

Effect Of High Load Strengthening Exercise Along With Phonophoresis On Plantar Fasciitis Pain And Foot Function

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ABSTRACT

Background: Plantar fasciitis (PF) is one of the most common causes of heel pain in adults, often resulting from repetitive mechanical loading of the plantar fascia. In India, the prevalence of PF is high among individuals involved in prolonged standing, overweight populations, and those wearing improper footwear. Although exercise therapy and physical modalities such as ultrasound or phonophoresis are widely used, the combined effect of high-load strengthening exercises and phonophoresis has not been extensively studied in Indian settings.

Objective: To evaluate the effectiveness of high-load strengthening exercise along with phonophoresis on pain and foot function among patients with plantar fasciitis.

Methods: A single-arm pre-post experimental study was conducted at the Department of NCD Physiotherapy OPD, Kharagpur Sub-Divisional Hospital, West Bengal. Thirty participants (20 female, 10 male; mean age 41.27 ± 9.88 years) with chronic plantar fasciitis were included. Participants underwent a 4-week program of high-load strengthening of the calf and plantar fascia using progressive heel raises with a rolled towel under the toes to activate the Windlass mechanism, combined with dexamethasone (0.5%) phonophoresis applied thrice weekly. Pain intensity and foot function were assessed using the Numeric Pain Rating Scale (NPRS) and Foot Function Index (FFI) before and after the intervention. Data were analysed using paired t-tests ($p < 0.05$).

Results: Significant improvements were observed in both outcomes. Mean NPRS reduced from 5.4 ± 1.4 to 2.43 ± 1.61 ($p < 0.0001$), while FFI decreased from 43.29 ± 11.72 to 18.41 ± 12.0 ($p < 0.0001$). Participants reported a 55% reduction in pain and 57% improvement in function, with no adverse events.

Conclusion: The combination of high-load strengthening and phonophoresis significantly improved pain and foot function in plantar fasciitis within four weeks. This integrated approach is safe, cost-effective, and feasible in Indian physiotherapy settings, addressing both mechanical and inflammatory components of the condition

Keyword: Plantar fasciitis, high-load strengthening, phonophoresis, heel pain, physiotherapy, foot function

1. INTRODUCTION

Plantar fasciitis (PF) is a degenerative, load-related condition of the plantar fascia characterized by localized heel pain and stiffness, particularly on first steps after prolonged rest. It is one of the most common causes of heel pain, affecting athletes and the general population alike, and can lead to substantial impairment in daily activities and mobility (1, 2).

Conservative management of PF includes activity modification, stretching, manual therapy, orthoses, shockwave therapy, exercise therapy, and pharmacological interventions (3). Recently, progressive loading programs, adapted from tendon rehabilitation protocols, have gained interest for plantar fasciopathy: high load strength training aims to increase the load tolerance of the fascia-muscle-tendon complex and encourage tissue remodelling (4–6).

Phonophoresis uses ultrasound to enhance transdermal drug delivery (commonly corticosteroids or NSAIDs) and to provide the thermal and non-thermal effects of therapeutic ultrasound, which may reduce pain and local inflammation (7). Evidence

for phonophoresis in plantar fasciitis is mixed but mechanistically plausible when combined with targeted loading programs (8). Combining progressive high load strengthening with phonophoresis could provide synergistic effects: phonophoresis may reduce pain allowing better participation and dosage in strengthening exercises, while strengthening addresses the mechanical aspects of the condition. To our knowledge, few clinical studies have examined the combined effect of these modalities.

This study aimed to find the effectiveness of High Load Strengthening exercise along with phonophoresis on Plantar fasciitis pain and foot function.

2. METHODS

Study design and participants

This was a prospective single-arm pre-post intervention study conducted at Department of NCD Physiotherapy OPD, Kharagpur Sub Divisional Hospital, West Bengal. Thirty participants (20 female, 10 male) aged 21–62 years (mean age 41.27 ± 9.88 years) with clinically diagnosed unilateral or bilateral plantar fasciitis were enrolled. Inclusion criteria: heel pain localized to the plantar fascia insertion for >3 months, pain on palpation of the medial calcaneal tubercle, and pain on first steps in the morning. Exclusion criteria: prior foot surgery, corticosteroid injection into the heel within previous 3 months, systemic inflammatory disease, pregnancy, current use of oral corticosteroids, and neurological conditions affecting gait.

All participants provided written informed consent. The local institutional review board approved the protocol.

