Original Article

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Effect of Muscle Energy Technique versus Conventional Exercise on Pain and Functional Outcome in Subjects with Plantar Fasciitis: A Quasi-experimental Study

Physiotherapy Section

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ABSTRACT

Introduction: Plantar Fasciitis (PF) is a prevalent degenerative disorder of the plantar fascia, responsible for 11% to 15% of foot-related medical consultations and estimated to affect roughly 10% of the population particularly individuals aged 40-60 years. Frequently attributed to repetitive microtrauma and biomechanical overload, its high prevalence paired with substantial impacts on mobility and quality of life emphasise the need for deeper study into its pathogenesis and improved treatment approaches.

Aim: The aim of the present study is to find out the effect of Muscle Energy Technique (MET) versus conventional exercise on pain and functional outcome in subjects with PF.

Materials and Methods: The present quasi-experimental study was conducted in the Department of Physiotherapy, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, India from January 2023 to July 2023. A total of 60 subjects with PF fulfilling the selection criteria were included. The Plantar Fasciitis Pain/Disability Scale (PFPS) was used for pre and post-test assessment. Subjects were randomly allocated into two groups: the MET group (n=30), who received post-isometric relaxation and Reciprocal Inhibition (RI) techniques; and the conventional exercise group (n=30), who received calf and plantar fascia stretching, intrinsic foot muscle strengthening, and both group received ultrasound for 15 minutes. Data were analysed using IBM Statistical Package for the Social Sciences (SPSS) Statistics version 25.0 Within-group comparisons were performed using the paired t-test, while between-group comparisons were analysed using the independent t-test. A p-value <0.05 was considered statistically significant. Results were presented as mean ± Standard Deviation (SD) and percentage distribution in tables and graphs.

Results: According to the statistical analysis, both groups had a statistically significant improvement between their pre and post values (p<0.0001). There was no statistically significant difference between the two groups in post-exercise outcomes (p=0.3404), indicating that both interventions were similarly effective.

Conclusion: MET and conventional exercise both are effective at relieving pain and improving functional outcome. It can be incorporated as a routine physiotherapy intervention to enhance recovery and mobility.

Keywords: Adult, Disability evaluation, Exercise therapy, Pain management, Physical therapy modality

INTRODUCTION

The plantar fascia is a dense aponeurotic structure composed of fibrous tissue. It originates from the plantar tuberosity of the calcaneus, divides into three distinct bands, and inserts into the bases of the proximal phalanges [1]. A taut bundle of connective tissue called the plantar fascia serves as a windlass to support the foot's arch and it is essential for arch support, weight transfer, energy conservation, and shock absorption during walking. An enthesopathy, PF arises at the closest connection and is defined as the interface between the tendon or ligament attachment and the bony surface (periosteal). The flexor digitorum brevis muscle, on the other hand, is located deep inside the plantar fascia and connects to the calcaneus proximally through a tendon enthesis [2].

The plantar fascia develops a degenerative disease called PF as a result a recurrent stress in the area where it originates on the calcaneus [3]. This is the most typical reason why the inferior heel irritates. The discomfort and suffering brought on by this ailment can significantly reduce one's physical mobility [4]. Forceful contraction of the gastrocnemius and soleus muscles pulls the Achilles tendon onto the calcaneum, exerting pressure on the bone. This pressure leads to inflammation of the plantar fascia, causing (PF) [5].

The PF and medial heel pain result from inflammation and degeneration in the plantar fascia, primarily at its origin on the heel's medial side [6]. PF, often termed "policeman's heel" typically impacts middle-aged or older individuals, especially women aged 40 to 70, who have higher body weight, flat feet, extremely high arches, or stiff Achilles tendons [7].

PF accounts for approximately 11-15% (around 2 million cases) of foot complaints requiring medical attention. PF typically starts with intense stabbing pain in the heel when first getting out of bed or after prolonged sitting, easing with weight bearing. Later in the day, a dull ache may spread to the forefoot or arch. Physical examination reveals persistent tenderness in the medial plantar heel and pain during passive foot and toe flexion (windlass test) [8].

The windlass mechanism is activated by dorsiflexion of the toes, particularly the hallux, which raises the longitudinal arch in the medial direction and passively stretches the plantar fascia [9]. During walking push off, dorsiflexion of the toes tightens the plantar fascia like a windlass, raising the arch by bringing the heel closer to the toes. This mechanism highlights the importance of addressing mechanical dysfunction alongside inflammation management in PF rehabilitation [10].

