"Efficacy of Extracorporeal Shock Wave Therapy and Ultrasound Therapy Combined with Instrument-Assisted Soft Tissue Mobilization in the Management of Plantar Fasciitis in a Rural Population: A Pilot Randomized Controlled Trial"

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Abstract

Background: Plantar fasciitis is a common cause of chronic heel pain, particularly in physically active individuals and those engaged in prolonged standing. In rural populations, limited access to advanced rehabilitation modalities necessitates evaluation of effective, resource-feasible interventions. Extracorporeal shock wave therapy (ESWT) and ultrasound therapy (UST), when combined with instrument-assisted soft tissue mobilization (IASTM), have shown potential benefits; however, comparative evidence in underserved settings remains scarce.

Objective: To compare the short-term efficacy of ESWT + IASTM versus UST + IASTM in reducing pain and improving function in patients with chronic plantar fasciitis in a rural physiotherapy setting.

Methods: This prospective, two-arm, patient-blinded, pilot randomized controlled trial enrolled 16 participants (n=8 per group) with unilateral plantar fasciitis of ≥3 months' duration. Group A received ESWT (0.12–0.28 mJ/mm², 1000–2000 pulses) + IASTM; Group B received UST (1.0–1.5 W/cm², 1 MHz) + IASTM. Both interventions were administered six times over two weeks. Pain and function were assessed at baseline, post-intervention, and 2-week follow-up using the Global Pain Scale (GPS) and Foot Function Index (FFI). Data were analyzed using repeated measures ANOVA, mixed-effects models, and independent t-tests.

Results: Both groups showed significant within-group improvements in GPS and FFI over time ($p<0.001$). Between-group comparisons revealed significantly greater reductions in GPS (t1: $p=0.001$; t2: $p<0.001$) and FFI (t1: $p=0.012$; t2: $p=0.009$) in the ESWT + IASTM group. At follow-up, ESWT + IASTM achieved mean GPS of 23.25 ± 1.75 and FFI of 60.50 ± 4.00, compared to 30.75 ± 3.15 and 76.38 ± 12.53, respectively, in the UST + IASTM group. No adverse events were reported.

Conclusion: In this rural pilot trial, ESWT + IASTM demonstrated superior short-term and sustained improvements in pain and function compared to UST + IASTM for chronic plantar fasciitis. These findings support the feasibility of a larger-scale RCT and suggest ESWT + IASTM as a promising first-line option in resource-limited settings.

Keywords: plantar fasciitis, extracorporeal shock wave therapy, ultrasound therapy, instrument-assisted soft tissue mobilization, rural rehabilitation, pain management.

Introduction

Plantar fasciitis is one of the most common causes for heel pain since it affects a portion of the population that is important, mainly those in high-impact activities and occupations needing standing for long durations[1]. The condition has plantar fascia inflammation, with large discomfort as a result and impaired function[2]. Repeated overstretching over time of the plantar fascia can cause micro-tears at the medial calcaneal tuberosity insertion point. Such micro-tears may trigger inflammation plus heel pain near the medial calcaneal tuberosity, usually 1–2 cm away[3]. Pain is most intense when the individual first stands up after a period of rest, especially in the early morning hours. As walking begins, the discomfort generally lessens, though it does not completely subside throughout the day. Activities such as extended walking or physical exertion, particularly on hard surfaces, tend to aggravate the pain[4]. Stress also can contribute to this condition through such factors as running and also sudden increases in activity in addition to obesity, rapid weight gain, wearing improper footwear, and prolonged standing or walking on hard surfaces[5]. Changes

in foot mechanics like excessive pronation or supination along with factors such as obesity, weak intrinsic foot muscles, unsuitable footwear, and tightness in the triceps surae muscle, contribute to repeated tensile strain on the plantar fascia. This repeated stress can lead to micro-injuries at its attachment point, resulting in pain and impaired function[6]. Biomechanical issues in the foot, such as a shortened Achilles tendon, high arches (pes cavus), and flat feet (pes planus), have also been linked to the development of plantar fasciitis[7]. It affects adults as well as occurs in around 10% of the population over their lifetime, also about 20% to 30% of patients experience it bilaterally[8].

