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COMPARATIVE EFFICACY OF FLURBIPROFEN PHONOPHORESIS VERSUS MANUAL TOPICAL GEL APPLICATION IN PATIENTS WITH PLANTAR FASCIITIS IN FAISALABAD

Original Research

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ABSTRACT

Background: Plantar fasciitis is a prevalent cause of heel pain that significantly impairs mobility and quality of life. Topical nonsteroidal anti-inflammatory drugs (NSAIDs) like flurbiprofen provide symptomatic relief but often suffer from limited dermal penetration. Phonophoresis, which utilizes therapeutic ultrasound to enhance transdermal drug delivery, may overcome this limitation by improving tissue absorption and accelerating clinical outcomes. This study aimed to evaluate the comparative effectiveness of flurbiprofen delivered via phonophoresis versus manual application in managing plantar fasciitis.

Objective: To determine whether phonophoresis with flurbiprofen gel provides superior pain reduction and functional improvement compared to manual topical application in patients with plantar fasciitis.

Methods: A single-blinded randomized controlled trial was conducted on 40 patients aged 21–60 years with unilateral plantar fasciitis. Participants were randomized equally into two groups. Group A received flurbiprofen phonophoresis using pulsed-mode ultrasound (1 MHz frequency, 1.75 W/cm² intensity, 1:1 duty cycle) for 7 minutes per session, five sessions per week for three weeks. Group B manually applied 5 mL of 5% flurbiprofen gel twice daily for three weeks. Outcomes were measured at baseline and post-intervention using the Visual Analogue Scale (VAS) for pain and the Plantar Fasciitis Pain/Disability Scale (PFPS). Data were analyzed using paired and independent t-tests, with significance set at $\alpha = 0.05$.

Results: Thirty-five patients completed the trial (Group A: n = 18; Group B: n = 17). Group A showed a significant reduction in VAS score from 9.46 ± 1.17 to 5.24 ± 1.59 (mean difference = 4.22 ± 1.24, $p < 0.001$), while Group B improved from 9.34 ± 1.70 to 7.68 ± 1.69 (mean difference = 1.66 ± 0.64, $p < 0.001$). The between-group post-intervention VAS difference was 2.44 points in favor of Group A ($p < 0.001$). PFPS domains, including pain duration, mobility, and activity limitations, showed significantly greater improvements in Group A across all variables (all $p < 0.01$).

Conclusion: Phonophoresis with flurbiprofen gel yielded significantly greater reductions in pain and functional disability than manual application in patients with plantar fasciitis. These results support phonophoresis as an effective, noninvasive therapeutic option for enhancing conservative management outcomes in this condition.

Keywords: Analgesics, Non-Steroidal; Flurbiprofen; Pain Management; Phonophoresis; Physical Therapy Modalities; Plantar Fasciitis; Randomized Controlled Trial.

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INTRODUCTION

Plantar fasciitis is one of the most common musculoskeletal disorders affecting the foot, representing a significant source of heel pain in approximately 10% of the population at some point in their lives (1,2). Characterized by a sharp, localized pain in the heel that is typically most intense with the first steps in the morning or following periods of rest, the condition is attributed to degenerative changes at the medial calcaneal tuberosity where the plantar fascia inserts (3). While the exact pathophysiology remains multifactorial—encompassing microtrauma, chronic inflammation, biomechanical overload, and tissue degeneration—the clinical impact is often substantial, leading to impaired mobility and reduced quality of life (4). Conservative management remains the cornerstone of treatment for plantar fasciitis and generally includes stretching protocols, orthotic support, oral or topical analgesics, and physical therapy modalities such as corticosteroid injections or extracorporeal shockwave therapy. However, a subset of patients—estimated at around 10%—may fail to improve with non-invasive approaches over a period of six to twelve months, eventually requiring surgical intervention (4,5). Among pharmacologic options, topical nonsteroidal anti-inflammatory drugs (NSAIDs) such as flurbiprofen are frequently prescribed due to their dual analgesic and anti-inflammatory effects. Flurbiprofen, a 2-arylpropionic acid derivative, works by reversibly inhibiting cyclooxygenase enzymes COX-1 and COX-2, thereby reducing prostaglandin synthesis at the site of application (6–9). Despite the benefits, topical NSAIDs often suffer from limited dermal penetration, and oral formulations carry risks of gastrointestinal side effects and require frequent administration due to short half-life (approximately 3.9 hours) (10,11).