MET is said to be efficient for a variety of objectives, comprising stretching and increasing myofascial tissue extensibility, boosting the Range of Motion (ROM) of a limited joint, building muscle, and functioning as lymph or vascular pumps to help with the drainage of fluid on RI and Post Isometric Relaxation (PIR) are the two basic modifications utilized in MET group [11]. MET is a technique in

which the subject makes active use of muscles up against a unique opposing force from a controlled orientation and in a particular direction. Isometric contractions are included in PIR. In other words, the antagonist is restrained, and the intra-fibral space is extended by the agonist [12]. Only a few fibers are activated when resistance is applied with little effort (isometric contraction); and rest are inhibited. However, PIR involves contracting the afflicted muscle, which is believed to be more beneficial in treating stiffness in the calf muscles. Stretching exercises effectively restore and enhance the muscle tendon units and attain the ROM and flexibility needed for desirable functional activities [13].

Targeting symptomatic and at risk populations with strength training therapies can help alleviate PF and increase the strength of the intrinsic foot muscles [14]. Stretching the gastrocnemius muscle and plantar fascia can alleviate discomfort in cases of PF [15]. One of the main stays of treatment for PF is thought to be stretching the calf muscle and plantar fascia [16]. Since the calf muscles and plantar fascia both insert onto the calcaneus, the purpose of a stretching programme is to release the tension that is placed on the plantar fascia, either by the calf muscles tightening the fascia or by the fascia itself being tight [17].

The high-frequency mechanical wave known as therapeutic ultrasound, delivers energy through vibration. Ultrasound therapy is widely used in the management of PF due to its therapeutic effects on soft tissues. By delivering high-frequency sound waves, ultrasound generates deep heat that enhances local blood flow, reduces inflammation, and facilitates tissue healing. Additionally, its mechanical effects may help in breaking down fibrous adhesions and promoting collagen remodeling within the plantar fascia. Continuous mode is possible indicator when treating chronic PF [18]. The PFPS is a condition-specific outcome measure designed to assess pain intensity and functional limitations associated with PF. It evaluates domains such as pain during activity, morning stiffness, limitations in walking, and daily function. The scale has demonstrated high internal consistency and test-retest reliability, with reported Cronbach's alpha values typically above 0.85, indicating strong reliability [11]. The aim of the present study is to find out the effect of MET versus Conventional exercise on pain and functional outcome in subjects with PF.

MATERIALS AND METHODS

The present study was a quasi-experimental study conducted in the Department of Physiotherapy at the Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, India. The study was conducted from January 2023 to July 2023. The study was approved by the Institutional Scientific Review Board (Approval No: 01/033/2023/ISRB/SR/SCPT). All participants were informed about the study objectives and procedures, and written informed consent was obtained from each subject in accordance with the Declaration of Helsinki.

Sample size calculation: Sample size was estimated using G*Power 3.1 software. Assuming a moderate effect size (Cohen's d = 0.6), an alpha level of 0.05, power of 80%, and a two-tailed test, the minimum required sample size was calculated as 26 participants per group. To compensate for possible attrition, the total sample size was increased to 60 participants (30 per group). A total of 60 subjects diagnosed with PF were recruited through convenience sampling.

Inclusion criteria: Inclusion criteria comprised males and females aged 30 to 50 years with a clinical diagnosis of PF, confirmed by a positive Windlass test [1], and experiencing heel pain for at least four weeks.

Exclusion criteria: Exclusion criteria included recent fractures or trauma to the lower limb; diagnosis of ankylosing spondylitis, psoriatic arthritis, rheumatoid arthritis, or gout; and conditions such as tarsal tunnel syndrome, club foot, calcaneal spur, flat foot, or retrocalcaneal bursitis.

All 60 screened subjects met the eligibility criteria and were included in the study. No participants were excluded.

Study Procedure

A total of 60 participants were randomly assigned into two groups of 30 each. Group-A received MET combined with ultrasound therapy, while Group-B underwent conventional stretching and strengthening exercises alongside ultrasound therapy. Ultrasound was applied to the plantar fascia using a 1 MHz frequency in continuous mode at an intensity of 1.5 W/cm² for 15 minutes per session. Both groups received their respective interventions three times per week for two weeks. Pain and disability were evaluated using the PFPS at baseline (pretest) and after the two-week intervention period (post-test). The primary parameter was assessed using the Plantar fasciitis disability scale (PFPS), a validated tool that measures pain intensity and functional limitations during activities of daily living and Body Mass Index (BMI) of participants was calculated and categorised according to World Health Organisation (WHO) classification [Table/Fig-1-5] [11].