Physiotherapy plays a key role in promoting recovery and reducing the functional impairments linked to plantar fasciitis. With advancements in treatment technologies, there has been growing interest in non-invasive options such as extracorporeal shock wave therapy (ESWT) and ultrasound therapy for managing this condition effectively[9]. Several Clinical studies have shown favorable results with extracorporeal shock wave therapy (ESWT), including marked pain relief and enhanced functional outcomes[10].Extracorporeal shock wave therapy (ESWT) works by delivering high-energy acoustic waves that create controlled microtrauma within the affected tissue, thereby increasing blood circulation and triggering the body's natural cellular repair mechanisms[9]. Ultrasound therapy, widely used treatment modality, uses sound waves to produce both thermal and non-thermal effects on soft tissues. It is thought to aid in reducing pain and inflammation, while also enhancing tissue repair by improving local blood flow[11].

Although ultrasound therapy is a commonly used modality in physiotherapy, its effectiveness relative to newer treatments like extracorporeal shock wave therapy (ESWT) remains under-researched especially when used in conjunction with methods such as instrument-assisted soft tissue mobilization (IASTM), which has shown potential in improving therapeutic outcomes[12]. In rural settings, ensuring access to effective and timely interventions for musculoskeletal disorders is essential, as these regions frequently encounter barriers such as inadequate healthcare infrastructure and a higher occurrence of chronic health conditions[13].

Therefore, this pilot study aims to evaluate the feasibility and preliminary outcomes of ESWT and UST combined with IASTM in the management of plantar fasciitis within a rural physiotherapy setup. The findings may inform future larger-scale trials and help guide resource-effective treatment planning in underserved populations.

Materials and methods

This is a prospective, two-arm, patient blinded, pilot randomized controlled trial was conducted to evaluate the preliminary efficacy of extracorporeal shock wave therapy (ESWT) versus ultrasound

therapy combined with instrument-assisted soft tissue mobilization (IASTM) in the management of plantar fasciitis in a rural population. Participants were screened and recruited from the Orthopaedic Outpatient Departments (OPD) of UPUMS, Saifai. Eligible subjects were identified based on clinical presentation and evaluated for inclusion and exclusion criteria.

A total of 16 participants 8 in each group will be enrolled in the study. This sample size is deemed sufficient for a pilot study to identify potential challenges in participant recruitment, intervention delivery, and outcome measurement.

The inclusion criteria for the study were adults aged between 18 and 45 years, of either sex, with a clinical diagnosis of unilateral plantar fasciitis confirmed through physical examination. Participants were required to have heel pain lasting for more than three months and be able to provide informed consent. Individuals were excluded if they had a history of foot surgery on the affected side, suffered from bilateral plantar fasciitis, or presented with neuropathic or systemic inflammatory conditions. Pregnant or lactating women and individuals with contraindications to ESWT or ultrasound therapy were also excluded.

In this pilot study, the effectiveness of two different treatment approaches for plantar fasciitis was evaluated using the Global Pain Scale and Foot Function Index (FFI) as primary outcome measures. A total of 16 participants were randomly assigned into two groups, using computerised Randomized sampling, with **Group A receiving Extracorporeal Shock Wave Therapy (ESWT) (energy density: 0.12–0.28 mJ/mm², 1000–2000 pulses per session, duration 10–15 minutes)** combined with Instrument-Assisted Soft Tissue Mobilization (IASTM), and **Group B receiving Ultrasound Therapy (UST) (intensity: 1.0–1.5 W/cm², frequency 1 MHz, duration 5–10 minutes per session)** along with IASTM. Each participant underwent six treatment sessions over a period of two weeks, with sessions administered on alternate days.

Both treatment protocols were designed to address the symptoms and functional limitations associated with plantar fasciitis. ESWT and UST were applied to the affected heel and plantar fascia, while IASTM techniques were used to mobilize soft tissue and improve tissue flexibility and pain. Each session included targeted therapy aimed at reducing inflammation, promoting healing, and enhancing tissue mobility.

Following the completion of the treatment sessions, participants in both groups were prescribed a standardized home exercise program, including calf stretches, plantar fascia stretches, towel stretches, and heel raises, performed daily to support continued recovery.