Intervention

High load strengthening exercise was performed in stair well. Roll up a T shirt in order to create a cylinder with approximately 2 cm in diameter to wrap toes around this shape. Diameter of rolled towel will be adjusted according to unique foot size. Unilateral heel raises with placed rolled towel under the toes to further activate the Windlass mechanism.

Every heel consisted of a 3 second going up and a 3 second coming down phase with a 2 second pause at the top of the exercise.

Patient will perform to ensure that the toes maximally dorsiflexed at the top of the heel raise.

12 repetitions for 3 sets, once a day, exercise will be done every other day. Start the exercise by using both legs until patient becomes stronger enough to do unilateral heel raises.

Start with 12 repetitions for 3 sets. When patient becomes stronger about 2-3 weeks increase load by using backpack with books approximately 5 pounds to increase load, reducing the number of repetitions to 10 repetitions of 4 sets (about 2 weeks) and then progress to 8 repetitions for 5 sets. Treatment will give for 4 weeks

Phonophoresis. Dexamethasone 0.5% gel was applied to the medial plantar heel region prior to therapeutic ultrasound.

Outcome measures

Assessments were performed at baseline and after 4 weeks.

Primary outcomes:

Pain intensity: Numeric Pain Rating scale (NPRS) for worst morning heel pain.

Foot function: Foot Function Index (FFI) total score (0–100; higher worse).

Sample size and statistical analysis

A convenience sample of 30 participants was used for this proof-of-concept study. Data were analysed using paired t-tests (baseline vs. 4 weeks). Normality of residuals was checked using the Shapiro–Wilk test. Where appropriate, non-parametric alternatives were planned.

Effect sizes (Cohen's *d* for paired samples) and 95% confidence intervals were calculated. Statistical significance was defined as $p < 0.05$. Analyses were conducted using standard statistical software.

3. RESULTS

The present study investigated the combined effect of high load strengthening exercise and phonophoresis in 30 individuals with clinically diagnosed plantar fasciitis. Out of 30 participate 20 (67%) were female and 10 (33%) were male in the study. All participants completed the 4-week intervention without dropouts, indicating good feasibility and adherence.

Table 1. Descriptive statistics of all participant (n = 30)

Variables		Minimum	Maximum	Median (IQR)	Mean $\pm$ SD
Age		21	62	39.5 (35-47.75)	41.27 $\pm$ 9.88
Pre Intervention	NPRS	3	8	5 (4-6)	5.4 $\pm$ 1.4
	FFT	24.7	72.35	43.52 (35.88-48.97)	43.29 $\pm$ 11.72
Post Intervention	NPRS	1	8	5 (1-3)	2.43 $\pm$ 1.61
	FFT	4.11	50	17.65 (7.20-23.96)	18.41 $\pm$ 12

Table 2. Comparing pain score and food function index score between baseline and after 4 weeks by using paired t-test

Variables	Pre Intervention	Post Intervention	Paired test	t-P - Value	Significance
NPRS	5.4 $\pm$ 1.4	2.43 $\pm$ 1.61	8.886	< 0.0001	Both are significant
FFT	43.29 $\pm$ 11.72	18.41 $\pm$ 12	10.313	< 0.0001	

Baseline vs. 4 weeks also showed statistically significant improvements for all outcomes ($p < 0.001$), indicating benefits by week 4.

The mean Numeric Pain Rating Scale (NPRS) score decreased significantly from 5.4 ± 1.4 at baseline to 2.43 ± 1.61 post-intervention ($p < 0.0001$), representing a 55% reduction in pain. Similarly, the Foot Function Index (FFI) score decreased from 43.29 ± 11.72 to 18.41 ± 12.0 ($p < 0.0001$), reflecting a 57% improvement in foot function. These changes exceeded the minimal clinically important differences (MCID) commonly reported for plantar fasciitis (a 30% change in pain and function) (Rathleff et al., 2015; DiGiovanni et al., 2003). No adverse effects were observed.

Thus, the intervention was both effective and safe, with meaningful reductions in heel pain and improvements in foot function after only four weeks of combined treatment.

4. DISCUSSION

The present study evaluated the combined effects of high-load strengthening exercise and phonophoresis on pain and functional recovery among individuals with plantar fasciitis (PF). Significant improvements were observed in both the Numeric Pain Rating Scale (NPRS) and the Foot Function Index (FFI) after four weeks of intervention, suggesting that this combined approach is effective for short-term pain reduction and functional restoration. These findings are consistent with and extend previous Indian studies on plantar fasciitis rehabilitation.