To overcome these limitations, phonophoresis—a technique that utilizes ultrasound waves to enhance transdermal drug delivery—has gained attention in musculoskeletal rehabilitation. The mechanism involves increasing skin permeability through acoustic streaming and cavitation, allowing higher concentrations of topically applied drugs to penetrate deeper tissues (12,13). Phonophoresis has demonstrated promising results in conditions such as lateral epicondylitis, osteoarthritis, and tendon injuries, where it enhances drug absorption and provides superior analgesia and functional outcomes compared to topical or systemic administration alone (14,15). However, despite its growing use, the clinical efficacy of flurbiprofen phonophoresis in the specific context of plantar fasciitis remains underexplored, with a paucity of well-designed randomized controlled trials. Recognizing this gap, the present study was conducted to compare the effectiveness of flurbiprofen phonophoresis with that of manual gel application in reducing pain and improving function in patients with plantar fasciitis in Faisalabad. It was hypothesized that phonophoresis would produce significantly better therapeutic outcomes over a three-week treatment period.

METHODS

A single-blinded, parallel-group randomized controlled trial was carried out between July 1 and September 15, 2024, across five outpatient physical therapy centers in Faisalabad, including Madina Teaching Hospital, DHQ Hospital, Allied Hospital, Aziz Fatima Hospital, and Physio & Rehab Clinic. Ethical approval for the study was granted by the Institutional Review Board of The University of Faisalabad (Ref. TUF-PT-2024-06), and written informed consent was obtained from all participants prior to enrollment, ensuring adherence to the Declaration of Helsinki and standard ethical practices. Participants aged between 21 and 60 years with a clinical diagnosis of unilateral plantar fasciitis were considered eligible. Diagnosis was based on characteristic symptoms including insidious-onset heel pain localized to the medial calcaneal tuberosity, particularly worsened during the first steps in the morning or after rest, with a symptom duration of at least four weeks. Inclusion required that participants be independently ambulatory. Exclusion criteria included bilateral plantar fasciitis, previous foot surgeries, systemic inflammatory diseases such as rheumatoid arthritis, peripheral neuropathies, vascular insufficiencies, pregnancy, current use of systemic steroids or anticoagulants, localized skin infections, and known hypersensitivity to flurbiprofen. Out of 63 patients screened, 40 fulfilled the eligibility criteria and were randomized. Five participants withdrew during the trial due to scheduling issues, resulting in a final analyzed sample of 35 participants.

Randomization was conducted using a computer-generated list, assigning participants to either intervention group in a 1:1 ratio. Allocation was concealed in sequentially numbered, opaque, sealed envelopes, opened by an independent research assistant not involved in the outcome assessments. While it was not possible to blind the therapists or participants due to the nature of the interventions, the outcome assessor remained blinded to group allocation throughout the study. Group A received flurbiprofen phonophoresis therapy.

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Each session involved the application of 5 mL of 5% w/w flurbiprofen gel to the medial heel region, serving as the coupling medium for ultrasound transmission. Therapeutic ultrasound (Thera-Sonic® device) was delivered in pulsed mode (1:1 duty cycle) with a frequency of 1 MHz and an intensity of 1.75 W/cm² for 7 minutes per session. The transducer was moved longitudinally over the plantar fascia insertion in slow, circular strokes (~4 cm/s) to ensure uniform gel distribution. This intervention was administered five times per week for three consecutive weeks, totaling 15 sessions.