Data collection was carried out at three key time points: baseline (before treatment), at the end of 2 weeks (immediately post-treatment), and again at a 2-week follow-up to assess short-term effects

and sustainability of the intervention. The outcome measures focused on pain reduction and functional improvement, allowing for a comparative evaluation of the efficacy of both treatment modalities.

Statistical Analysis

The baseline data were first checked for normality using the Mann–Whitney 'U' test to ensure the appropriate selection of statistical methods. All the collected data were presented in terms of mean and standard deviation (SD) to provide a clear understanding of the central tendency and variability within the dataset. Following this, the data were systematically analysed to determine statistical significance using repeated measures ANOVA. Within-group changes were assessed using repeated-measures ANOVA. Between-group comparisons over time were assessed using mixed-effects models (group × time, random intercept for subject). Pairwise between-group comparisons at each timepoint were done using independent t-tests. Effect sizes were calculated where appropriate. This comprehensive statistical approach allowed for the evaluation of changes over time as well as differences between the two treatment modalities, thereby enhancing the strength and reliability of the findings.

Table 1. Baseline demographic and clinical characteristics of participants

Factor	ESWT + IASTM (Group A)	UST + IASTM (Group B)
Number of participants (n)	8	8
Age (years), Mean ± SD	29.25 ± 5.20	30.63 ± 6.82
Gender (Male:Female)	5:3	5:3
BMI (kg/m²), Mean ± SD	25.85 ± 1.11	25.48 ± 0.32
Diabetic:Non-diabetic	1:7	2:6
Hypertension:Non-hypertensive	1:7	0:8
GPS score, Mean ± SD	47.69 ± 5.62	49.12 ± 4.99
FFI score, Mean ± SD	104.88 ± 16.15	102.62 ± 18.01

Table 2. Descriptive statistics (mean ± SD) for GPS and FFI at baseline (t0), post-intervention (t1), and follow-up (t2).

Group	Time	n	GPS mean	GPS SD	FFI mean	FFI SD
ESWT + IASTM	t0	8	47.69	5.62	104.88	16.15
ESWT + IASTM	t1	8	25.69	2.99	65.75	5.87
ESWT + IASTM	t2	8	23.25	1.75	60.50	4.00
UST + IASTM	t0	8	49.12	4.99	102.62	18.01
UST + IASTM	t1	8	33.38	3.74	78.12	10.03
UST + IASTM	t2	8	30.75	3.15	76.38	12.53

Within-group repeated measures ANOVA results:

Table 3. Within-group Repeated Measures ANOVA for GPS and FFI

Group	Measure	F Value	Num DF	Den DF	p-value
ESWT + IASTM	GPS	184.5181	2	14	<0.001
ESWT + IASTM	FFI	60.0375	2	14	<0.001
UST + IASTM	GPS	94.4776	2	14	<0.001
UST + IASTM	FFI	34.0900	2	14	<0.001

Table 4 and 5. Between-group mixed-effects model (group × time) fixed-effect coefficients:

GPS model:

Predictor	Coef.	Std. Err.	z	p-value	95% CI Lower	95% CI Upper
Intercept (ESWT + IASTM, t0)	47.687	1.298	36.747	<0.001	45.144	50.231
Group: UST + IASTM	1.438	1.835	0.783	0.433	-2.160	5.035
Time: t1	-22.000	1.332	-16.518	<0.001	-24.610	-19.390
Time: t2	-24.437	1.332	-18.348	<0.001	-27.048	-21.827
Group × Time: UST + IASTM × t1	6.250	1.884	3.318	0.001	2.558	9.942
Group × Time: UST + IASTM × t2	6.062	1.884	3.219	0.001	2.371	9.754

FFI model:

Predictor	Coef.	Std. Err.	z	p-value	95% CI Lower	95% CI Upper
Intercept (ESWT + IASTM, t0)	104.875	4.035	25.989	<0.001	96.966	112.784
Group: UST + IASTM	-2.250	5.707	-0.394	0.693	-13.435	8.935
Time: t1	-39.125	3.755	-10.421	<0.001	-46.484	-31.766
Time: t2	-44.375	3.755	-11.819	<0.001	-51.734	-37.016

Predictor	Coef.	Std. Err.	z	p-value	95% CI Lower	95% CI Upper
Group × Time: UST + IASTM × t1	14.625	5.310	2.754	0.006	4.218	25.032
Group × Time: UST + IASTM × t2	18.125	5.310	3.413	0.001	7.718	28.532