Muscle Energy Technique (MET) Group: The 30 subjects with PF were assigned with MET along with ultrasound for 45 minutes per day. Two effective MET for PF: PIR and RI.

Exercise/ Intervention	Procedure	Freqency/Time/ Duration
PIR	PIR for gastrocnemius, the subjects were in supine and the foot extended over the edge of the couch keeping the knee in full extension Subject's ankle joint was dorsiflexed by the therapist's hand until a resistance or discomfort was felt. This position was held and subject was asked to exert effort (isometric contraction using approximately 20% of force) towards plantar flexion for a period of 5 to 7 seconds with appropriate breathing, then resistance was slowly released and relaxation for a period of 10 seconds was given, during this relaxation period, ankle was passively dorsiflexed to a new barrier (gastrocnemius stretch=60seconds) [Table/Fig-2]. PIR for soleus, same as gastrocnemius but the knee slightly in flexed position [Table/Fig-3] [5].	MET group was given for 20 minutes with 10 minutes rest interval. Followed by the ultrasound therapy with the subject in prone position with the foot out of the couch. The parameter of 1 MHz frequency, 1.5 W/ cm2 intensity for 15 minutes of continuous mode was delivered to the subject.
RI	The therapist places the subject's foot support while they are in a supine position then the subject actively contracts the calf muscles by attempting to push the foot downward (plantarflexion) against the therapist's resistance. After 5-7 seconds of contractions, the subject rest for 10 seconds, and the therapist assists in gently stretching the calf muscles (60seconds) by dorsiflexing the foot [Table/Fig-4] [6].	

[Table/Fig-1]: Muscle Energy Technique (MET).

[Table/Fig-2]: Post Isometric Relaxation (PIR) for gastrocnemius.

[Table/Fig-3]: Post Isometric Relaxation (PIR) for soleus.

[Table/Fig-4]: Reciprocal Inhibition (RI) for calf.

[Table/Fig-5]: Ultrasound for Muscle Energy Technique (MET) group.

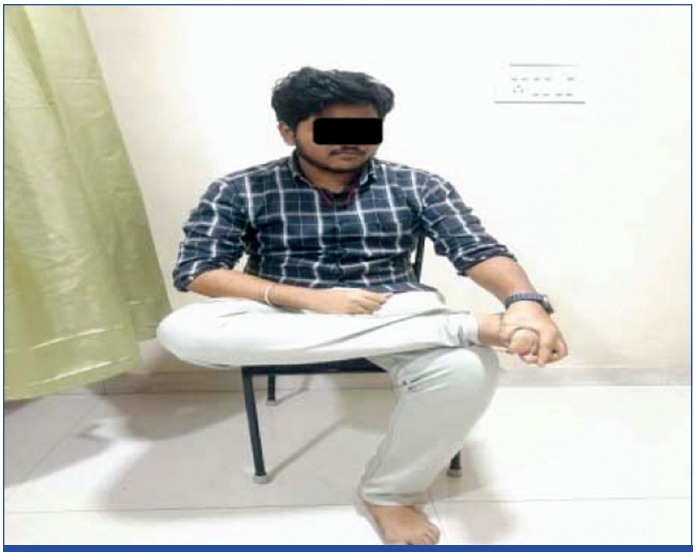
Conventional exercise group: A total of 30 subjects with PF were assigned with conventional exercise along with Ultrasound for 45 minutes per day. The stretching exercise includes calf muscles stretch and plantar fascia stretch and strengthening exercises include heel raise, towel curls, toe spread and dome, tennis ball exercise [Table/Fig-6-13].

The treatment duration for both groups was given for thrice a day/week for two weeks. The within-group analysis showed a significant improvement from pretest to post-test in both groups. Between-group comparison at post-test demonstrated a greater improvement in Group-A compared to Group-B. At 2-week follow-up, Group-A maintained significant improvement compared to post-test values, while Group-B showed only a mild change. The between-group comparison at follow-up revealed a significant difference in favour of Group-A.

