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Comparison of immediate effect of instrument assisted soft tissue mobilization versus muscle energy technique along with hot pack on pain and range of motion in individuals with heel pain

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ABSTRACT

Background: Heel pain is a common musculoskeletal complaint that affects daily activities and mobility. Various therapeutic interventions, including instrument assisted soft tissue mobilization (IASTM) and muscle energy technique (MET), are employed to alleviate pain and improve range of motion (ROM). However, limited studies compare their immediate effectiveness. This study aimed to compare the immediate effects of IASTM versus MET along with hot pack on pain and ankle dorsiflexion ROM in individuals with unilateral heel pain.
Methods: A total of 60 participants with unilateral heel pain were randomly allocated into two groups: Group A (IASTM) and Group B (MET with hot pack), with 30 participants in each. Pain was assessed using the visual analog scale (VAS) and ankle dorsiflexion ROM was measured using a clinometer smartphone application. Pre- and post-intervention assessments were conducted. A Wilcoxon signed-rank test and paired t-tests were used for within-group comparisons, while the Mann-Whitney U Test and unpaired t-test were used for between-group comparisons.
Results: Both interventions significantly reduced pain and improved dorsiflexion ROM ($p<0.001$). However, the IASTM group exhibited a greater reduction in VAS scores ($Z=-4.893$, $p<0.001$) and significant increase in dorsiflexion ROM ($t=-40.934$, $p<0.001$) compared to the MET with hot pack group ($Z=-4.977$, $p<0.001$) ($t=-15.642$, $p<0.001$). Between-group analysis further confirmed that IASTM was superior to MET with a hot pack in both pain reduction ($U=153$, $p<0.001$) and ROM improvement ($t=3.604$, $p=0.001$).
Conclusions: Both IASTM and MET with a hot pack are effective in reducing heel pain and improving dorsiflexion ROM.

Keywords: Heel pain, Manual therapy, Pain modulation, Tissue extensibility

INTRODUCTION

Plantar heel pain is a condition that affects adults across all ages of both active and sedentary lifestyles. It is a musculoskeletal disorder primarily affecting the plantar fascia. The most common causes of heel pain includes plantar fasciitis, heel spur, Achilles tendinitis.[1] Pain usually occurs in medial tubercle of heel bone or just behind it, where the Achilles tendon connects to heel.[2] The prevalence of heel pain among adults of age 18 years and above ranges from 17% to 24%.[3] Most current evidence suggests that tight gastrocnemius is an etiologic factor for plantar fasciitis, thus limiting the range of ankle dorsiflexion.[4] Patel et al, reported an incidence of 83% of reduced ankle dorsiflexion in their study, looking at patients with plantar fasciitis.[5] The Achilles tendon is known as the largest and most powerful tendon in the ankle. The tendons formed by the fibres of two muscle units: the gastrocnemius muscle, composed of medial and lateral heads and the soleus muscle.[6] The gastrocnemius (both the medial and lateral heads) and soleus muscles work through the Achilles tendon in their posterior insertion on the calcaneus.[7] The medial head of the gastrocnemius muscle originates from behind the medial supracondylar ridge and adductor tubercle on the posterior surface of the femur. The lateral head originates from the lateral surface of the lateral condyle of the femur, proximal and posterior to the lateral epicondyle and attaches to the posterior aspect of the medial and lateral femoral condyles. The medial head is broader and thicker compared to the lateral head. Each of these heads has additional attachments from the posterior capsule of the knee joint and from the oblique popliteal ligament.[3]

The gastrocnemius crosses three major joints are knee, ankle and subtalar. The soleus muscle is deep to the gastrocnemius muscle and originates from the upper part of the posterior tibia, fibula and interosseus membrane and crosses only the ankle and subtalar joints. The gastrocnemius act as a flexor of the knee and ankle. The gastrocnemius is most effective as ankle plantaflexors with the knee extended, whereas the soleus is most effective as ankle plantaflexors with the knee flexed.[6] Muscle tightness makes muscles and tendons more susceptible to injuries and limits the movement of the joint where the muscle is involved.[8] Gastrocnemius-soleus tightness increases Achilles tendon tension and increases dorsiflexion stiffness of the ankle joint during weight- bearing activities, which in turn lead to increase plantar fascia tension during weight-bearing, thus increasing the risk of heel pain.[7]