Table 6. Between-group comparisons at each time point (independent t-tests):

Time	GPS t-stat	GPS p	FFI t-stat	FFI p
t0	-0.541	0.597	0.263	0.796
t1	-4.543	0.001	-3.010	0.012
t2	-5.883	0.000	-3.413	0.009

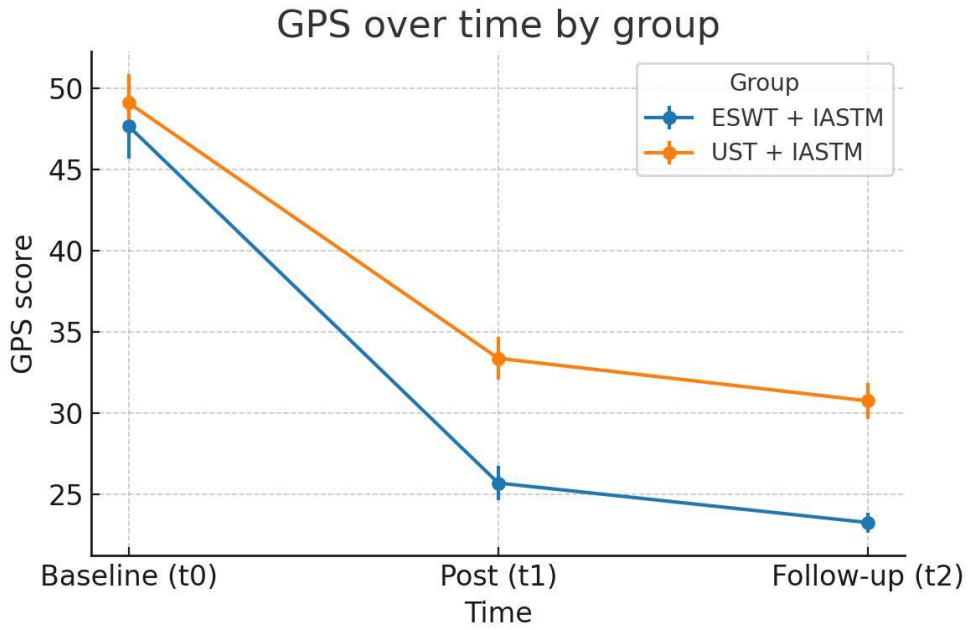

Fig.1 : Graph representing the GPS over time for group A and B

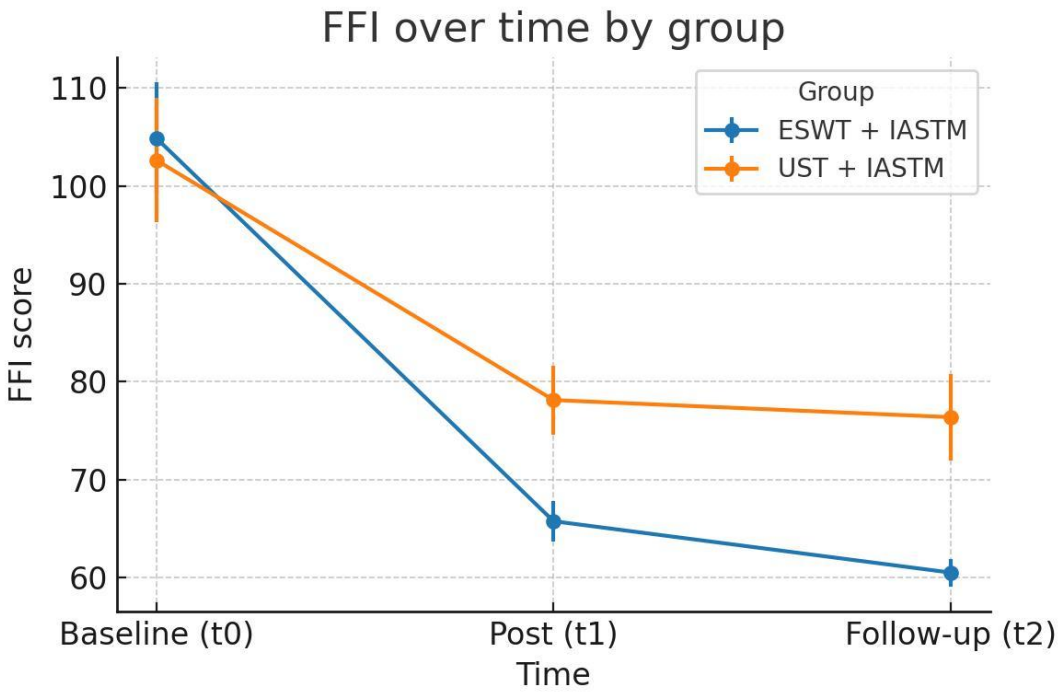

Fig.2 : Graph representing the FFI over time for group A and B

Results

Sixteen participants (n=8 per group) completed the study. Baseline demographic and clinical characteristics were comparable between the **ESWT + IASTM** and **UST + IASTM** groups ($p>0.05$ for all baseline comparisons). No adverse events were reported.

Within-group analysis

Repeated measures ANOVA revealed statistically significant improvements in both **Global Pain Scale (GPS)** and **Foot Function Index (FFI)** scores over time in both groups ($p<0.001$ for all measures). In the ESWT + IASTM group, mean GPS reduced from 47.69 ± 5.62 at baseline to 23.25 ± 1.75 at follow-up, and FFI decreased from 104.88 ± 16.15 to 60.50 ± 4.00. Similarly, the UST + IASTM group improved from 49.12 ± 4.99 to 30.75 ± 3.15 (GPS) and from 102.62 ± 18.01 to 76.38 ± 12.53 (FFI).

Between-group analysis

Mixed-effects modelling indicated significant group × time interactions for both GPS (t1: $p=0.001$; t2: $p=0.001$) and FFI (t1: $p=0.006$; t2: $p=0.001$), with the ESWT + IASTM group demonstrating greater reductions in pain and functional limitation. Independent t-tests confirmed no significant baseline differences ($p>0.05$), but at post-intervention and follow-up, ESWT + IASTM achieved

significantly lower GPS (t1: p=0.001; t2: p<0.001) and FFI scores (t1: p=0.012; t2: p=0.009) compared to UST + IASTM.

Overall, the ESWT + IASTM group exhibited superior short-term and sustained improvements in pain and function relative to the UST + IASTM group.

Discussion

This pilot randomized controlled trial provides preliminary evidence that **ESWT combined with IASTM** is more effective than **UST combined with IASTM** in reducing pain and improving function in individuals with chronic plantar fasciitis in a rural population.