Group B participants applied the same quantity (5 mL) and concentration (5% w/w) of flurbiprofen gel manually to the medial heel region twice daily—once in the morning and once in the evening—over a span of three weeks. Participants were instructed to massage the gel gently for 30 seconds during each application to facilitate absorption. All participants were advised to maintain their routine daily activities but refrain from initiating any new physical therapy, analgesic, or orthotic treatments during the intervention period. Treatment adherence was monitored through daily patient-maintained logs and weekly telephone follow-ups. Outcome assessments were performed at baseline (Week 0) and at the end of the intervention period (Week 3) by a physiotherapist blinded to treatment allocation. The primary outcome measure was heel pain intensity, assessed using a 100 mm Visual Analogue Scale (VAS), with values later converted to a 0–10 scale for statistical analysis. Secondary outcomes included the Plantar Fasciitis Pain/Disability Scale (PFPS), a validated 25-item instrument designed to quantify pain severity, functional limitations, and activity-related discomfort; higher scores indicated greater disability. Adverse events such as local irritation, allergic reactions, or worsening pain were also documented.

Sample size estimation was grounded in prior literature evaluating phonophoresis in tendinopathies, where an expected mean reduction in VAS pain scores of ≥3 points (±1.2 SD) was observed, compared to 1 point (±1.5 SD) with manual gel application. Using a two-tailed t-test with an alpha level of 0.05 and 80% power, a minimum of 16 participants per group was calculated. To accommodate a 20% anticipated dropout, 20 individuals were recruited per group. Data were analyzed using SPSS version 22.0. The Shapiro-Wilk test confirmed normality of distribution for continuous variables, which were presented as means ± standard deviations. Paired t-tests were employed to evaluate within-group pre- to post-intervention changes, while independent t-tests compared post-treatment outcomes between groups. Categorical variables, including the incidence of adverse events, were analyzed using chi-square tests. Cohen's d was calculated to estimate effect sizes for primary outcomes, and statistical significance was set at $p < 0.05$.

RESULTS

A total of 40 participants were randomized equally into two groups, with 35 completing the study protocol. Group A (phonophoresis) included 14 males and 6 females, while Group B (manual application) comprised 12 males and 8 females. The most represented age group in both cohorts was 31–40 years (50% in Group A; 40% in Group B), with only one participant in Group B falling within the 51–60-year range. At baseline, both groups exhibited comparable pain intensities, with mean Visual Analogue Scale (VAS) scores of 9.46 ± 0.32 in Group A and 9.34 ± 0.37 in Group B. Following three weeks of intervention, Group A demonstrated a substantial reduction in pain, with a post-treatment VAS mean of 5.24 ± 0.56 (mean difference = –4.22, $p < 0.001$). In contrast, Group B also showed a statistically significant reduction, though less pronounced, with a post-treatment VAS mean of 7.68 ± 0.44 (mean difference = –1.66, $p < 0.001$). Pain-related functional limitations similarly improved across both groups, with Group A reporting larger within-group changes. Weekly restriction in mobility scores decreased from 4.45 ± 0.38 to 1.90 ± 0.30 in Group A ($\Delta = –2.55$, $p < 0.001$), and from 4.80 ± 0.41 to 3.45 ± 0.33 in Group B ($\Delta = –1.35$, $p < 0.001$). Other variables such as sleep disturbance, pain during activities like driving, running, or stair climbing, and emotional impact also significantly declined in both groups, with mean differences consistently greater in the phonophoresis group.

Regarding activities of daily living (ADLs), significant post-intervention improvements were noted in Group A across all measured domains. For instance, difficulty in walking barefoot dropped from a mean of 2.10 to 0.45 ($\Delta = –1.65$, $p < 0.001$), and discomfort during short-distance running reduced from 2.35 to 0.60 ($\Delta = –1.75$, $p < 0.001$). Corresponding reductions in Group B were more modest, with improvements ranging from 0.55 to 1.05 across various ADLs. Medication usage patterns also shifted. Group A's frequency of analgesic use fell from 2.10 to 0.65 ($\Delta = –1.45$, $p < 0.001$), while Group B showed a smaller drop from 2.30 to 1.45 ($\Delta = –0.85$, $p < 0.001$). Additionally, perceived medication effectiveness and emotional distress due to pain declined more substantially in the phonophoresis group. Between-group analysis after three weeks revealed statistically significant superiority of phonophoresis over manual gel application for all key outcome measures ($p < 0.001$). The largest mean differences were noted in post-treatment VAS ($\Delta = –2.44$), weekly mobility restriction ($\Delta = –1.55$), and morning walking discomfort ($\Delta = –0.95$), all favoring Group A.