IASTM is applied using specially designed instruments to provide a mobilizing effect to soft tissue to decrease pain and improve ROM and function. The use of the instrument provides a mechanical advantage for the clinician by allowing deeper penetration and offering more specific treatment, while also reducing stress on the hand.[9] There are various theories regarding the effects of IASTM, most notable mechanical and neurophysiological. The mechanical theory suggests that pressure and shearing from the instrument may release and breakdown adhesions, fascial restrictions, increase blood supply to the treatment area by the increased temperature. Thus, it promotes realignment and increases the tissue and fascial flexibility and mobility.

The neurophysiological theory suggests that the compression from the instrument may stimulate mechanoreceptors, A-beta sensory fibres to block the A-delta and C-fibres. As per the "pain gate theory", as long as sensory fibres are firing the gate to the transmission of pain is closed.[10,11] M2T blade (Canada) is a latest invention in IASTM technique. MET is a technique that involves the subject to voluntarily contract the muscle in a precisely controlled direction against the therapist's counter force. Its therapeutic effects are to reduce pain, stretch tightened muscles, strengthen the weak muscles.[12] Studies suggest MET and related post-isometric technique involves activation of muscle and joint mechanoreceptors leading to activation of periaqueductal gray matter. This plays a role in descending modulation of pain.[13] Post-isometric relaxation refers to the subsequent reduction in the tone of agonist muscle after isometric contraction, it occurs due to Golgi tendon organ (GTO). The GTO inhibits the agonist muscle contraction and allows the antagonist muscle to contract more readily, thus the agonist muscle can be stretched further easily.[14] Taylor et al, in their study done in 1997, suggested that a combination of contractions and stretches (as used in MET) is more effective in producing viscoelastic changes than passive stretching alone, because greater forces produce increased viscoelastic change and passive extensibility.[12]

Modalities that can cause an increase in tissue temperature at a depth of 1-2 cm are classifies as superficial thermotherapy. Examples of superficial heating modalities include moist hot packs, paraffin baths and warm whirlpools.[15] Among superficial heating modalities, moist hot packs range in temperatures from 160–166-degree F are the most commonly used in the clinical setting.[16] Effects include rise in temperature of superficial tissue thereby causing dilatation of vessels, rises oxygen and nutrient supply in the applied area, removes metabolic waste and thus promotes muscle relaxation.[17]

The study aimed to assess and compare the immediate effects of IASTM and MET combined with a hot pack, on heel pain intensity measured using the VAS and ankle passive dorsiflexion range of motion measured using a clinometer smartphone application in individuals with unilateral heel pain and gastrocnemius–soleus tightness, by analyzing pre- and post-treatment differences between the two groups.

METHODS

Patients and study design

A comparative experimental study was conducted from October 2023 to September 2024 in the Physiotherapy Outpatient Department (OPD) of Topiwala National Medical College and B.Y.L. Nair Charitable Hospital, Mumbai, a government tertiary care hospital, using a convenience sampling method. Prior to commencement, ethical approval was obtained from the T.N.M.C. & B.Y.L. Nair Ch. Hospital Institutional Ethics Committee. Informed written consent was obtained from each participant prior to all the procedure. The study was registered under Clinical Trials Registry- India (CTRI) with CTRI No – CTRI/2024/02/062311. The participant was given full information about the study as well as description of any foreseeable risks and discomfort. He/she was informed about his/her right to opt out of the study whenever they wished to without having to give any reason.

The study included 60 participants, who were randomly assigned into two groups: Group A (IASTM intervention, n=30) and Group B (MET along with hot pack intervention, n=30). Participants were selected based on specific inclusion and exclusion criteria. The inclusion criteria consisted of individuals aged 18-65 years with unilateral heel pain persisting for more than three months, having a VAS score between 3 and 7 during daily activities and exhibiting limited passive ankle dorsiflexion due to mild to moderate gastrocnemius-soleus tightness. Individuals with a history of acute ankle sprain, recent lower limb trauma, neurological conditions, vascular disorders or comorbidities like diabetes and hypertension were excluded from the study.