Exercise/ Intervention	Procedure	Frequency/Time/ Duration
Stretching exercise:	**Calf muscles stretching:** Sit on the floor with your legs extended in front of you and loop a towel or resistance band around the ball of one foot. Gently pull the towel or band towards you, flexing your foot at the same time. Hold for 30 seconds and switch sides [Table/Fig-7]. **Plantar fascia stretching:** Sit down and cross one foot over the opposite thigh and hold your toes with your hand and gently pull them back, creating a stretch along the sole of your foot.30 seconds of holding the stretch, then release it [Table/Fig-8].	Conventional exercise was given for 20 minutes (10 minutes stretching and 10 minutes strengthening)=20 repetitions (2 sets) then 10 minutes rest [3]. Followed by the same ultrasound therapy procedure.
Strengthening exercise	**Heel raise:** Stand up straight with your feet hip-width apart You can do this exercise on the floor or on an elevated surface like a step.Raise the heels off the ground by pushing up onto the balls of your feet. Hold the raised position for a second or two.Lower the heels back down below the level of the step or floor [Table/Fig-9]. **Towel curls:** Sit on a chair with your feet flat on the ground. Place a small towel or cloth on the floor in front of you. Use the toes to grip the towel and scrunch it toward you. Hold the towel curled under your foot for a few seconds, engaging the toe muscles. Release the tension and straighten the towel back out [Table/Fig-10]. **Toe Spread and Dome:** Sit in a chair with your feet flat on the ground. Start by spreading your toes as wide as you can, creating a fan-like shape. After spreading your toes, focus on lifting the central part of your arch, as if you're creating a small dome [Table/Fig- 11] **Tennis ball exercise:** Sit on a chair and place a tennis ball on the floor. Roll your foot over the ball, applying gentle pressure. Focus on different areas of your foot, including the arch, heel, and ball of the foot. This can help relieve tension and promote circulation in your feet. Hold the domed position for a few seconds and then release [Table/Fig-12].	Conventional exercise was given for 20 min (10 min stretching and 10 min strengthening)=20 repetitions (2 sets) then 10 mins rest. Followed by the ultrasound therapy with the subject in prone position with the foot out of the couch. The parameter of 1 MHz frequency, 1.5 W/cm^2 intensity for 15 minutes of continuous mode was delivered to the subject [Table/Fig-13].

[Table/Fig-6]: Conventional exercise protocol.

[Table/Fig-7]: Calf stretch.



[Table/Fig-8]: Plantar Fascia stretch.

[Table/Fig-9]: Heel raise.

[Table/Fig-10]: Towel curl.

[Table/Fig-11]: Toe spread and dome.

[Table/Fig-12]: Tennis ball exercise.

[Table/Fig-13]: Ultrasound for conventional exercise group.

STATISTICAL ANALYSIS

The pretest and post-test values of PFPS were analysed using paired and unpaired t-tests. A paired t-test was employed to assess the within-group differences between pretest and post-test values, whereas an unpaired t-test was applied to compare the post-test values between the two groups. Data were analyzed using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarise demographic and clinical data. Paired t-tests were performed to assess within-group differences (pre- vs. post-test), while independent t-tests were used for between-group comparisons. A p-value<0.05 was considered statistically significant.

RESULTS

The [Table/Fig-14] shows the baseline characteristics of MET group and conventional exercise group. In the MET group, there were five males and 25 females, while the Conventional Exercise group comprised nine males and 21 females. The majority of participants in both groups were aged between 30 and 36 years, with 17 participants in this range in the MET group and 14 in the Conventional Exercise group. Participants aged 37 to 43 years included nine in the MET group and 10 in the Conventional group, while those aged 44 to 50 years included 4 and 6 participants, respectively. Regarding BMI, most participants had a BMI between 25 and 30 kg/m² 18 in the MET group and 21 in the Conventional group. A smaller proportion of participants had a BMI above 30 kg/m² (9 in MET and 6 in conventional), while only three participants in each group had a BMI within the 18.6-24 kg/m² range.

Baseline characteristics		Muscle Energy Technique (MET) Group	Conventional Exercise Group
Gender	Male	5	9
	Female	25	21
Age (years)	30-36	17	14
	37-43	9	10
	44-50	4	6
BMI	18.6-24	3	3
	25-30	18	21
	Above 30	9	6

[Table/Fig-14]: Baseline characteristics (N=30).

In [Table/Fig-15], the statistical analysis of pre and post-test of MET group conventional group using PFPS, pre and post-test values of mean 79.37 and 38.67, SD value of 11.36 and 14.20, p<0.0001 were statistically significant.

METs group	Mean	SD	t-test	p-value
Pretest	79.37	11.36	28.531	<0.0001
Post-test	38.67	14.20		

[Table/Fig-15]: Comparison Pretest and post-test values of Muscle Energy Technique (METs) group in PFPS.
MET: Muscle energy technique; SD= Standard deviation, PFPS: Plantar fasciitis pain and disability scale

In [Table/Fig-16], the statistical analysis of pre and post-test of conventional exercise Conventional group using PFPS, pre and post-test values of mean 79.70 and 42.20, SD value of 10.30 and 14.27, p<0.0001 were statistically significant.

