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Lecture

Influence of a knee brace intervention on perceived pain and patellofemoral loading in recreational athletes

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ABSTRACT

Background: The current investigation aimed to investigate the effects of an intervention using knee bracing on pain symptoms and patellofemoral loading in male and female recreational athletes.
Methods: Twenty participants (11 males & 9 females) with patellofemoral pain were provided with a knee brace which they wore for a period of 2 weeks. Lower extremity kinematics and patellofemoral loading were obtained during three sport specific tasks, jog, cut and single leg hop. In addition their self-reported knee pain scores were examined using the Knee injury and Osteoarthritis Outcome Score. Data were collected before and after wearing the knee brace for 2 weeks.
Findings: Significant reductions were found in the run and cut movements for peak patellofemoral force/pressure and in all movements for the peak knee abduction moment when wearing the brace. Significant improvements were also shown for Knee injury and Osteoarthritis Outcome Score subscale symptoms (pre: male = 70.27, female = 73.22 & post: male = 85.64, female = 82.44), pain (pre: male = 72.36, female = 78.89 & post: male = 85.73, female = 84.20), sport (pre: male = 60.18, female = 59.33 & post: male = 80.91, female = 79.11), function and daily living (pre: male = 82.18, female = 86.00 & post: male = 88.91, female = 90.00) and quality of life (pre: male = 51.27, female = 54.89 & post: male = 69.36, female = 66.89).
Interpretation: Male and female recreational athletes who suffer from patellofemoral pain can be advised to utilise knee bracing as a conservative method to reduce pain symptoms.

1. Introduction

Patellofemoral pain is the most common knee pathology (Dixit et al., 2007), characterised by retro-patellar pain mediated by prolonged sitting, stair climbing, and sport activities (Al-Hakim et al., 2012; Petersen et al., 2014). In athletic populations patellofemoral pain symptoms force many to limit or even end their participation in sport activities (Blond and Hansen, 1998). Importantly it has been shown that between 71 and 91% of those who present with patellofemoral pain have ongoing symptoms up to 20 years following diagnosis (Nimon et al., 1998). Furthermore, it has been suggested that patellofemoral pain may serve as a precursor to the progression of osteoarthritic symptoms in later life (Crossley, 2014; Thomas et al., 2010). The prevalence of patellofemoral pain in athletic populations is considered to be between 8 and 40%, with a greater frequency in females (Boling et al., 2010; Robinson and Nee, 2007). Although Selfe et al. (2016) found that in a patellofemoral subgroup with higher levels of physical activity 54% were males.

One of the functions of the patella as the body's largest sesamoid bone is to enhance the effective moment arm of the quadriceps muscle group and reduce the mechanical effort required to extend the knee joint (Tumia and Maffulli, 2002). The articular surface of the patellofemoral joint is comprised of dense hyaline cartilage which is capable of bearing high, compressive loads (Garth, 2001). Patellofemoral contact forces are enhanced with increasing angles of knee flexion and can reach up to 8 B.W during sport tasks (Thomee et al., 1999).

Although the incidence of patellofemoral pain is high, the causative mechanisms which lead to the initiation of symptoms are not well understood. Those with patellofemoral pain are much more likely to be physically active than age-matched controls (Fulkerson, 2002). The current consensus is that there are multiple causative factors and that patellofemoral pain is the end result of numerous pathophysiological processes (Witvrouw et al., 2014). Aetiological research investigating the causes of patellofemoral symptoms has cited both extrinsic and intrinsic mechanisms as contributory factors. Extrinsic mechanisms consist of overtraining, training errors and inferior athletic equipment (Tumia and Maffulli, 2002). Intrinsic biomechanical mechanisms consist of knee joint laxity, lower extremity mal-alignment and muscular imbalance (Tumia and Maffulli, 2002). In addition mechanical overloading of the patellofemoral joint is considered to be a key risk factor for the

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initiation of pain symptoms in athletes (Ho et al., 2012; LaBella, 2004). The knee abduction moment has also been shown to correspond with increased load borne by the lateral facet of the patellofemoral joint and thus also contribute to the aetiology of patellofemoral pain syndrome (Miyazaki et al., 2002; Myer et al., 2015; Sigward et al., 2012; Zhao et al., 2007). Excessive patellofemoral forces and knee abduction moments in conjunction with a high training volume leads to the initiation of symptoms, by overloading the patellofemoral joint beyond functional adaptive structural responses (Dye, 2005; Ho et al., 2012; LaBella, 2004).

Treatment options for patellofemoral pain typically include; exercise, patella taping, knee bracing, foot orthoses and manual therapy (Bolgla and Boling, 2011). Knee braces are defined as external, non-adhesive apparatus which attempt to alter the position of the patella (Paluska and McKeag, 2000). Knee braces come in a range of different interventions which typically include knee braces in a range of materials, sleeves and bandages (Bolgla and Boling, 2011). These are considered a relatively inexpensive treatment modality that can be purchased independently or prescribed by a therapist (Warden et al., 2008). Importantly the majority of knee braces can be applied by the wearer without assistance from a healthcare professional meaning that the user has more control over the management of their condition (Paluska and McKeag, 2000). A well-fitting knee orthosis can be used during normal daily activities and also during athletic pursuits (Warden et al., 2008).

