High-Power Pain Threshold Ultrasound versus Myofascial Release Technique in Patients with Chronic Plantar Fasciitis

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ABSTRACT

Background: Heel discomfort and incapacity are symptoms of plantar fasciitis (PF), an inflammatory disorder of the thick tissue (plantar fascia) near the base of the foot.

Objective: To compare between high-power pain threshold ultrasound and myofascial release techniques in treatment of patient with chronic planter fasciitis.

Patients and Methods: Sixty subjects from both sex with age ranged from 40-60 years old were recruited. They were assigned randomly and equally in three groups. Group (A): received intrinsic muscle strengthening plantar fascia stretching. Group (B): received treatment of Group (a) and myofascial release. Group (C): received treatment of Group (a) and high-power pain threshold ultrasound. Each group received 4 weeks treatment three sessions per week.

Results: MANOVA was conducted to investigate the effect of treatment within groups, and it revealed significant decrease in mean value of pain and, significant increase in mean value of ankle dorsiflexion ($p = 0.001$). Post-hoc test was conducted between groups, and it revealed that compared to other groups, Group (b) had significant increase in mean value of ankle dorsiflexion ($p = 0.001$), while, Group (b) and Group (c) had significant decrease in mean value of pain ($p = 0.001$).

Conclusion: Conventional treatment, myofascial release treatment, high power pain threshold ultrasound, were effective at decreasing pain and increasing dorsiflexion ROM, with superiority of myofascial release to increase dorsiflexion ROM and of myofascial release (MFR) and high-power pain threshold ultrasound (HPPTUS) to decrease pain intensity.

Keywords: PF, HPPTUS, Myofascial release, Numerical pain rating scale.

INTRODUCTION

Inflammation of the plantar aponeurosis at its connection to the calcaneal tuberosity results in plantar fasciitis, a common cause of heel discomfort. Early in the morning is when the pain is the worst, and movement frequently makes it better [(1)].

Plantar fasciitis is a condition that develops as a result of recurrent stress to the plantar fascia at its calcaneal insertion [(2)].

This explanation can be used to explain around 15% of all foot issues that require medical treatment. Additionally, it causes 8% of injuries among athletes who compete in sports that include running. Without regard to gender, those between the ages of 40 and 60 are most frequently affected by PF [(3)].

Pain in the inferior heel area of the sole of the foot is the traditional symptom of plantar fasciitis. The first few steps performed after awakening in the morning or after a prolonged break from weight-bearing activities are particularly painful. In many cases, the discomfort goes away after a few steps and throughout the day, but it comes back if vigorous or extended weight-bearing exercise is done. Although the heel pain may begin as widespread or migratory, it eventually tends to centre in the medial tuberosity of the calcaneum [(2)].

The direct MFR approach often uses the fingers, thumb, forearm, or elbows to apply a steady, controlled mechanical stress directly into a limitation with the goal of improving soft tissue mobility. The amount of pressure is progressively raised or applied repeatedly until the tissue's mobility is perceived to improve.

Indirect methods are used in a similar way as direct techniques, but the amount of force exerted is less intense and lasts considerably longer, giving the tissue time to "melt" or relax [(4)].

MFR is a soft tissue mobilisation treatment that is applied to soft tissues that are constricted and restricted due to chronic diseases. By changing the ground substance's viscosity to a more fluid condition, myofascial release therapy relieves the fascia's excessive pressure on the pain-sensitive tissue and returns the body to its natural alignment. Therefore, it is suggested that this method serve as a catalyst in the resolution of PF [(5)].

Due to its ability to increase vasodilatation, increase viscoelasticity, and reduce muscular spasm, high-power pain threshold ultrasound is regarded an effective treatment for myofascial pain syndrome (MPS). To treat MPS, increasing the dose of ultrasound causes deep heat. When MPS is treated with ultrasound, the painful-spasm-pain-ischemia loop is broken [(6)].

In a study by **Koca *et al.*** [(7)], comparing different ultrasonic intensities on the management of myofascial pain syndrome, the authors concluded that HPPT was more efficient with less sessions and less expensive.

In addition, **Unalan and Majlesi** [(8)] claimed that HPPT was successful in minimising discomfort in

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myofascial pain syndrome. Their study comparing the effects of HPPT and injection treatment on myofascial pain syndrome showed that HPPT had the same impact as injection therapy while having less side effects since it is non-invasive.