The outcome measures included heel pain intensity, assessed using the VAS and ankle dorsiflexion ROM and measured using the Clinometer smartphone app. VAS is a 10 cm horizontal scale, with 0 indicating no pain and 10 representing the worst pain. The clinometer app, a reliable and valid tool, was used to measure passive ankle dorsiflexion ROM. Participants were randomly assigned to either Group A or Group B using a chit method.

Procedure

The study procedure followed a standardized approach. Demographic details were recorded and baseline measurements of VAS and ankle dorsiflexion ROM were taken. Group A underwent IASTM using an M2T blade, applied with alternating proximal and distal strokes for 5 minutes, maintaining moderate pressure adjusted based on participant tolerance. Group B received a hot pack application over the affected area for 20 minutes, followed by MET using the post-isometric relaxation method. MET was applied with knee extended for gastrocnemius and knee flexed for soleus, involving isometric contractions against therapist resistance for 10 seconds, repeated three times. Post-intervention, VAS and ROM were reassessed in both groups.

Statistical analysis

The data was entered using Microsoft Office Excel 2013 and data analysis was done using SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp 2019. Data was than tested for normality. For VAS, non-parametric test was performed. ROM data pass the normality, so parametric t-test was done. Descriptive analysis of the above data was also done to find out minimum, maximum, mean and the standard deviation values of the outcome measures. As per the objective of this study, the pre and the post- values of the pain and mobility outcomes were determined and the results were checked for any significant differences for the same using Wilcoxon Signed rank test for VAS and paired t-test for Range of motion. To compare post treatment improvement in VAS score between both the groups The Mann-Whitney U Test was used. To compare post treatment improvement in ROM values between both the groups An Unpaired T Test was used. The confidence interval was set as 95% and significance level was set as 0.05. The data was considered as significant if p<0.05.

RESULTS

Total 60 participants were included in this study. In Group A there were 14 males (46.7%) and 16 females (53.3%). In Group B there were 13 males (43.3%) and 17 females (56.7%) as shown in (Table 1). Mean age was 42.87±9.07 years in Group A and 42.53±6.25 years in Group B as shown in (Table 2). A Wilcoxon signed-rank test was conducted to compare the median scores of participants' pre- and post-intervention on VAS score. The results indicate that there were significant differences in the VAS score (Z=-4.893, p<0.001) in Group A and (Z=-4.977, p<0.001) in Group B between the pre- and post-intervention as shown in (Table 3).

The Mann-Whitney U Test was conducted to compare the post-treatment improvement in VAS Score between the IASTM and MET groups. The results revealed that there is a significant difference in VAS Score (U=153, p<0.001) between the IASTM and MET groups. Specifically, the IASTM group exhibited a significantly higher change in VAS Score compared to the MET group as presented in (Table 4). A paired t-test was conducted to compare the mean scores of participants' pre- and post- intervention on ROM values.

The results indicate that there were significant differences in the ROM (t=-40.934, p<0.001) in Group A and (t=-15.642, p<0.001) in Group B between the pre and post-intervention as shown in (Table 5). An Unpaired T Test was conducted to compare the post treatment improvement in ROM values between the IASTM and MET groups. The result revealed that there is a significant difference in ROM (t=3.604, p=<0.001) between the IASTM and MET groups. Specifically, the IASTM group exhibited a significantly higher change in ROM compared to the MET group as seen (Table 6).

Table 1: Gender distribution of participants in group A and group B.

		Gender			
		Females		Males	
		Count	%	Count	%
Group	A (IASTM)	16	53.3	14	46.7
	B (MET)	17	56.7	13	43.3

Table 2: A Demographic detail (age) of participants in group A and group B.

		Age			
		Mean	Standard Deviation	Minimum	Maximum
Group	A (IASTM)	42.87	9.07	25.00	57.00
	B (MET)	42.53	6.25	32.00	58.00

Table 3: Analysis of VAS in Group A and Group B.

		VAS	Mean	Standard Deviation	Median	Range	95.00% Lower CL for Mean	95.00% Upper CL for Mean	P value
Group	A (IASTM)	PRE	4.93	0.83	5	3	4.62	5.24	<0.001*
		POST	2.63	0.96	3	3	2.27	2.99	
	B (MET)	PRE	5.07	1.01	5	3	4.69	5.45	
		POST	3.7	1.24	4	4	3.24	4.16	<0.001*

*p<0.001.

