



## Original article

# Effect of stretching with and without muscle strengthening exercises for the foot and hip in patients with plantar fasciitis: A randomized controlled single-blind clinical trial<sup>☆</sup>



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## ABSTRACT

**Objective:** To compare the effect of stretching with and without muscle strengthening of the foot alone or foot and hip on pain and function in patients with plantar fasciitis.

**Design:** Single blind randomized controlled trial.

**Method:** Eighty-three patients with plantar fasciitis were allocated to one of three treatment options for an eight-week period: Foot Exercise Group (FEG – extrinsic and intrinsic foot muscles), Foot and Hip Exercise Group (FHEG – abductor and lateral rotator muscles) and Stretching Alone Exercise Group (SAEG). Main measures: A visual analog scale for pain, the Foot and Ankle Outcome Score and the Star Excursion Balance Test. All evaluations were performed before treatment and after the last treatment session.

**Results:** Improvements were found in all groups regarding the visual analog scale, the pain, activities of daily living, sports and recreation, quality of life ( $p < 0.001$ ) and other symptoms ( $p < 0.01$ ) subscales of the Foot and Ankle Outcome Score as well as posterolateral movement, posteromedial movement and composite score ( $p < 0.001$ ) on the Star Excursion Balance Test. No time–group interactions were found for any of the variables ( $p > 0.05$ ).

**Conclusions:** All three exercise protocols analyzed led to improvements at eight-week follow-up in pain, function and dynamic lower limb stability in patients with plantar fasciitis.

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## 1. Introduction

Plantar fasciitis (PF) is one of the most common conditions of the lower limbs. It is estimated that 10% of the population is affected at some time in life and two million Americans are treated for PF every year (McPoil et al., 2008). The multifactor etiology of this condition is not yet fully understood. Reduced strength of the plantar flexors, toe flexors and abductor hallucis muscles as well as a reduction in muscle volume in the forefoot are reported to contribute to PF (Kibler et al., 1991; Allen and Gross, 2003; Jung

et al., 2011; Chang et al., 2012). Intrinsic and extrinsic muscles of the feet assist in supporting the medial longitudinal arch, absorption of impact during gait and lower limb function. However, studies on the effects of strengthening exercises for these muscles in patients with PF have reached inconclusive results (Soysa et al., 2012).

A low risk factor for PF is the reduction in strength of the abductor and lateral rotator muscles of the hips (McPoil et al., 2008; Martin et al., 2014). These muscles are important to the dynamic alignment of the lower limbs. A reduction in the strength of these muscles can lead to adduction and medial rotation of the hip and dynamic knee valgus, which is related to pronation of the foot (Khamis and Yizhar, 2007; Powers, 2010; Barton et al., 2012). Thus, strengthening the abductor and lateral rotator muscles of the hips may improve the dynamic alignment of the lower limbs and alleviate pain related to dynamic valgus (Snyder et al., 2009; Fukuda et al., 2010; Dolak et al., 2011). However, the effects of such exercises on PF are not yet understood.

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Stretching of the plantar fascia and triceps surae muscle is often employed in the conservative treatment of PF. [Sweeting et al. \(2011\)](#) performed a systematic review on the effects of stretching and concluded that this method can assist in reducing pain symptoms. However, there is no consensus on the ideal number of repetitions and frequency. Moreover, there is no evidence of the benefits of combining stretching and strengthening exercises.

The purpose of the present study was to compare the effect of stretching and strengthening of foot and hip with stretching alone on pain and function in patients with plantar fasciitis. We hypothesized that patients who received foot and hip strengthening would demonstrate greater improvements in pain and function than those who received just stretching.

## 2. Methods

### 2.1. Patients

Eighty-three male and female patients participated in a randomized controlled clinical trial and were allocated into one of the three treatment options for an eight-week period: Foot Exercise Group (FEG), Foot and Hip Exercise Group (FHEG) and Stretching Alone Exercise Group (SAEG). The participants were 20–60 years old, had a medical diagnosis of PF with symptoms for more than 30 days and were recruited through printed and digital media. The diagnosis was performed by physicians from Santa Casa de Santos.

Subjects were eligible to participate in the study if they had pain on the plantar face of the heel, or in the middle portion of the central band of plantar fascia with the following features: 1) pain upon palpation; or 2) insidious pain onset; 3) pain that was accentuated after long periods of upright activities or after rest, such as the first steps in the morning; and 4) a reduction in pain following light activities ([McPoil et al., 2008](#); [Renan-Ordine et al., 2011](#)). The following were the exclusion criteria: history of lower limb surgery or trauma; a diagnosis of fibromyalgia, neurological disease, Achilles tendinopathy, metatarsalgia, acute ankle sprain, tarsal tunnel syndrome or heel pad syndrome; having undergone a strengthening or physiotherapy intervention for the lower limbs in the previous six months; body mass index (BMI) higher than 35 kg/m<sup>2</sup>; or currently taking pain medication.