As a result, it is unclear from the available research whether MFR or HPPTUS has a stronger therapeutic impact on patients with persistent plantar fasciitis. The current study's objective is to compare the effects of HPPTUS and MFR on those who have persistent plantar fasciitis.

MATERIAL AND METHODS

Design and setting:

Pre-test and post-test randomized controlled trial design was carried out at El-Set Khadra Hospital, Helwan, Cairo. The research was carried out between November 2022 and July 2023.

Sample size calculation:

Sixty participants joined in the present study according to G-power test.

Subjects:

Sixty patients were enrolled in this study, representing both genders from the outpatient clinic of El- Set Khadra Hospital. The participant's age ranged from 40 to 60 years and were diagnosed and referred from an orthopedist complaining of chronic plantar fasciitis. Subjects were chosen for the study after meeting certain inclusion criteria. Having plantar fasciitis more than three months ago body mass index (MBI) <30 kg/m^2.

People who had surgery on their distal tibia, fibula, ankle joint, or rear foot area in the past were excluded. Exclusion criteria for the study included the existence of any red flags, such as tumour, fracture, heterotrophic ossification, and acute inflammatory disease in the ankle-foot area. Subjects with referred pain from sciatica and other neurological disorders, as well as deformed feet and ankles.

Randomization and allocation:

Sixty chronic plantar fasciitis were evaluated for eligibility; participants were randomized into three equal groups using computer permuted randomization method, opening consecutively numbered, sealed envelopes revealed the group assignment as either A, B, or C. This was followed by a covert allocation.

Group A (control group) received conventional therapy only in the form of stretching of plantar fascia and strengthening foot intrinsic muscle, **Group B** (experimental group) received MFR of plantar fascia, gastrocnemius muscle and soleus muscle and the conventional therapy and **Group C** (experimental group) received HPPTUS and conventional therapy Figure (1).

