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Efficacy of Low-Frequency Electrical Stimulation and Massage in Treatment of Planter Heel Pain

Adel Rashad Ahmed

Department of Basic Sciences, Faculty of Physical Therapy, Cairo University, Egypt

Abstract: Planter heel pain is one of the most common foot complains. The purpose of this study was to examine the efficacy of low frequency electrical stimulation in conjunction with specific planter fascial massage, stretching and strengthening exercises in treatment of planter heel pain. Twenty-six patients aged 18 to 60 years complaining from planter heel pain were assigned randomly to two treatment groups: control group received specific planter fascial massage, stretching and strengthening exercises and experimental group received the same treatment as in the control group in addition to low-frequency electrical stimulation. Visual analogue scale (VAS) and foot function activity level in terms of Foot Function Index (FFI) were assessed before and after 4 weeks of treatment. Results showed significant improvements in pain and foot function activity after treatment intervention in both groups ($p<0.05$) with non significant differences between the two groups ($p>0.05$). It could be concluded that planter fascial massage, stretching and strengthening exercises have short-term pain relief and improvement in foot functional activity level in patients with planter heel pain. The use of low-frequency electrical stimulation with the previous treatment protocol has no effect.

Key words: Painful heel · Low frequency electrical stimulation · Planter fasciitis · Stretching exercises · Massage

INTRODUCTION

Heel pain (Plantar fasciitis) is one of the most common musculoskeletal pathologies of the foot and estimated to affect 10% of the population at some time in their life [1]. It is generally accepted that heel pain predominantly affects middle aged as well as older adults [2]. Although the exact etiology of planter fasciitis is controversial, it is generally involves an inflammatory reaction of the planter fascia at its origin in the calcaneus [3]. The classic presentation of plantar fasciitis is pain on the sole of foot at the inferior region of the heel particularly with the first step taken on rising in the morning or after an extended refrain from weight bearing activity [4].

A wide variety of conservative treatments had been recommended for the treatment of plantar heel pain [5]. Conservative treatment based on physical therapy are known to improve symptoms of the condition, including electrical modalities, soft tissue massage, night splints, orthotics, stretching, ice, heat, strengthening and extracorporeal shockwave therapy [6-9].

Stretching has been identified as one of the best, safe and cost effective conservative therapy for plantar fasciitis [10-12]. Various stretching exercises showed decrease in pain on first steps in the morning and relief of other symptoms associated with plantar fasciitis [13]. It was suggested that specific plantar fascia-stretching exercises are superior to the standard Achilles tendon-stretching exercises for relieving chronic heel pain, because it directly isolates the plantar fascia by recreating the tensioning of the plantar fascia by pulling the toes and ankle backward toward the shin of the tibia [8].

Low Frequency Electrical Stimulation (LFES) has found to increase blood flow by eliciting muscular contraction in soft tissues [14]. It was concluded that LFES at a rate ranging from 7 to 50 pulses per sec can be used to increase blood flow without irritating the involved tissues by eliciting muscular contractions [15, 16]. The effects of high- and low-frequency electrical stimulation were examined on 30 healthy participants. Although no significant temperature changes were observed, participants receiving LFES had a significant increase in blood flow that peaked at 12 minutes [15].

Corresponding Author: Adel Rashad Ahmed, Department of Basic Sciences, Faculty of Physical Therapy, Cairo University, Egypt.

Because musculature is an integral component of the plantar fascial complex, it follows that optimal blood flow would be important in the healing of the plantar fascia and related soft-tissue structures [14]. However, only few studies to date, to our knowledge, have examined the efficacy of LFES as an adjunct treatment for plantar heel pain.

The use of massage therapy is well documented and supported and clinically found to be quite helpful in the treatment of plantar fasciitis [17]. It is agreed that plantar fasciitis can respond well to bodywork and massage is often suggested both to decrease tension in the deep fascial muscles and to have an organizing influence on the growth of scar tissue on the plantar fascia itself [18]. Similar to massage therapy is myofascial release and it has been one of the physical therapy treatments given in the chronic conditions that cause tightness and restriction in soft tissues much as plantar fasciitis does [19].

