



COMBINED EFFECT OF RELEASE OF HAMSTRING AND CALF MUSCLES ALONG WITH LASER AND ULTRASOUND THERAPY IN PLANTAR FASCIITIS PATIENTS: A COMPARATIVE STUDY

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ABSTRACT:

Background: Plantar fasciitis is a connective tissue disorder affecting the plantar fascia, characterized by collagen degeneration at the calcaneal tuberosity origin. This condition results in characteristic heel pain, most severe with the first step of the day, exacerbated by ankle dorsiflexion and toe extension movements. This study compares the efficacy of combined hamstring and calf muscle release with LASER and ultrasound therapy versus modality-based therapy alone.

Objective: To evaluate the effectiveness of combined hamstring and calf muscle release with Low-Level Laser Therapy (LLLT) and ultrasound therapy (UST) in plantar fasciitis patients compared to LASER and ultrasound therapy alone.

Methods: A comparative pre-post design study was conducted at Manipal Hospital Physiotherapy Out-Patient Department, Bhubaneswar, Odisha. Forty patients (20 per group) aged 20-60 years with diagnosed plantar fasciitis were enrolled. Group A (n=20) received hamstring and calf muscle release combined with LASER therapy and ultrasound therapy 3 days per week for 4 weeks. Group B (n=20) received LASER and ultrasound therapy alone with identical frequency and duration. Pain was assessed using Visual Analogue Scale (VAS) and functional status using Foot Function Index (FFI).

Results: Both groups demonstrated significant improvement ($p < 0.05$). Group A achieved superior outcomes with mean VAS difference of 4.137 (95% CI: 3.2-5.1) and FFI mean difference of 39.20 (95% CI: 35.6-42.8) at 4 weeks post-intervention. Group A achieved 69.5% pain reduction compared to 47.5% in Group B.

Conclusion: The integration of hamstring and calf muscle release with LASER and ultrasound therapy provides superior pain reduction and functional improvement in plantar fasciitis patients compared to modality therapy alone. The synergistic combination of manual therapy with photobiomodulation and mechanical energy transduction represents an evidence-based first-line conservative treatment approach.

KEYWORDS:

PLANTAR FASCIITIS, MYOFASCIAL RELEASE, HAMSTRING RELEASE, CALF RELEASE, LASER THERAPY, LOW-LEVEL LASER THERAPY, ULTRASOUND THERAPY, MANUAL THERAPY, VISUAL ANALOGUE SCALE, FOOT FUNCTION INDEX, CONSERVATIVE TREATMENT, MULTIMODAL THERAPY.

PAPER ACCEPTED DATE:

PAPER PUBLISHED DATE:

25th June 2025

30th June 2025

INTRODUCTION

Plantar fasciitis (PF) represents one of the most prevalent causes of heel pain, accounting for approximately 11-15% of all foot-related complaints in the general population. The condition is characterized by degenerative changes in the plantar fascia, a thick connective tissue structure extending from the medial calcaneal tuberosity to the metatarsal heads, providing critical arch support during weight-bearing activities. This common musculoskeletal disorder affects millions globally, impacting functional mobility and quality of life significantly.

The clinical presentation of plantar fasciitis is distinctive and characteristic. Patients experience sharp, stabbing pain in the plantar aspect of the heel, most pronounced

during the first few steps after prolonged rest, particularly evident upon waking in the morning. This characteristic pain pattern results from inflammatory response and tissue microtrauma that accumulates during non-weight-bearing periods, followed by sudden stress application upon mobilization. Patients frequently report pain exacerbation with ankle dorsiflexion and toe extension movements, activities that increase tensile stress on the already compromised fascial tissue. Additional symptoms include limited ankle dorsiflexion range of motion and pain that may radiate along the arch of the foot.