Although a substantial body of literature exists regarding the mechanical effects of knee bracing, there is currently a paucity of research investigating the influence of knee bracing for the treatment of symptoms in those with patellofemoral pain. Powers et al. (2004) showed that knee bracing provided an immediate improvement of 54% in knee pain symptoms which were assessed using a 10 cm visual analogue scale. Arazpour et al. (2014) demonstrated that a 6 week intervention produced a significant reduction in knee pain symptoms. Khadavi et al. (2015) showed that knee bracing produced significant reductions in the knee pain parameters which were examined via the Knee injury and Osteoarthritis Outcome Score (KOOS). Callaghan et al. (2015) found that knee bracing proved to be significantly better than control for reducing symptoms after a 6 week intervention, in patients with patellofemoral pain. Miller et al. (1997) however revealed that knee bracing produced only very small non-significant improvements in patellofemoral pain symptoms. Yu et al. (2015) similarly showed that neither tibiofemoral nor patellofemoral bracing provided any additional benefits in comparison to a control group which received no bracing.

To date there has been no published work which has examined the efficacy and effectiveness of knee bracing for the treatment of symptoms in recreational athletes with patellofemoral pain during sporting activities. Selfe et al. (2016) identified that different subgroups exist within the patellofemoral pain population and different treatment regimens may be more effective for each of the different subgroups. Selfe et al. (2016) showed that the 'strong' subgroup was characterised by higher levels of physical activity. Suggestions for the strong, more athletic subgroup included; proprioceptive training, taping and bracing although this has yet to be fully explored. Therefore the aim of the current investigation was to investigate the effects of an intervention using knee bracing on pain symptoms and patellofemoral loading in male and female recreational athletes. Research of this nature may improve understanding of conservative management of patellofemoral pain and also provide recreational athletes with an alternative treatment. The current study tests the hypothesis that intervention using knee bracing will improve pain symptoms and reduce patellofemoral loading in recreational athletes with patellofemoral pain.

2. Methods

2.1. Participants

Twenty participants (11 males and 9 females) volunteered to take part in the current investigation. Participants were included into the study only if they showed symptoms of patellofemoral pain and no evidence of any other pathology. Patellofemoral pain diagnosis was made as a function of the clinical presentation of symptoms in accordance with the recommendations of Crossley et al. (2002). Participants were firstly required to exhibit symptoms of patellofemoral pain with no evidence of any other condition. The inclusion conditions were a) anterior knee pain resulting from two or more of the following; sustained sitting, climbing stairs, squatting, running, kneeling, and hopping or jumping; b) initiation of pain symptoms not caused by a specific painful incident; and c) manifestation of pain with palpation of the patellar facets. Participants were excluded from the study if there was evidence of any other knee pathology or had previously undergone surgery on the patellofemoral joint. In addition participants who had exhibited symptoms for less than 3 months or were taking any anti-inflammatory/corticosteroid medications were also excluded. Finally participants who were aged 50 or above were excluded in order to reduce the likelihood of pain being caused by degenerative joint disease. Written informed consent was provided in accordance with the declaration of Helsinki. The procedure was approved by the Universities Science, Technology, Engineering, Medicine and Health ethics committee, with the reference STEMH 295.

2.2. Knee brace

A single knee brace was used in this study, (Trizone, DJO USA), which came in three different sizes; small, medium and large to accommodate all participants (Fig. 1).

2.3. Procedure

Participants were required to report to the laboratory on two occasions. On their initial visit to the laboratory they were required to complete five repetitions of three sport specific movements; jog, cut and single leg hop. In addition to this the participants also completed the KOOS questionnaire in order to assess self-reported knee pain. Once the biomechanical and KOOS data were obtained, participants were then provided with a knee brace in their size which they were asked to wear for all of their physical activities for 14 days. Participants were instructed to maintain their habitual sport/exercise regime and also recorded the number of hours spent exercising/ playing sport during the 14 days prior to the intervention and also during the intervention itself. Following the 14 day intervention participants returned to the laboratory where the protocol was repeated whilst wearing their knee brace.

Kinematic information from the lower extremity joints was obtained using an eight camera motion capture system (Qualisys Medical AB, Goteburg, Sweden) using a capture frequency of 250 Hz. Dynamic calibration of the system was performed before each data collection session. Calibrations producing residuals <0.85 mm and points above 4000 in all cameras were considered acceptable. To measure kinetic information an embedded piezoelectric force platform (Kistler National Instruments, Switzerland Model 9281CA) operating at 1000 Hz was utilised. The kinetic and kinematic information were synchronously obtained and interfaced using Qualisys track manager.

To quantify lower extremity joint kinematics in all three planes of rotation the calibrated anatomical systems technique was utilised (Cappozzo et al., 1995). Retroreflective markers (19 mm) were positioned unilaterally allowing the; foot, shank and thigh to be defined. The foot was defined via the 1st and 5th metatarsal heads, medial and lateral malleoli and tracked using the calcaneus, 1st metatarsal and 5th metatarsal heads. The shank was defined via the medial and lateral malleoli and medial and lateral femoral epicondyles and tracked using a cluster positioned onto the shank. The thigh was defined via the medial and lateral femoral epicondyles and the hip joint centre and tracked using a cluster positioned onto the thigh. To define the pelvis additional markers were positioned onto the anterior (ASIS) and posterior (PSIS) superior iliac spines and this segment was tracked using the same