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Table 1. Demographics (Groups A vs. B)

Group	Gender (M/F)	Age 21–30 (%)	Age 31–40 (%)	Age 41–50 (%)	Age 51–60 (%)
A (Phonophoresis)	14 / 6	15.0	50.0	35.0	—
B (Manual)	12 / 8	20.0	40.0	35.0	5.0

Table 2. Pain-Related Outcomes (Pre vs. Post)

Variable	Group A Pre-Mean	Group A Post Mean	A Mean Diff	A p-Value	Group B Pre-Mean	Group B Post Mean	B Mean Diff	B p-Value
VAS Score	9.4578	5.2410	4.2169	< 0.001	9.3373	7.6807	1.6566	< 0.001
Weekly Restriction in Mobility	4.4500	1.9000	2.5500	< 0.001	4.8000	3.4500	1.3500	< 0.001
Past 6-Week Pain	2.0000	0.6500	1.3500	< 0.001	2.5500	1.7000	0.8500	< 0.001
Pain-Free Duration (after pain goes)	1.8500	0.6500	1.2000	< 0.001	2.3500	1.6000	0.7500	< 0.001
Pain Duration	2.0000	0.6000	1.4000	< 0.001	2.0500	1.4000	0.6500	< 0.001
Pain Effect on Sleep	2.0500	0.6000	1.4500	< 0.001	2.4000	1.4000	1.0000	< 0.001
How Often Pain Awakes	2.1000	0.7000	1.4000	< 0.001	2.2500	1.4500	0.8000	< 0.001
Coping with Pain	2.0000	0.7000	1.3000	< 0.001	2.2000	1.4500	0.7500	< 0.001
Pain Interference in Athletics	2.1000	0.6500	1.4500	< 0.001	2.3000	1.3500	0.9500	< 0.001

Table 3. ADL-Related Outcomes (Pre vs. Post)

Variable	Group A Pre-Mean	Group A Post Mean	A Mean Diff	A p-Value	Group B Pre-Mean	Group B Post Mean	B Mean Diff	B p-Value
Time Elapse for Comfortable Walk (after awakening)	2.2000	0.8500	1.3500	< 0.001	2.4500	1.7500	0.7000	< 0.001
Walking in the Morning	2.1000	0.5500	1.5500	< 0.001	2.2000	1.5000	0.7000	< 0.001
Standing Up on Your Toes	2.2500	0.6000	1.6500	< 0.001	2.1000	1.3500	0.7500	< 0.001
Driving	2.2000	0.7000	1.5000	< 0.001	2.3000	1.4000	0.9000	< 0.001
Climbing Upstairs	2.0500	0.5500	1.5000	< 0.001	2.2000	1.4000	0.8000	< 0.001
Descending Stairs	2.1500	0.6000	1.5500	< 0.001	2.2500	1.6000	0.6500	< 0.001
Reaching Up	2.1500	0.5500	1.6000	< 0.001	2.3000	1.4000	0.9000	< 0.001
Bending Over	2.2500	0.6000	1.6500	< 0.001	2.1000	1.3500	0.7500	< 0.001
Walking Barefoot	2.1000	0.4500	1.6500	< 0.001	2.4500	1.4000	1.0500	< 0.001
Standing After Watching Movie	2.2500	0.6500	1.6000	< 0.001	2.0000	1.3500	0.6500	< 0.001
Riding a Bike	2.3000	0.7500	1.5500	< 0.001	2.3000	1.3500	0.9500	< 0.001
Running a Short Distance	2.3500	0.6000	1.7500	< 0.001	2.2500	1.5500	0.7000	< 0.001