Table 4: Comparison of post-treatment improvement in VAS scores between group A and group B.

Scale	Group	Median (IQR)	U	P value
VAS	A (IASTM)	2 (2-3)	153	<0.001*
	B (MET)	1 (1-2)		

*p<0.001. Abbreviations: IASTM=Instrument Assisted Soft Tissue Mobilization, MET=Muscle Energy Technique, VAS=Visual Analogue Scale.

Table 5: Analysis of dorsiflexion ROM in group A and group B.

		Dorsiflexion ROM	Mean	Standard deviation	Median	Range	95.0% Lower CL for Mean	95.0% Upper CL for Mean	P value
Group	A (IASTM)	PRE	12.33	1.49	12.50	6.00	11.78	12.89	<0.001*
		POST	16.10	1.47	16.00	6.00	15.55	16.65	
	B (MET)	PRE	12.57	1.61	13.00	7.00	11.96	13.17	<0.001*
		POST	15.57	2.03	15.50	9.00	14.81	16.32	

*p<0.001.

Table 6: Comparison of post-treatment improvement in ROM values between group A and group B.

Scale	Group	Mean±SD	T	P value
ROM	A (IASTM)	3.7667±0.50401	3.604	<0.001*
	B (MET)	3±1.05045		

*p<0.001. Abbreviations: IASTM=Instrument Assisted Soft Tissue Mobilization, MET=Muscle Energy Technique, ROM=Range Of Motion.

DISCUSSION

The present study aimed to compare the immediate effects of IASTM versus MET along with a hot pack on pain and ROM in individuals with heel pain.

Effect of instrument assisted soft tissue mobilization and muscle energy technique along with hot pack on heel pain.

In the present study, the mean pre-treatment VAS score was 4.93±0.83 for Group A and 5.07±1.01 for Group B. The mean post-treatment VAS score was 2.63±0.96 for Group A and 3.70±1.24 for Group B respectively. Participants in IASTM intervention group were given IASTM in alternating proximal and distal directions parallel to muscle fibres for 5 mins. IASTM stimulates the A-beta sensory fibers thereby blocking the pain carrying A-delta and C-fibers thereby reducing pain. The current study's findings of pain reduction have been proven in various studies. Shah et al demonstrated that applying IASTM on tight calf muscles in individuals wearing high heels for 40-120 secs was helpful in reducing pain based on VAS scores pre and post intervention.[25] Cheatham et al and Weiqing et al stated that the IASTM instrument may stimulate mechanoreceptors, 10 and decrease the pain perception based on pain gate control theory.[26] Another possibility for pain reduction includes increased blood flow because of IASTM. Increased blood flow can quickly remove pain substrates, as hypothesized by Jooyoung Kim et al.[27]

Participants in MET along with hot pack intervention group were given MET for ankle for 10 secs, 3 reps along with hot pack over the calf for 20 mins. In MET, the resistance applied to the muscles activates mechanoreceptors that involve centrally mediated pathways, such as the periaqueductal grey (PAG) and descending inhibitory pathways thereby reducing pain. Furthermore, rhythmic muscle contractions during MET increase muscle blood flow and mechanical forces on fibroblasts, thereby enhancing transcapillary blood flow and further reducing pain as hypothesized by Freyer et al.[13]

In a study by Faqih et al it was proposed that the significant reduction in VAS score observed with MET is due to its hypoalgesic effects, which inhibit the Golgi tendon reflex activated during isometric contraction, leading to muscle relaxation.[28] The addition of a hot pack enhances these effects by increasing tissue temperature, which reduces muscle stiffness and promotes relaxation. The results of the present study align with these hypotheses.