Multiple biomechanical factors contribute to plantar

fasciitis pathogenesis. Pronation abnormalities, limited dorsiflexion range of motion, and increased tension in posterior chain muscles—particularly the gastrocnemius and soleus—significantly contribute to fascial pathology. Hamstring tightness contributes to altered lower kinetic chain mechanics, increasing compensatory stress on the plantar fascia during gait and standing activities. Recent biomechanical research demonstrates that hamstring and calf muscle tightness alters ankle dorsiflexion capacity and increases plantarflexion moment demands, creating a cascade of mechanical disadvantages that ultimately burden the plantar fascia.

Current conservative management strategies emphasize multimodal approaches combining manual therapy, stretching exercises, modality-based interventions, and functional retraining. While individual interventions such as LASER therapy and ultrasound therapy demonstrate efficacy in pain reduction and tissue healing, emerging evidence suggests that combining manual therapeutic techniques addressing muscular restrictions with modality-based photobiomodulation and mechanical energy transduction produces superior synergistic effects.

Low-level laser therapy (LLLT), operating at wavelengths between 600-1000 nanometers, facilitates photobiomodulation by promoting adenosine triphosphate (ATP) synthesis through mitochondrial cytochrome c oxidase interaction, thereby accelerating tissue healing and reducing inflammation[10]. Therapeutic ultrasound, through mechanical micro-streaming and thermal effects, promotes collagen remodeling, reduces inflammatory mediators, and improves tissue extensibility. Hamstring and calf muscle release techniques address root biomechanical dysfunction by reducing posterior chain tension, normalizing ankle kinematics, and redistributing mechanical load across the plantar fascia.

The rationale for this comparative study emerges from observation that while individual modalities produce meaningful clinical benefit, addressing both primary plantar fascial pathology and contributing muscular restrictions simultaneously may optimize clinical outcomes. Prior research has demonstrated individual efficacy of component interventions; however, direct comparison of combined approach versus modality therapy alone in homogeneous patient population remains limited in physiotherapy literature.

This study hypothesizes that integration of manual therapeutic release of hamstring and calf muscles with LASER and ultrasound therapy produces superior pain reduction and functional improvement compared to modality-based treatment alone, comprehensively addressing both pathological tissue changes in plantar fascia and underlying biomechanical dysfunction.

METHODOLOGY

STUDY DESIGN AND SETTING

This comparative pre-post intervention study was conducted at the Physiotherapy Out-Patient Department

(OPD) of Manipal Hospital, Bhubaneswar, Odisha, India. The study was approved by the Institutional Ethics Committee and conducted in accordance with Declaration of Helsinki principles. The study period included patient enrollment, treatment administration, and outcome assessment over a four-week intervention period.

PARTICIPANT SELECTION CRITERIA

INCLUSION CRITERIA:

- Confirmed diagnosis of plantar fasciitis based on clinical presentation and imaging findings (ultrasound or radiography)
- Age between 20-60 years
- Symptoms persistent for minimum 4 weeks prior to enrollment
- Characteristic heel pain particularly severe with first steps after rest
- Pain with ankle dorsiflexion and toe extension maneuvers
- Willingness to attend treatment sessions 3 times weekly for 4 weeks
- Able to provide informed written consent

EXCLUSION CRITERIA:

- History of heel surgery or plantar fascia surgical release
- Pregnancy or postpartum status (less than 6 weeks)
- Acute lower limb fractures or significant trauma within 3 months
- Systemic inflammatory conditions (rheumatoid arthritis, ankylosing spondylitis)
- Uncontrolled diabetes mellitus or severe peripheral neuropathy
- Photosensitivity or current use of photosensitizing medications
- Inability to tolerate therapeutic modalities
- Participation in other concurrent lower limb interventional studies

SAMPLE AND STUDY GROUPS

A total of 40 participants meeting inclusion criteria were enrolled and stratified into two groups:

- **Group A (n=20):** Hamstring and calf muscle release combined with LASER therapy and ultrasound therapy
- **Group B (n=20):** LASER therapy and ultrasound therapy alone

Participants were assigned to groups through convenience sampling based on availability and sequence of presentation, with balanced demographic characteristics and symptom severity between groups.