The purpose of this study was to examine the efficacy of low frequency electrical stimulation in conjunction with specific planter fascial massage, stretching and strengthening exercises in treatment of planter heel pain.

MATERIALS AND METHODS

Study Design: This study was an experimental randomized controlled trial, performed over the period from Oct 2008 to Mar 2009 at the outpatient's physiotherapy clinic of the university hospital. After taking the ethical approval, all of the participants provided written informed consent before their participation into the study. Randomization is done by allocating subjects with odd number to the control group and even number to the experimental group.

Subjects: Twenty-six male volunteers aged 18- 60 years who had referred to the physiotherapy outpatients department from Rheumatology and Orthopedic clinics with clinical diagnosis of planter heel pain were participated in this study. Patients selected for the study met the following criteria:1) are 18 years or older; 2) clinically diagnosed as unilateral planter fasciitis more than 3 weeks and less than 6 months; 3) no history of physical therapy for planter fasciitis in the past month; 4) those who are willing to participate in the study. Patients were excluded; 1) if they had previous planter fascia surgical procedures; 2) if they have any orthopedic or neurological impairment; 3) If they were physically unable to perform the planter fascia stretching exercises or subjects with clinical disorders where soft tissue massage are contraindication as dermatitis.

Procedures:

Outcomes Measures: Outcomes were performed before and after 4 weeks of treatment intervention. Baseline demographic variables that include name, age, weight and duration of symptoms were carried out. The outcome measures were "first step" pain and the foot functional activity. The pain experienced with the first step out of bed each morning was measured on a 10 cm a visual analog scale (VAS) scored from zero (no pain) and 10 (worst possible pain). This scale has been established as a reliable and valid instrument to measure acute and chronic pain [20].

The foot functional activity was measured using foot function index (FFI) as it includes all the activities which are part of our daily normal function [21]. The FFI is a self-administered index consisting of three domain or subscale, pain, activity limitation and disability. Subject were asked to answer the questions related to his pain and activity and score each question on a scale from 0 (no pain) to 10 (worst pain imaginable).

Treatment Intervention: After the baseline assessment, Subjects selected for the study were randomly assigned to two treatment groups, control and experimental groups.

In the Control Group: Subjects were treated with:

- Specific planter fascia Stretching exercises which were done with each subject sitting on the side of the bed and crossing the affected leg over the other leg, resting the ankle on top of the thigh. Using the hand on the affected side, the patient places the fingers across the base of the toes on the bottom of the foot and pulls the toes toward the shin of the tibia until he feels a stretch in the arch of the foot. The patient places the other hand on the sole of the foot to feel the tension and confirm that it is being stretched. Each stretching was hold for account of ten and to repeat it ten times [8].

- Specific planter fascia strengthening exercises was done using towel gripping exercises and active ankle exercises. For towel gripping exercises, subject sat with foot flat on the end of towel placed on a smooth surface, small weight is kept at the other end of towel. Keeping the heel on the floor, the towel was pulled towards the body with the toes to strength the intrinsic musculature of the foot, for 10 minutes. For active ankle exercises, subjects perform dorsiflexion, plantar flexion, inversion and eversion in supine lying for10 times.
- Specific planter fascial massage was given while, the subject in the lying position with one pillow supporting the ankles. Massage to the whole foot in the form of fingertip spreading and cross fiber friction to the calcaneal attachment of the planter fascia as well as adhesions along the planter fascia. Repetitive spreading was applied to the entire planter fascia for 10 minutes.