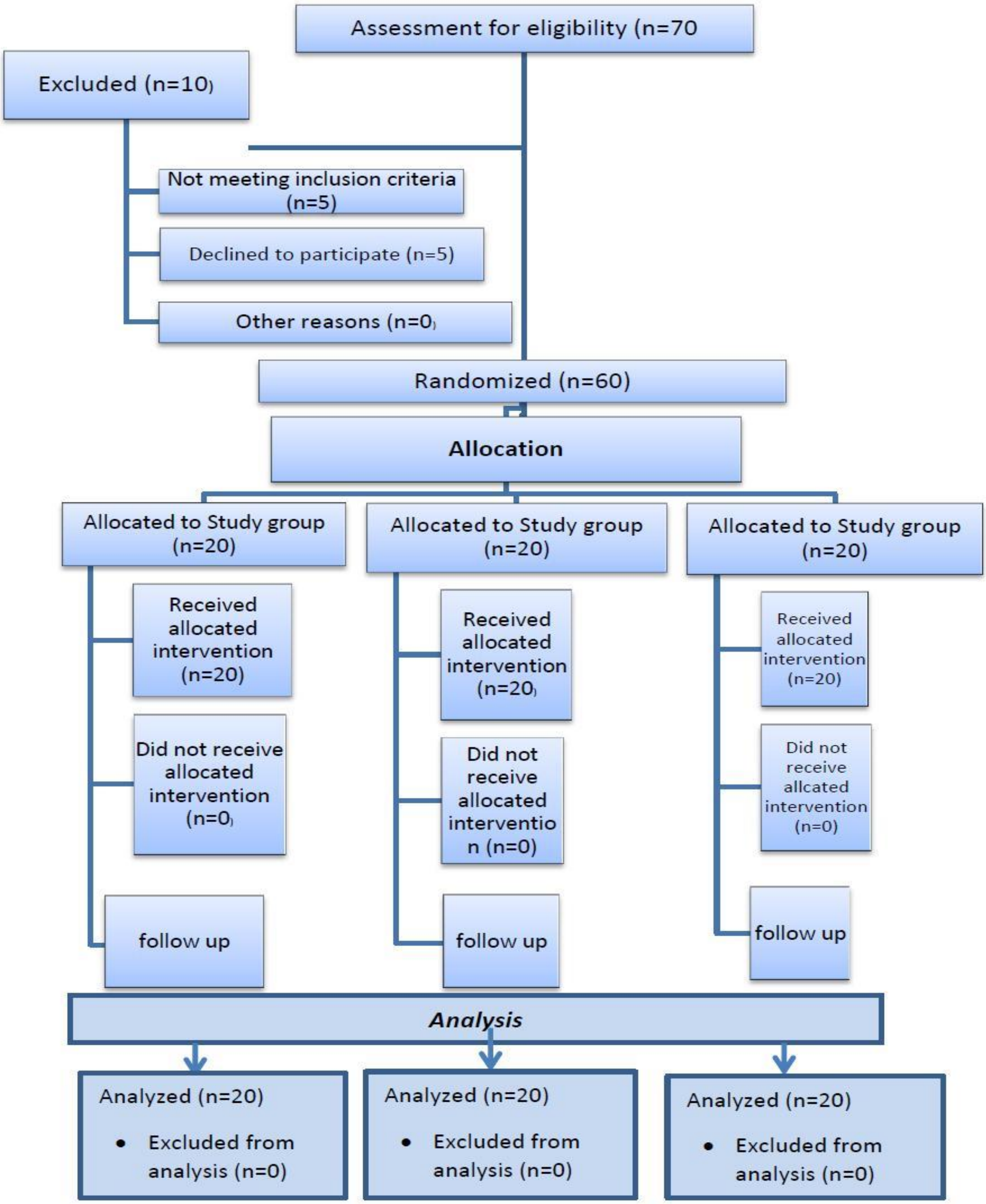

Figure (1): Flow chart

Clinical Assessment:

1- Arabic version of numerical pain rating scale:

Adults, even those with chronic pain, can rate their level of pain using the Numeric Pain Rating Scale (NPRS), which is a one-dimensional scale. A responder uses the NPRS, a segmented numeric version of the visual analogue scale, to choose an integer from 0 to 10 that best describes the severity of their pain.

- A horizontal bar or line is the most typical format.
- The NPRS is grounded by phrases that describe the extremes of pain severity, just like the VAS.

The NPRS scale spans from '0' indicating one extreme of pain (for example, "no pain") to '10' reflecting the opposite extreme of pain (for example, "pain as bad as you can imagine" or "worst pain imaginable") [(9)].

The ANPRS has a fair to outstanding repeatability (ICC 0.89). SEM and MDC, respectively, were 0.71 and 1.96. The VAS and VRS ratings showed significant associations ($p<0.01$) [(10)].

2-Manual goniometer:

Is an instrument that measures ankle dorsiflexion.

Intervention:

One of the ultrasonic modifications used to treat myofascial constriction is the HPPTUS approach. The US probe was maintained stationary throughout this method, which "be applied in continuous mode with intensity from 0.5 to 2 watt/cm to elicit pain threshold", and the intensity was gradually raised until the highest amount of discomfort the patient could tolerate was chosen. It was then held at this level for three to four seconds before being halved for 15 seconds. The treatment process was then repeated three times [(6)].

Myofascial release:

Technique of plantar fascia release:

The patient's foot was off the table and they were laying prone. The therapist was seated at the far end of the table, facing the patient. The fascia from the head of the calcaneus to the downward direction was released using the hand's knuckles. A 5-minute session consisted of 3 repeats.

Technique of soleus myofascial release:

The patient was laying prone with a 10- to 15-degree flexion of the knees. At the far end of the table, the therapist was standing with his back to the patient. By making contact with the soleus insertion at the tendocalcaneus and applying stress in the cranial direction, a 90-degree bent elbow was employed. Each session lasted for 5 minutes and had 3 repetitions.

Technique of gastrocnemius myofascial release:

The patient's foot was off the table and they were laying prone. At the far end of the table, the therapist was standing with his back to the patient. By making contact with the gastrocnemius' insertion at the tendocalcaneus into the mid-posterior calcaneus and applying stress in the cranial direction, a 90-degree bent elbow was employed. Each session lasted for 5 minutes and had 3 repetitions.

The conventional therapy:

With their feet flat on the end of a towel that was put on a smooth surface, the patient was strengthening their intrinsic muscles while sitting on a chair. The towel was pushed towards the body by curling it with the toes while keeping the heel in touch with the floor.
The patient was comfortably seated on a chair and had a tennis ball beneath their foot in this plantar fascia stretching picture. Then they rolled the ball both forward and backward with the aid of their foot.

