Journal of Bodywork & Movement Therapies (2017) 21, 216—222

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/jbmt

PREVENTION & REHABILITATION: ORIGINAL RESEARCH

Foot exercise and taping in patients with patellofemoral pain and pronated foot☆

Jihyun Lee, PT, MS [a], Jangwhon Yoon, PT, PhD [b,*], Heonseock Cynn, PT, PhD [a]

[a] *Applied Kinesiology and Ergonomic Technology Laboratory, Department of Physical Therapy, Graduate School, Yonsei University, Wonju, South Korea*
[b] *Department of Physical Therapy, College of Natural Science, Hoseo University, Asan, South Korea*

Received 23 May 2016; received in revised form 21 July 2016; accepted 4 August 2016

KEYWORDS
Descending stair;
Pronated foot;
Short foot exercise;
Tape;
Patellofemoral pain syndrome

Summary This study compared the effect of three foot conditions (untreated, short foot [SF] exercise, and Tape) on knee and ankle muscle activity during forward descending of stairs in subjects with patellofemoral pain syndrome (PFPS) and a pronated foot. Surface electromyography activities in the vastus medialis oblique (VMO), vastus lateralis (VL), and abductor hallucis (AbdH) were recorded during forward descending stairs; Surface electromyography data were expressed as percentages of the maximal voluntary isometric contraction. A total of 18 subjects (6 males and 12 females) with PFPS and a pronated foot participated in the current study. The SF exercise was associated with significantly greater AbdH muscle activity compared to the tape condition during forward descending stairs. However, there was no significant difference in VMO or VL muscle activity, or in the VMO/VL muscle activity ratio, among the three foot conditions. The SF exercise was the most effective method of increasing AbdH muscle activity during forward descending stairs in subjects with PFPS and a pronated foot.

Introduction

Patellofemoral pain syndrome (PFPS) is defined as retropatellar or peripatellar pain resulting from physical and biomechanical changes in the patellofemoral joint (Juhn, 1999). It is among the most common musculoskeletal conditions experienced by young, active individuals with knee complaints (Brody and Thein, 1998; Lankhorst et al., 2012). The pain is usually provoked by walking, running and squatting, and particularly during stair descent (Collins

☆ We deny any conflicts of interest including personal, financial, or other related to our submitted manuscript titled "foot exercise and taping in patients with patellofemoral pain and pronated foot".

* Corresponding author. 20 Hoseo-ro 79gil, Baebang-eup, Asan-si, Chungnam, 336-795, South Korea. Fax: +82 41 540 9975.
E-mail addresses: jihyun.lee@yonsei.ac.kr (J. Lee), jyoon@hoseo.edu (J. Yoon), cynn@yonsei.ac.kr (H. Cynn).

http://dx.doi.org/10.1016/j.jbmt.2016.07.010
1360-8592/

et al., 2008; Loudon et al., 2002). Descending stairs requires precise dynamic control of weight-bearing stress on the knee joint. Mechanical alterations such as various knee flexion angles may create abnormal stress to the tibiofemoral and patellofemoral joint (Loudon et al., 2002). Numerous causes of PFPS have been reported, including altered tracking of the patella or increased stress at the lateral patellofemoral joint (Dye, 2005; Feller et al., 2007) due to an imbalance between the vastus medialis oblique (VMO) and vastus lateralis (VL), hip abductor weakness, and excessive mid foot mobility and rear foot eversion (Boling, 2012; Boling et al., 2009; Brukner et al., 2007; Cerny, 1995; Souza and Gross, 1991; Taskiran et al., 1998).

Excessive mid-foot mobility and rear-foot eversion (or sub-conditions such as a pronated foot) have recently been considered as possible intrinsic risk factors for increased lateral patellofemoral joint stress and subsequent PFPS development (Boling, 2012; Boling et al., 2009). A prospective study identified a non-gender-specific increase in mid-foot mobility as a risk factor for PFPS in military trainees (Boling, 2012; Boling et al., 2009). Another previous investigation reported that excessive rear-foot eversion during the stance phase of gait may result in increased internal rotation of the tibia with respect to the talus; associated joint coupling would cause the hip to internally rotate to a greater degree, thereby also increasing hip adduction and the dynamic Q angle (Tiberio, 1987). These kinematic factors are thought to be detrimental to the patellofemoral joint due to a reduction in the contact area and an associated increase in lateral patellofemoral joint compression (Wilson, 2007).