Effect of instrument assisted soft tissue mobilization and muscle energy along with hot pack on dorsiflexion range of motion

In the present study, both interventions demonstrated a significant improve in dorsiflexion range of motion from pre-intervention to post-intervention. The mean pre-treatment ROM value was 12.333±1.49 for group A and 12.57±1.61 for Group B. The mean post-treatment VAS score was 16.10±1.47 for Group A and 15.57±2.03 for group B respectively. These findings underscore the efficacy of both IASTM and MET with a hot pack in improving dorsiflexion range of motion. The study conducted by Miners et al and Nadeem et al demonstrated that improved dorsiflexion ROM in plantar fasciitis using IASTM could be attributed to the increased fibroblastic activity and enhanced fibronectin activity when strokes are applied to the affected tissue. This facilitates the synthesis and realignment of collagen, leading to decrease in tissue adhesions.[29] Kim et al found that IASTM improves the extensibility of soft tissue by treating their restrictions and that the friction-generated heat from the instrument decreases tissue viscosity, thereby improving ROM.[27]

Naoki et al found that IASTM was effective in improving dorsiflexion ROM in their study on the mechanical and neural properties of the triceps surae muscles.[30] Additionally, Jahnvi et al reported that IASTM technique helps in reducing pain and improving ankle ROM in individuals wearing high heels.[25] A randomized controlled trial by Carrie et al. Rowlett et al demonstrated that a single session of IASTM significantly increased ankle dorsiflexion ROM.[31] The improvement in dorsiflexion ROM observed in our study is consistent with these findings.

MET involves an isometric relaxation through the influence of the Golgi tendon organs (autogenic inhibition). Also, a combination of contractions and stretches as used in MET might be more effective in producing viscoelastic changes than passive stretching alone, which in turn increases passive extensibility. Our results align with those of Himanshi et al who studied the immediate effects of MET and positional release therapy in individuals with restricted dorsiflexion range of motion and found significant improvement in dorsiflexion ROM.[32] Additionally, a study by Yogita et al on the effects of MET on calf muscle flexibility, strength and endurance in football players concluded that MET was effective in improving all 3 aspects.[33]

Comparison of treatment efficacy between instrument assisted soft tissue mobilization and muscle energy Based on visual analog scale scores and dorsiflexion range of motion

When both the groups were compared, the Mann-Whitney U Test (U=153, p<0.001) and the Unpaired T Test (t=3.604, p=0.001) showed that the reduction in VAS scores were significantly greater in IASTM group- 2 (2-3) compared to the MET group-1 (1-2). Similarly, the increase in dorsiflexion ROM were significantly greater in the IASTM group (3.7667±0.50401) compared to the MET group (3±1.05045). This may be because IASTM provides a mechanical advantage for the clinician, allowing for deeper penetration. When the instrument is moved across the skin during IASTM intervention, the skin is compressed and then stretched resulting in significantly greater mechanical stress compared to MET performed with hands alone. It may lead to increased neural activities of large fiber neurons and thereby be more significant in decreasing the pain perception. IASTM also increases vibration perception by the clinician's hand holding the instrument to detect altered tissue properties and thus causing more effective mobilization of the soft tissue.[27]

The micro trauma induced by IASTM is more controlled and uniform than the manual forces applied during MET. This micro trauma triggers a more robust inflammatory response, which promotes a more effective healing process.[9] A sweeping stroke applied during scanning generates frictional heat from the instrument, which in turn reduces the viscosity of the underlying tissues. This decrease in tissue viscosity enhances tissue pliability, making it easier to mobilize. The heat produced by friction helps soften the tissues, allowing for more efficient movement thereby improving range of motion.[28] IASTM demonstrates a superior immediate effect compared to MET along with hot pack, making it a valuable technique for clinicians seeking rapid pain relief and functional improvement in their patients with heel pain. However, the need for specialized instruments and training may limit the accessibility of IASTM in certain clinical settings. Therefore, in the future, based on availability and convenience, both IASTM and MET in combination with a hot pack, can be effectively incorporated into clinical practice for managing individuals with heel pain.

CONCLUSION

The present study aimed to compare the immediate effects of IASTM versus MET along with a hot pack on pain and ROM in individuals with unilateral heel pain. According to the results of the present study, both IASTM and MET along with hot pack were effective in reducing heel pain, as measured by the VAS and in improving ankle passive dorsiflexion range of motion, as assessed using a clinometer smartphone app. However, the findings of the present study endorse that the IASTM is better than MET along with hot pack in both pain reduction and range of motion improvement.

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