Outcomes:

At baseline and 4 weeks following treatments, the degree of pain and the range of motion of the ankle were assessed.

Ethical considerations:

The Research Ethics Committee of the Faculty of Physical Therapy at Cairo University in Giza, Egypt, gave its approval to the study procedure (approval number: P.T.REC/012/004168), and registered in clinical trials with ID (NCT05827367). All participants gave their informed consent to participate in the study and generalise the results after being fully aware of its techniques and goals. The study was conducted in accordance with the Helsinki Declaration.

Statistical analysis

SPSS V. 20 for windows was employed for all statistical tests. Descriptive statistics and ANOVA test were carried out for assessment of the Mean±Standard Deviation (SD) of age (years), weight (Kg), height (cm), and BMI (kg/m^2) of the three groups. Test of Chi squared was performed for evaluation of sex among groups. In advance of analysis, test of Shapiro-Wilk was employed to check the data normality.

Variance's homogeneity test of Leaven was performed to evaluate among groups homogeneity, which revealed normally distributed data with variance homogeneity. Boxplot showed no data outliers. MANOVA of mixed 3 x 2 design was carried out to examine the impact of treatment (between groups), time (pre versus post) besides the interaction impact on values of mean of pain pressure threshold, pain intensity, ankle disability function, ankle active dorsiflexion and walk endurance. The significance level for all statistical examinations appointed at $p < 0.05$.

RESULTS

The mean values of age, weight, height, and BMI were not significantly different between the three groups, nor was there a significant variation in the distribution of sexes between the groups (Table 1).

Table (1): General characteristics of subjects of three groups

Subject characteristic	Group A (n=20)	Group B (n=20)	Group C (n=20)	F-value	p-value
Age (years)	47.4 ± 5.4	49.9 ± 6.4	50.5 ± 6.6	1.41	0.252
Weight (kg)	74.7 ± 9.4	71.5 ± 10.5	71.9 ± 9	0.656	0.523
Height (cm)	164.3 ± 6.9	164.9 ± 6.4	163.2 ± 5.6	0.393	0.677
BMI (kg/m^2)	27.6 ± 2.2	26.2 ± 2.8	27.1 ± 2.4	1.64	0.202
Sex N (%)					
Male	2 (10%)	4 (20%)	3 (15%)	χ^2 =0.784	0.676
Females	18 (90%)	16 (80%)	17 (85%)		

Data are represented as mean ±SD or as number (percent)

Effect of treatment on pain intensity:

In groups A, B, and C, the mean value of pain significantly decreased after the research compared to before it by 29.6%, 71.6%, and 69.9% respectively (Table 2).

Comparison between groups

The three groups' pre-study mean pain intensity values did not differ significantly from one another, however there was a significant difference after the study (Table 3).

Effect of treatment on ankle dorsiflexion:

The mean value of ankle dorsiflexion in groups A, B, and C significantly increased after the research compared to before by 15.2%, 30.6%, and 14% respectively (Table 2).

Comparison between groups

The mean ankle dorsiflexion values pre-study were not significantly different between the three groups, however there was a significant difference post-study (Table 2 and 3).

Table (2): Comparison of the mean values of the measured variables across and within groups between the pre- and post-study periods

Measured variables	Group A	Group B	Group C	F-value	P value	η^2
% of change (P-value)	↑ 51% 0.001*	↑ 277% 0.001*	↑ 170% 0.001*			
Pain						
Pre-study	7.1 ± 1.9	7.4 ± 1.5	7.3 ± 1.3	0.262	0.770	0.009
Post-study	5 ± 1.6	2.1 ± 1.5	2.2 ± 1.3	22.345	0.001*	0.439
% of change (P-value)	↓ 29.6% 0.001*	↓ 71.6% 0.001*	↓ 69.9% 0.001*			
Ankle dorsiflexion (degrees)						
Pre-study ***(???)***	14.5 ± 2.3	14.7 ± 2.6	14.3 ± 1.8	0.162	0.851	0.006
Post-study	16.7 ± 2.1	19.2 ± 1.4	16.3 ± 1.8	15.700	0.001*	0.355
% of change (P-value)	↑ 15.2% 0.001*	↑ 30.6% 0.001*	↑ 14% 0.001*			