In the Experimental Group: subjects received the same treatment as in the control group in addition to low-frequency electrical stimulation. Before the application of LFES cleaning the bottom of the foot was done using soap and water and then dry the foot thoroughly with a clean towel. Treatment was given while the subject in supine laying position, two self adhesive electrodes were positioned, one on the planter surface of the foot just proximal to the metatarsal heads and the another one over the origin of the planter fascia. The unit (Gymnex 4, GymnaUniphy, Belgium) was then turned on and slightly increase the intensity of the electrical stimulation until subject felt a moderate comfortable contraction or pulsing action. The rate of the contraction was set at 10 pulses per sec for 20 minutes [14].

All subjects in both groups were encouraged not to change their regular shoe wear or activity level. Patients in both groups were treated 3 times per week for 4 weeks.

Data Analysis: All statistics were calculated by using the statistical package of social sciences (SPSS) version 15. Descriptive statistics (means and standard deviation) were computed for all the data. Paired *t*- test was applied within the group. Unpaired *t*- test and Mann- Whitney U- test were applied to compare the measurable parameters of pain and FFI between groups. The results were considered statistical significant with $p < 0.05$.

RESULTS

Demographic characteristics for all subjects in both groups at baseline are presented in table (1). At the beginning of the study, there were no significant differences in demographic data between the control and experimental group ($p>0.05$).

The mean changes in pain level (VAS) and FFI before and after treatment in both groups are summarized in table 2. Comparison revealed that there were no significant differences in mean changes for all measurements between the two groups before treatment ($p>0.05$). Results of pain (VAS) showed that there was a significant improvement in pain at the end of treatment in both groups $p<0.05$, while there was no significant statistical difference $p>0.05$ between both groups after treatment.

The results of the FFI showed statistically significant differences were found within groups $p<0.05$, while the results between groups after treatment revealed no statistically significant difference seen with $p>0.05$.

Table 1: Demographic Characteristics for the control and experimental groups

Group	Age (Years) Mean±SD	Body weight (Kg) Mean±SD	Duration of symptoms (Day) Mean±SD
Control	48.9±9.8	82.83±3.14	89.2±36.0
Experimental	49.1±10.1	83.14±4.31	91.1±41.0
Significant	p>0.05	p>0.05	p>0.05

Table 2: Visual Analog Scale Scores (VAS) for First-Step Morning Pain and Foot Function Index (FFI) Scores for the control and experimental groups

		Control group Mean±SD	Experimental group Mean±SD	P-value
VAS	Before	8.1±1.50	7.9±1.62	p>0.05
	After	1.9±0.92	2.1±0.95	p>0.05
	P-value	p< 0.001	p< 0.001	
FFI	Before	49.24±14.48	48.61±13.81	p>0.05
	After	11.58±9.8	11.05±10.12	p>0.05
	P-value	p< 0.001	p< 0.001	

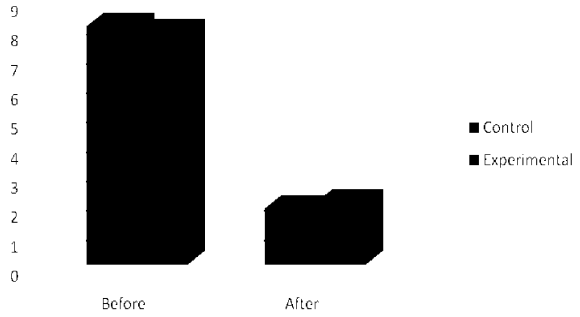

Fig. 1: Visual Analog Scale Scores (VAS) before and after treatment in both groups

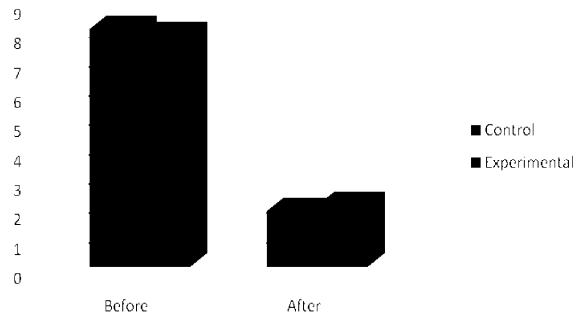

Fig. 2: Foot Function Index (FFI) Scores before and after treatment in both groups