In a pronated foot, abnormal alignment may stretch and weaken the intrinsic foot muscles, by elongating them beyond their neutral physiological resting position. Additionally, the alignment changes the length -tension relationship of the muscles which may preclude the muscle from being able to generate adequate or optimal force. Various methods have been advocated in the treatment of a pronated foot, including active strengthening exercises (Anderson et al., 2004; Jung et al., 2011b; Prentice, 2009). Several active exercises can be used to strengthen the intrinsic foot muscles, to reduce foot pronation and raise the medial longitudinal arch (MLA), such as picking up objects, engaging in unilateral balance activities, and performing shin curls, towel toe curls, and the short foot (SF) exercise (Anderson et al., 2004; Prentice, 2009). The SF exercise is frequently prescribed and performed in the context of sports and rehabilitation, to strengthen the intrinsic foot muscles and enhance the longitudinal and transverse arches. One study reported that the SF exercise was more effective than towel toe curls in activating the abductor hallucis (AbdH) muscles and preventing a lowered MLA (Jung et al., 2011a).

The use of passive supports, such as custom orthoses or taping, has also been utilized in the management of foot pronation. During an 8-week intervention in pes planus patients, foot orthoses used during performance of the SF exercise increased the cross-sectional area of the AbdH to a greater degree than did foot orthoses alone (Jung et al., 2011b). The use of foot orthoses has been used to decrease patellofemoral pain and increase functional performance (Barton et al., 2011; Mills et al., 2012; Vicenzino et al., 2010). However, a meta-analysis reported that therapeutic taping was more effective in reducing pronation compared to foot orthoses, motion control footwear, and standard taping (Cheung et al., 2011). Therapeutic tape is often applied by a therapist and confers an additional advantage over foot orthoses because subjects are assessed on multiple occasions; i.e., before each taping, such that changes in foot condition can be assessed and managed more effectively. Although both the SF exercise and foot taping have been shown to be effective in the management of a pronated foot, no study has investigated the use of foot muscle exercises and foot taping for subjects with PFPS who present with a pronated foot.

The purpose of this study was to compare the effects of three foot interventions (untreated, SF, and Tape) on knee and ankle muscle activity (VMO, VL, and AbdH) during forward descending stairs (FDS) in patients with PFPS and a pronated foot. The researchers hypothesized that VMO and AbdH muscle activities would be greater and VL muscle activity was less SF exercise during FDS compared to untreated and Tape.

Methods

Subjects

A total of 18 subjects (6 males and 12 females) with PFPS and a pronated foot participated in the current study; all underwent a physical examination to diagnose PFPS and foot pronation (mean age = 20.06 ± 1.63 years, mean height = 165.28 ± 5.90 cm, mean weight = 57.53 ± 11.05 kg, mean body mass index [BMI] = 20.85 ± 3.31 kg/m^2, mean visual analog pain scale [VAS] score = 4.29 ± 1.91, mean resting calcaneal stance position [RCSP] = 9.44 ± 3.26°, and mean foot posture index [FPI] = 6.28 ± 3.34). The G*power software package (ver. 3.1.6; Franz Faul, Kiel University, Kiel, Germany) was used for power analyses. A sample size of eight subjects was determined as necessary, using data obtained from a pilot study ($n = 6$), to achieve a power of 0.80 and an effect size of 0.51 (calculated from the partial η^2 of 0.21 of the pilot study), with an α level of 0.05.

A qualified physiotherapist (JHL) made diagnosis of PFPS during an interview and clinical examination. The inclusion criteria were aged 18–35 years old; insidious onset of peripatellar or retropatellar knee pain of at least 6 weeks' duration; pain provoked by at least two of the following activities: running, walking, hopping, squatting, stair negotiation, kneeling, or prolonged sitting; and pain elicited by patellar palpation, patellofemoral joint compression or resisted isometric quadriceps contraction (Barton et al., 2012). In cases of bilateral involvement, only the more painful side was evaluated (Lee et al., 2012). The unilateral limb on the pronated foot side was chosen as the standing leg. On the VAS, 0 denoted "no pain at all" and 10 corresponded to "the worst pain imaginable"; scores in excess of 3 points were taken to indicate at least moderate pain (Collins et al., 1997). A pronated foot was defined as an RCSP of ≥4° eversion. To measure RCSP, the examiner drew a line that bisected the calcaneus with the subject in a prone position; subjects were then asked to stand in a relaxed position on a 20-cm-high wooden box. The RCSP was quantified by measuring the posterior bisection line of