The greater efficacy of ESWT observed in this study is consistent with previous trials demonstrating its capacity to stimulate neovascularization, disrupt pain receptor activity, and promote tissue regeneration via controlled microtrauma. By integrating IASTM, a modality that enhances soft tissue mobility and breaks down fascial adhesions, the intervention may have yielded additive benefits through complementary mechanisms.

Although UST also resulted in clinically meaningful improvements, its effects were less pronounced. This may be due to its primarily thermal and micro-massaging effects, which, while beneficial for pain modulation and circulation, may not match the regenerative stimulus produced by ESWT.

The findings align with earlier reports suggesting that radial or focused shock wave therapy can achieve faster and more sustained symptom relief compared to ultrasound therapy, especially when applied in multi-modal treatment frameworks. In rural contexts—where access to prolonged physiotherapy sessions is limited—the rapid and durable effects of ESWT may offer a practical advantage.

Strengths and limitations

Strengths include the randomized controlled design, standardized protocols, and the inclusion of a rural patient population—a group often underrepresented in rehabilitation research. Limitations include the small sample size inherent to a pilot study, short follow-up duration, and lack of blinding of the treating therapist. The findings should therefore be interpreted cautiously and confirmed in larger, long-term studies.

Conclusion

In this pilot trial, **ESWT combined with IASTM** produced greater reductions in pain and functional disability than **UST combined with IASTM** in patients with chronic plantar fasciitis in

a rural physiotherapy setting. Both interventions were safe and well tolerated, but ESWT demonstrated superior short-term and sustained benefits.

These results support the feasibility of a larger-scale randomized trial and suggest that ESWT + IASTM could be a preferred first-line, resource-efficient intervention for plantar fasciitis in underserved rural populations.

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