DISCUSSION

This study was carried out to examine the efficacy of adding low frequency electrical stimulation in conjunction with specific planter fascial massage, stretching and strengthening exercises in treatment of planter heel pain. Results demonstrated significant improvements in pain levels foot functional activity after treatment interventions in both groups. There were also no significant differences between the control and experimental group in VAS and FFI scores. The present results indicate that the application of LFES in conjunction with planter fascial massage, stretching and strengthening exercises has no additional benefit in improving pain and function in planter heel pain. Based on these results the efficacy of low frequency electrical stimulation in treatment of planter fasciitis is questionable. The finding of this study are consistent with previously reported results which suggested that treatment programs for planter fasciitis, in general provide short-term pain relief and function improvement [22, 23].

Stretching for planter fasciitis is one of intervention that has demonstrated short and long term treatment effectiveness. One study reported the short term use of planter fascia stretching exercise and showed significant reduction in pain and improvements in activity level. The same study reported also that patients who continued to perform planter fascia-stretching continued to show improvements in pain and function [8]. A recent systematic review [24], of randomized trials examined the effect of calf muscle stretching on ankle range of motion and found that stretching produces statistically significant increase in ankle range of motion. This increase in ROM may reduce the symptoms of plantar heel pain by reducing the strain in the plantar fascia that the calf muscle places on it during standing and ambulation [25, 26]. However, calf muscle stretch does not optimally isolate the planter fascia and should be viewed as supplemental to the stretching exercise specific to the planter fascia. The major goals of the planter fascia stretching protocol were to recreate the windlass mechanism and to limit repetitive microtrauma and associated chronic inflammation [8].

Massage therapy has been used in the treatment of planter fasciitis [17,18]. It was stated that longitudinal stripping methods applied to the planter foot surface will help reduce tension in the intrinsic flexor muscles [17]. Kuhar *et al*. [19] investigated the effectiveness of myofascial release in the treatment of planter fasciitis, they concluded that the group which received myofascial release technique showed significantly high improvement levels in terms of both pain relief and in function ability [19]. Also, massage therapy has been found to be beneficial in treating patients with chronic planter fasciitis, this treatment combined traditional massage therapy technique with myofascial release technique[27]. The effects of positional release [28] and myofascial release [19] therapy had been studied and concluded that these treatment regimes are useful in treating patients with plantar fasciitis. Myofascial release technique has been shown to stimulate fibroblast proliferation, leading to collagen synthesis that may promote healing of plantar fasciitis by replacing degenerated tissue with a stronger and more functional tissue [29]. There is considerable clinical evidence to support the effectiveness of deep tissue procedure (massage) in treatment of strain/sprain injuries [30].

The results of the present study showed that the addition of LFES to specific planter fascial massage, stretching and strengthening exercises doesn't add an additional effect in reduction of morning pain and improvement in foot function ability in planter fasciitis.

Although, Low frequency electrical stimulation has been shown to increase blood flow and enhance tissue healing in a noninvasive manner [14]. These results could be attributed to several factors; one of these factors is the planter skin resistance which could affect the conductance of the electrical current to the planter surface of the foot. Also the use of 10 Hz or pulses per second for electrical stimulation may affect the results; previous research studied the effects of LFES of 10 Hz per sec and came in consistent with our results [14]. It is possible that a higher frequency for the application of LFES could produce different outcomes. Also, it is possible that the small number of the subjects in this study may have contributed to the difficulty in establishing whether LFES was an effective treatment.

CONCLUSION

The finding of this study suggest that regardless the use of low-frequency electrical stimulation as treatment tool, specific planter fascial massage, stretching and strengthening exercises have short-term effect in pain relief and improvement in foot functional activity in treating patients with planter heel pain.

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