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Table 4. Medication & Emotional-Impact Outcomes (Pre vs. Post)

Variable	Group A Pre-Mean	Group A Post Mean	A Mean Diff	A p-Value	Group B Pre-Mean	Group B Post Mean	B Mean Diff	B p-Value
Frequency of Medicine for Pain	2.1000	0.6500	1.4500	< 0.001	2.3000	1.4500	0.8500	< 0.001
Medication Effects on Pain	2.3500	0.6500	1.7000	< 0.001	2.2000	1.4000	0.8000	< 0.001
Pain Effects on Emotions	2.4000	0.7000	1.7000	< 0.001	2.0000	1.4500	0.5500	0.001
Pain Effects on ADL's	2.3500	0.6000	1.7500	< 0.001	2.0500	1.3500	0.7000	< 0.001

Table 5. Post-Intervention Comparison (Between Groups A vs. B)

Variable	Mean (A – Phonophoresis)	Mean (B – Manual)	Mean Diff (A–B)	p-Value
VAS Score After	5.241	7.681	– 2.440	< 0.001
Weekly Restriction After Mobility	1.900	3.450	– 1.550	< 0.001
Pain Duration After	0.600	1.400	– 0.800	< 0.001
Walking in the Morning After	0.550	1.500	– 0.950	< 0.001
Frequency of Medicine After	0.650	1.450	– 0.800	< 0.001