This study received approval from the Human Research Ethics Committee of the Universidade Federal de São Paulo (CAAE: 05439012.0.0000.5505) and is registered in Clinical Trials Registry. The patients received clarifications regarding the procedures and those who agreed to participate signed an informed consent statement. An examiner blinded to the allocation of the participants performed the evaluations before and after treatment. During the initial evaluation, general data were collected to determine similarities among the groups regarding age, height, BMI, weight-bearing range of motion of ankle dorsiflexion, duration of PF, level of physical activity, foot posture and lower limb dominance. Lower limb dominance was determined by asking the participant which leg he/she would use to kick a ball ([Brown et al., 2014](#)). Foot posture was evaluated using Foot Posture Index (FPI) ([Redmond et al., 2008](#)).

The level of physical activity was evaluated using the short version of the International Physical Activity Questionnaire ([Matsudo et al., 2001](#)). Randomization was performed by an independent researcher with the aid of the Excel™ program. Sealed, opaque envelopes were used for the allocation of the individuals to the different groups.

### 2.2. Interventions

The total intervention period was eight weeks. The volunteers in each group received information on PF and usual

medical care, instructions, an explicative chart on the stretching exercises and a check list to record the frequency of daily stretching exercises. The volunteers in the FEG and FHEG also underwent two weekly sessions of strengthening exercises (total: 16 sessions) at a physical therapy clinic with the assistance of a physical therapist. If a patient missed an exercise strengthening session, he/she was expected to replace the lost session within the same week.

The volunteers in the SAEG were followed up weekly at the physical therapy clinic to monitor the frequency and manner by which the daily exercises were performed. Exercises with elastic resistance (Thera-band®) were adjusted weekly according to visual observation of the physical therapist along with verbal feedback from the subjects. They were asked to execute every exercise movement in a correct manner so that the last movement was close to their concentric failure.

#### 2.2.1. Stretching Alone Exercise Group

The SAEG performed four daily stretching exercises (three 30-sets).

Stretching of the hamstrings and ankle plantar flexors (straight leg raise in the supine position). Self-stretching of the calf muscles: The patient leaned forward in the standing position with the affected foot farther away from the wall, while keeping the heel on the floor; the soleus muscle was emphasized with the knee flexed and the gastrocnemius muscle with the knee extended. Self-stretching of the plantar fascia: in the sitting position, the patient crossed the affected foot over the contralateral thigh and performed passive extension of the metatarsophalangeal joints ([Fig. 1](#)).

In the first session, the volunteers were instructed on how to correctly perform the exercises. The frequency and manner by which the exercises were performed were monitored once a week.

#### 2.2.2. Foot Exercise Group

The FEG performed the same stretching exercises as the SAEG as well as strengthening exercises for the intrinsic and extrinsic muscles of the foot ([Fig. 2](#)). Toe curl exercise (three sets of 15 repetitions): the volunteers pulled a towel along a smooth surface with the toes; gradual resistance was achieved with 1 and 2 Kg weights placed on the towel ([Young et al., 2001](#)). Short foot exercise: with one foot on the ground, the volunteer brought the heads of the metatarsals to the heel without removing the forefoot from the ground or flexing the toes, thereby shortening the foot in the anteroposterior direction and elevating the medial longitudinal arch; three 1-min sets were performed, alternating the feet ([Jung et al., 2011](#); [Mulligan and Cook, 2013](#)). The invertors, evertors (in side-lying position) and dorsiflexors (in supine position) were strengthened using elastic resistance. For the plantar flexors, an inclined (25°) board was used, on which the volunteers remained standing and elevated their heels from the board (three sets of 10 repetitions).

#### 2.2.3. Foot and Hip Exercise Group

The FHEG performed the same exercises as the SAEG and FEG as well as exercises for the abductor and lateral rotator muscles of the hip using elastic resistance (three sets of 10 repetitions). The exercise for the lateral rotators was performed with the volunteer seated on massage table adjusted to position the hip at 60°. The abductors were strengthened with three exercises: in the side-lying position with limb to be strengthened positioned on top; in the standing position; and side-stepping with elastic resistance in the distal region of the thigh ([Fig. 3](#)).

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