Plantar fasciitis is one of the most common causes of heel pain in the Indian population, with a prevalence of 10–15% among adults seeking foot and ankle care. Common predisposing factors reported in Indian cohorts include prolonged standing, high body mass index (BMI), poor footwear, and hard floor walking—conditions typical for many working-class individuals (Ganesan et al., 2018). Therefore, cost-effective, clinic-based interventions such as high-load strengthening and phonophoresis are highly relevant in Indian settings. A study of Divya Bharathy et al. (2023), who compared high-load strengthening plus plantar-specific stretching with manual therapy and found greater reductions in pain and improved Foot and Ankle Ability Measure (FAAM) scores in the high-load group over six weeks. Similar findings were reported by Ramya et al. (2024), who demonstrated that high-load plantar fascia resistance training combined with therapeutic ultrasound significantly improved pain and functional mobility among athletes with plantar fasciitis. In both studies, progressive loading of the plantar fascia was more effective than traditional stretching or passive modalities. The current findings echo these outcomes, emphasizing that strengthening the plantar intrinsic and extrinsic musculature enhances load tolerance and reduces mechanical strain on the fascia. Another study by Anitha et al. (2022) from Chennai examined intrinsic foot muscle strengthening along with phonophoresis using diclofenac gel and found substantial reductions in pain and disability within three weeks. The authors suggested that phonophoresis facilitates early pain relief by improving local drug absorption through ultrasonic energy, which enables patients to participate in active rehabilitation earlier. This mechanism parallels the present results, where participants achieved significant symptom reduction within four weeks—likely due to early pain modulation by phonophoresis combined with progressive tissue loading. A related study conducted at Perambalur (Karthikeyan et al., 2021) tested the efficacy of phonophoresis with foam-roller stretching and intrinsic muscle activities in 20 patients with PF. They reported significant improvements in VAS pain and FFI after three weeks of intervention. These

findings align with the current study, reinforcing that phonophoresis provides short-term analgesic benefits, particularly when paired with active exercise regimens.

The improvement seen in this study may be attributed to the synergistic effects of mechanical loading and phonophoretic drug delivery. High-load strengthening induces collagen remodelling, stimulates tenocyte activity, and enhances the mechanical stiffness of the plantar fascia, improving its load-bearing capacity (Rathleff et al., 2015). Simultaneously, phonophoresis enhances transdermal penetration of corticosteroids such as dexamethasone, reducing inflammatory mediators and nociceptor sensitivity (Watson, 2008). This dual mechanism—early inflammation control followed by progressive tissue strengthening—appears particularly effective in reducing both pain and disability.

Indian physiotherapy settings often encounter limitations in equipment availability, supervision, and patient compliance. Combining simple progressive heel-raise exercises with phonophoresis offers a practical and cost-efficient alternative to expensive interventions such as extracorporeal shockwave therapy or platelet-rich plasma injections, which are less accessible in resource-constrained hospitals. Moreover, dexamethasone and ultrasound units are widely available in Indian government and private physiotherapy clinics, making this protocol feasible.

A recent Indian observational study using ultrasonography found that patients with PF exhibit significantly increased plantar fascia and heel-pad thickness compared to healthy controls, which correlates with BMI and occupational loading (Chatterjee et al., 2023). Although the current study did not include imaging outcomes, it is plausible that reduced pain and improved function reflect early decreases in fascia inflammation and micro-edema. Future Indian studies incorporating ultrasound assessment could validate these assumptions.

5. LIMITATIONS & FUTURE DIRECTIONS

Although promising, this study has some limitations. The single-group pre-post design limits causal inference; future randomized controlled trials comparing (a) exercise alone, (b) phonophoresis alone, and (c) combined treatment are needed within Indian populations. The short duration (four weeks) restricts long-term conclusions. Additionally, inclusion of ultrasonographic measures would strengthen the mechanistic interpretation of outcomes. Future Indian studies should explore long-term efficacy, cost-effectiveness, and adherence to home-based strengthening programs, as well as the influence of factors like BMI, footwear, and occupation on outcomes.

6. CONCLUSION

In summary, the current findings demonstrate that combining high-load strengthening with phonophoresis significantly reduces pain and improves foot function in patients with plantar fasciitis. The intervention is simple, cost-effective, and practical for Indian clinical settings. By addressing both mechanical and inflammatory components of plantar fasciitis, this integrated approach offers a promising rehabilitation strategy suited to the needs of the Indian population.

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