Conventional group	Mean	SD	t-value	p-value
Pretest	79.7	10.30	16.128	<0.0001
Post test	42.2	14.27		

[Table/Fig-16]: Comparison Pretest and post-test values of conventional exercise in PFPS.
SD: Standard deviation; PFPS: Plantar Fasciitis pain and disability scale

In [Table/Fig-17], the statistical difference of the MET group and conventional exercise subjects was evaluated by both pre values and post values of PFPS and comparison of both groups. Pretest of MET group and conventional exercise group mean 79.37 and 79.70 and; SD value of 11.36 and 10.30 and p-value is 0.906 and post-test of MET group and conventional exercise group mean 38.67 and 42.20 and; SD value of 14.20 and 14.27 and p-value is equal to 0.3404.

PFPS		Mean	SD	t-test	p-value
Muscle Energy Technique (MET)	Pretest	79.37	11.36	0.118	0.906
Conventional exercise	Pretest	79.70	10.30		
PFPS		Mean	SD	t-test	p-value
Muscle Energy Technique (MET)	Post-test	38.67	14.20	0.9613	0.3404
Conventional exercise	Post-test	42.20	14.27		

[Table/Fig-17]: Comparison between the pretest and post-test values of MET and conventional exercise in PF.
SD: Standard deviation; PFPS: Plantar fasciitis pain and disability scale

DISCUSSION

The present study establishes a significant association between gastrocnemius equinus and PF, with reduced ankle dorsiflexion correlating with increased plantar fascia thickness, higher pain levels, and poorer function, suggesting that limited dorsiflexion heightens mechanical strain on the fascia, contributing to chronic symptoms. The results highlight gastrocnemius tightness as a modifiable risk factor and support the incorporation of calf flexibility assessment and targeted stretching into conservative treatment. While the study is limited by sample size, it provides a basis for future research on long-term outcomes of flexibility-focused interventions [14].

MET involve active patient participation to improve muscle function, ROM, and reduce pain as well as subject bears the responsibility for the dosage that is administrated. It can be applied to any area with voluntary movement. The patient's effort can range from a slight twitch to a maximum contraction, lasting from milliseconds to seconds [6]. Most individuals with PF recover with conservative treatment, which involves stretching and modifying or avoiding uncomfortable activities [13]. The PFPS is a 19 item questionnaire that assesses pain severity and functional limitations in PF. It uses a 100-point scale and focuses on questions specific to PFP and its impact on daily activities. This tool may be useful in diagnosing and evaluating PFPS [11].

Although physiotherapists generally followed established assessment principles for PF, the consistent use of standardised outcome measures was lacking. Commonly reported interventions included calf and hamstring stretches, patient education, and self-management strategies. However, due to potential response bias, unclear response rates, and a limited sample size, these findings may not accurately represent clinical practices across the UK [15].

The present study compared the effects of MET and Myofascial Release (MFR) on pain, Pressure Pain Threshold (PPT), and lower limb function in individuals with PF. Both interventions were effective in reducing pain, increasing PPT, and enhancing functional activity. These findings suggest that MET and MFR can be valuable components of conservative management for PF, offering comparable benefits in improving pain and functional outcomes [5].

The study findings indicate that regular follow-up contributed to reductions in discomfort and improvements in activity levels and lower limb stability among individuals with PF, regardless of the exercise regimen followed. Daily stretching proved effective in managing symptoms, while the addition of strengthening exercises did not produce significantly greater benefits compared to stretching alone [3].

The current study demonstrated that MET was effective than static stretching in improving gastro-soleus flexibility, reducing pain, and enhancing lower limb function in subjects with PF. The improvement is likely attributed to mechanisms such as post-isometric relaxation and enhanced muscle elongation. These findings support the clinical utility of MET as part of conservative management for PF. However, the limited sample size and lack of detailed statistical analysis suggest the need for larger, controlled studies to validate long-term efficacy [19].

Hence, the present study compared the effect of MET group versus conventional exercise reduces pain and improves functional outcome in subjects with PF. The current study concluded that MET group and conventional exercise are effective.

Limitation(s)

The present study was done in a short time and no proper follow-up data were collected.

CONCLUSION(S)

The present study finding led to the conclusion that MET group along with ultrasound and conventional exercise along with ultrasound has effectiveness on reducing pain, improving functional outcome in subjects with PF.

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