in patients with good proprioception beforehand. Similar results were observed in healthy participants: a positive effect of wearing an elastic bandage was found, and the largest improvements were observed in those persons who originally had poor proprioception.[13]

The use of patellar straps during sports is common among athletes with patellar tendinopathy who are trying to remain active in sports despite the pain. To our knowledge, no study has yet investigated the effect of a patellar strap on knee joint proprioception. If wearing a patellar strap enhances proprioception, it could potentially play a role in prevention and management of patellar

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tendinopathy. This study aims to investigate the effect of the use of a patellar strap on knee joint proprioception in both healthy participants and patients with PT. Secondary aims are to examine whether there is a difference in effectiveness of the use of a patellar strap between participants with high and low proprioceptive acuity and if possible predictors of effectiveness can be determined.

2. Methods

In a case-control study, proprioception of the knee was assessed during one measurement session. Two groups of subjects, all between ages 18 and 50, were included in this study: a group of healthy participants and a group of patients with PT. The healthy participants had to be free of current or previous symptoms of knee pain in the patellar tendon or its insertion, and had to have a VISA-P score higher than 80. For the PT group, participants had to be diagnosed with patellar tendinopathy (one-sided) by a physician or physical therapist, have palpation tenderness of the patellar tendon, have symptoms of knee pain in the patellar tendon or its patellar or tibial insertion during sports longer than three months, and have a VISA-P score ≤ 80. Exclusion criteria for both groups were presence of neurological symptoms (e.g. diabetic neuropathy) and other injuries to the lower extremities like ACL ruptures or conditions that required knee surgery (such as ACL reconstruction or meniscus tear) that might influence the proprioception measurements.

The healthy participants were recruited via social media, posters at educational settings and sports environments, and a mailing to students. PT patients were recruited via the UMCG Centre for Sports Medicine, physiotherapy practices, social media, posters and advertisements on the websites of sports clubs. Individuals who met the criteria were asked to participate in the study. The medical ethics committee of the University Medical Centre Groningen gave approval for this study (METC 2011/075) and all participants were asked to complete an informed consent form prior to the study. The ethical guidelines according the Medical Research Involving Human Subjects Act for all aspects of the study were closely followed.

Prior to the measurements, participants were asked to fill out a questionnaire about general characteristics, including injury-specific factors in PT patients; and the Victorian Institute of Sport Assessment – Patella (VISA-P) questionnaire. The VISA-P questionnaire is a commonly used, self-reported questionnaire that measures severity of symptoms in patients with PT. The score ranges between 0 and 100, with 100 corresponding to an asymptomatic athlete. This questionnaire is considered to be reliable and valid.[14,15]

To determine proprioception, the threshold to detect passive motion (TTDPM) was assessed. In this study a device was used based on a prototype of Friden and Roberts and previously validated to measure TTDPM.[16] The device has a high reliability with a measurement error of 0.03°.[16] A platform with a revolving sled was mounted on a former hospital bed. The sled was driven by an electric motor and a splint was attached to the sled for fixation and positioning of the leg and foot. With the movement of the sled the knee was brought into extension or flexion.

After receiving instructions about the procedure, the participant was positioned on one side on the hospital bed, with the lower leg placed in the splint (Fig. 1). This underlying leg was measured while the other leg was placed on another platform. The trunk of the participant was stabilised by a vacuum mattress.[16] Only movements of the underlying leg in the sagittal plane were possible. Participants were unable to see their own leg and auditory cues were suppressed by using earphones and instrumental music. The leg was moved with an angular velocity of 0.5/s. As soon as participants sensed motion in their knee they were instructed to press a button to stop the device. TTDPM was determined with the angle (in degrees) at which the device was halted. The onset of the rotation had a random delay (range 5–15 s) after the participants were told to be ready. This was programmed to avoid guessing. More detailed information about this device can be found in the validation study of Boerboom et al.

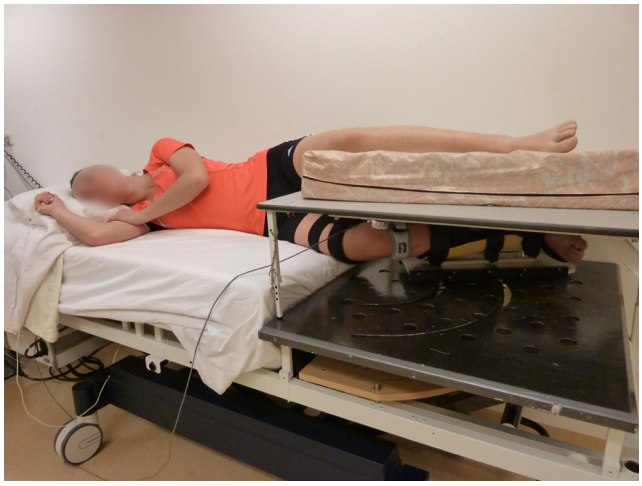

Fig. 1. A participant positioned in the TTDPM device, with the right leg placed in the splint (shown without vacuum mattress) and the patellar strap attached.

Participants were tested according to a standard protocol. The order of starting position (20° and 40° knee flexion) was kept the same for all participants, but the leg that was measured first (left or right) and the condition (with or without patellar strap) were randomised. The patellar strap used was a Push Med patellar brace (NEA Int, Maastricht Airport, The Netherlands). It was positioned by the researcher according to manufacturers' instructions. For each starting position 10 measurements towards flexion (TF) and 10 towards extension (TE) were taken at random, with a total of 160 measurements taken per participant (80 per leg).

All TTDPM values below 0.05 (in accordance with 0.1 s after the onset of the movement of the device) were considered a mistake or a guess, given that physiological reaction time is considered to be at least 0.1 s.[16] These values therefore were excluded from analysis. TTDPM values exceeding three standard deviations from the mean were also removed from analysis, as these values were probably caused by the participant's lack of focus. Because of positive skewed data a log transformation was performed before calculating the mean and the standard deviations and before analysing the data using mixed-model analysis.[16] Prior to presenting the data, a return transformation was performed. A correction for gender and age was included in the analysis, as research shows that females and older subjects have significantly higher TTDPM values.[16] To investigate if the effectiveness of the patellar strap was different in participants with low or high proprioceptive acuity, two groups were put together based on the median. The median was calculated for the healthy participants and the PT patients separately and both groups were split based on the median of that group. The group below the median was indicated as having high proprioceptive acuity, the group with TTDPM values above the median as having low proprioceptive acuity. It was also analysed if possible predictors of effectiveness of the patellar strap on proprioception could be determined using linear regression analysis. The difference in TTDPM values between the strapped and non-strapped condition was taken as the outcome; age, BMI, VISA-P, duration of symptoms (in PT patients), sports participation and TTDPM values were included as predictors. IBM SPSS v.20 was used to analyse the data and a p-value < 0.05 was considered statistically significant.