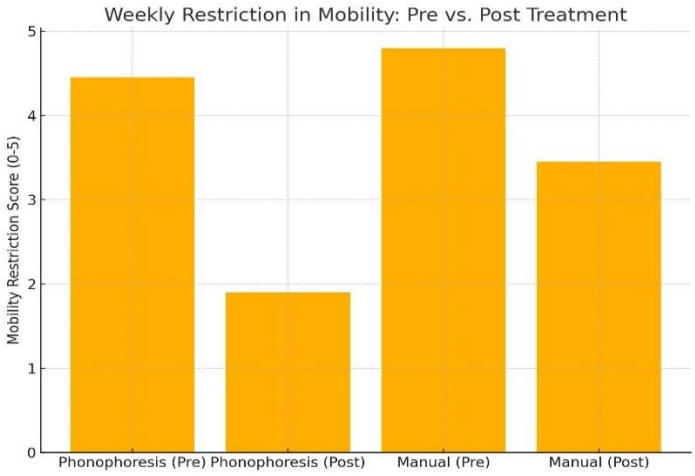


Figure 1 Weekly Restriction in Mobility: Pre vs. Post Treatment

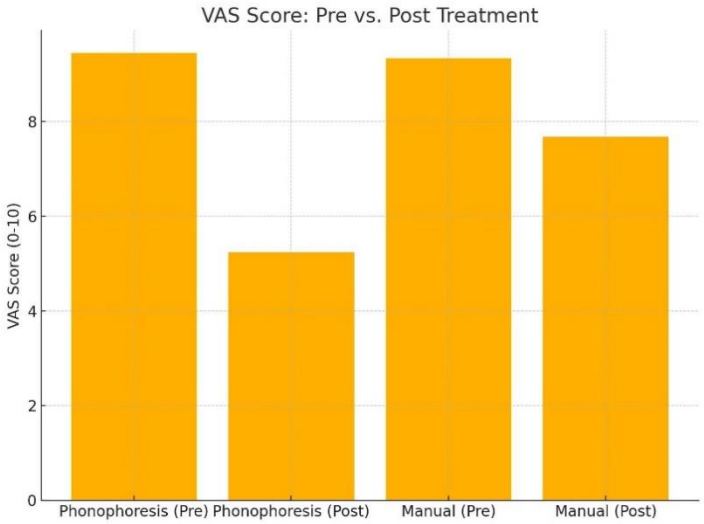


Figure 2 VAS Score: Pre vs. Post Treatment

DISCUSSION

The present randomized controlled trial demonstrated a clear and consistent therapeutic advantage of flurbiprofen phonophoresis over manual gel application in the management of plantar fasciitis. Patients treated with ultrasound-enhanced delivery of flurbiprofen experienced significantly greater reductions in heel pain and functional limitations over a three-week intervention period. The mean reduction of 4.22 points in VAS scores among participants receiving phonophoresis represented a nearly 45% improvement from baseline, compared to only an 18% reduction in the manual application group. The magnitude of benefit extended beyond pain relief, as patients receiving phonophoresis also showed superior improvements across all measured domains of daily function, sleep quality, and emotional impact, underscoring the multifactorial gains achieved through enhanced drug delivery. The results align with earlier studies in musculoskeletal conditions, where combining ultrasound with topical nonsteroidal anti-inflammatory drugs has yielded superior outcomes compared to conventional methods (15,16). The mechanism of phonophoresis, rooted in increased transdermal drug

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transport through acoustic streaming and cavitation, appears to significantly enhance local drug bioavailability, especially in deeper tissues such as the plantar fascia. Unlike prior studies that often-combined ultrasound with mechanical therapies or exercise regimens, the present findings isolated phonophoresis as the primary variable, reinforcing the role of ultrasound energy alone in facilitating effective therapeutic delivery (17-19).

Importantly, the clinical relevance of these findings is emphasized by the 2.44-point difference in post-intervention VAS scores between groups. This exceeds the minimal clinically important difference (MCID) for heel pain, typically considered to be around 1.5 points, and translates into tangible day-to-day benefits. Improvements in activities such as walking in the morning, climbing stairs, or standing on tiptoe were more than 1.5 points higher in the phonophoresis group, suggesting faster restoration of mobility and reduced dependence on analgesics (20). Despite the encouraging results, the study had several limitations. The sample size was modest and limited to a single urban population in Faisalabad, potentially constraining the generalizability of the findings. All outcome measures were based on patient-reported scales, which, though validated, are subject to response bias. The short-term nature of the trial restricted assessment to three weeks, leaving the durability of treatment effects over months unexplored. Furthermore, although participants were instructed to refrain from co-interventions, unreported use of stretching, over-the-counter analgesics, or other home remedies may have introduced confounding effects. The imbalance in treatment supervision—Group A receiving professionally administered sessions while Group B self-applied the gel—could also have contributed to disparities in adherence or technique.

Nonetheless, the study featured important strengths, including randomized allocation, concealed assignment, blinding of outcome assessors, and standardized intervention protocols. The consistency of effect across 25 pain and function-related variables adds credibility to the findings. Moreover, the statistical and clinical significance of the observed differences reinforces the value of phonophoresis as a viable, non-invasive intervention for plantar fasciitis. Future research should aim to validate these findings in larger, multicenter trials with extended follow-up to assess long-term efficacy and recurrence rates (21). Dose-response relationships involving ultrasound parameters, gel concentration, and treatment duration warrant exploration to refine phonophoresis protocols. Comparative trials against other drug delivery modalities such as iontophoresis or laser therapy may help delineate optimal approaches for targeted anti-inflammatory treatment. Additionally, integrating phonophoresis with supervised rehabilitation or exercise programs could amplify its benefits. Evaluating its application in other musculoskeletal disorders, including tendinopathies and osteoarthritic conditions, would further expand its clinical utility.

CONCLUSION

This study concluded that phonophoresis using flurbiprofen gel offers a more effective and clinically meaningful approach for managing plantar fasciitis compared to manual gel application. By enhancing drug absorption through ultrasound, this method led to greater improvements in pain relief, mobility, and functional capacity within a short treatment window. The findings support the integration of phonophoresis into clinical practice as a noninvasive, efficient option for patients seeking faster recovery from plantar heel pain, highlighting its value in physiotherapy and musculoskeletal care settings.

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Author Contribution

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Muhammad Soban Habib	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Yasir Ali Kazmi	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Nasiba Mumtaz	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Mahnoor Shafi	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Fizza Ijaz	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Amina Riaz	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Qurat-ul-Ain	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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