Data are represented as mean ±SD, *: significant, η^2: partial eta square

Table (3): Post hoc test between groups of measured variables post-study

Post hoc between groups		Pain	Dorsiflexion
Group A vs. B	Mean difference	2.8	-2.5
	P-value	0.001*	0.001*
Group A vs. C	Mean difference	2.8	0.35
	P-value	0.001*	1
Group B vs. C	Mean difference	-0.05	2.9
	P-value	1	0.001*

*: significant

DISCUSSION

There was significant difference among three groups, after treatment, that received conventional treatment, myofascial release and HPPTUS. All methods of treatment decreased pain intensity and increased active dorsiflexion ROM. But MFR had the superior effect at increasing ankle dorsiflexion and MFR and HPPTUS had superior effect at decreasing pain intensity.

Regarding the improvement in the HPPT group, it could be argued that this is because US is widely regarded as an effective therapeutic modality in the treatment of musculoskeletal disorders because of its thermal and biological effects. Heat generation is one of these effects, and there are other notable metabolic changes connected to its thermal effect, as well as increased blood circulation, analgesic substance, and long-lasting analgesic effect [(11)].

When **Koca *et al.*** [(7)] looked at participants with myofascial pain syndrome using various intensities of ultrasound, they came to the conclusion that HPPT was more beneficial since it improved neck function and the number of trigger points in just four sessions.

Research that supported our findings in a pivotal clinical trial single-blinded study, recruited 33 patients who had chronic plantar fasciitis received two treatments on the plantar fascia tissue, spaced four weeks apart, in addition to receiving conservative standard care, getting a physical exam, and completing a patient-/subject-reported outcome measure. The objective was to lessen overall pain, and 86% of the population met the criterion. The mean pain score differed considerably from the starting point ($p< 0.001$) [(12)].

Another investigation backed up our findings. With the understanding that this technique necessitates more focus and interaction between the patient and the therapist, high-power, pain-threshold, static ultrasound therapy may be considered in the treatment of patients with myofascial pain syndrome. There were significant decreases in pain and significant increases in range of motion [(13)].

Other study that supported our findings in this study indicated that HPPTUS could be useful in the treatment of MPS. Additionally, HPPTUS was successful in reducing anxiety levels, relieving pain, and improving range of motion (ROM) [(6)].

In a research, **Meltzer *et al.*** [(14)] showed that MFR therapy after repeated strain damage led to normalisation of the apoptotic rate, changes in cell shape, and reorientation of fibroblasts. It's probable that MFR in PHP therapy will speed up the healing process and stop the plantar fascia's degenerative process.

According to **Tandel and Shukla** [(2)], fascia and connective tissues often move with little constraint under normal circumstances. Fascial tissue length and suppleness are hypothesised to diminish as a result of physical damage, repetitive strain injury, and inflammation, leading to fascial constriction. It's also conceivable that MFR-induced pain alleviation results from collagen reorganisation that lengthens the fascial tissue to its normal state.

Research that supported our findings MFR approach may be thought of as an additional treatment for plantar fasciitis since it is helpful in lowering pain and dorsiflexion range of motion in those with plantar fasciitis [(2)].

Another research that supported ours found that MFR therapy for chronic plantar fasciitis improved after 10 days of treatment, as evidenced by a substantial reduction in pain (VAS), and that it may be utilised as a successful treatment strategy for patients with this condition [(15)].

Our investigation concurred with another study as well. Sixty-six patients having a clinical diagnosis of PF (17 men and 49 women) were randomly allocated to the MFR or control group, and each received 12 sessions of therapy over a period of four weeks. Significantly less discomfort and more dorsiflexion range of motion were seen [(16)].

CONCLUSION

Conventional treatments, myofascial release treatment, high power pain threshold ultrasound, were effective at decreasing pain, increasing dorsiflexion ROM at patient with chronic planter fasciitis; with superiority of myofascial release at increasing dorsiflexion ROM and of MFR and HPPTUS at decreasing pain intensity.

LIMITATIONS

This study was delimited by the following:

The therapies lasted for 4 weeks, but there was no follow-up to determine if they had a long-term impact. Few male individuals made up the majority of female participants. Psychological and physiological elements that could have affected how well the individuals performed and responded.

- **Disclosure:** No financial interest or benefit has been gained from this research.
- **Conflict of interest:** The present study's authors have not disclosed any conflicts of interest.

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