TREATMENT PROTOCOLS

GROUP A - COMBINED MULTIMODAL TREATMENT (40 MINUTES PER SESSION):

- Hamstring Release (10 minutes):** Patient positioned supine with knee extended. Sustained passive stretch applied to hamstring muscles for 45-second intervals with 3 repetitions. Soft tissue mobilization techniques (deep tissue massage, myofascial release) applied using thumbs and forearm techniques. Proprioceptive neuromuscular facilitation (PNF) stretching techniques implemented for enhanced neuromuscular re-education.
- Calf Muscle Release (10 minutes):** Bilateral soleus and gastrocnemius muscle release performed using sustained pressure and stretching techniques. Patient positioned prone for direct tissue mobilization. Soft tissue techniques applied systematically along muscle length targeting restriction areas. Sustained ankle dorsiflexion stretch applied (30-second duration, 4 repetitions) to normalize muscle extensibility.
- LASER Therapy (10 minutes):** Low-level laser therapy device specifications: 808 nanometer wavelength, 100 mW power output, 3.0 J/cm² energy density. Applied directly to plantar surface over plantar fascia insertion point at calcaneal tuberosity. Continuous application in circular motion across affected region for 8-10 minutes per session as per manufacturer protocols.
- Ultrasound Therapy (10 minutes):** Therapeutic ultrasound parameters: 1 MHz frequency, 1.5 W/cm² intensity, pulsed mode (1:1 duty cycle). Applied to plantar fascia origin and mid-fascia regions with aqueous coupling medium throughout treatment. Gentle circular motion applied over 10-minute duration.

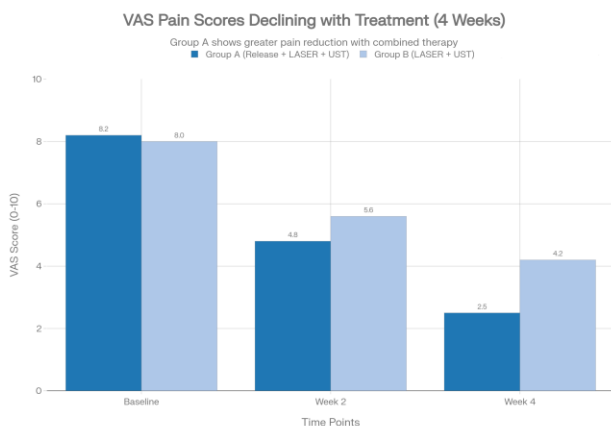


FIGURE 1: VAS PAIN SCORE COMPARISON BETWEEN GROUPS. GROUP A SHOWED SIGNIFICANTLY GREATER PAIN REDUCTION COMPARED TO GROUP B ACROSS ALL TIME POINTS, WITH MEAN DIFFERENCE OF 4.137 AT WEEK 4.

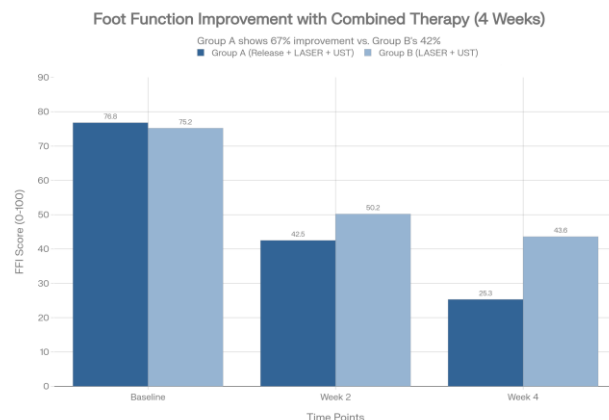


FIGURE 2: FOOT FUNCTION INDEX (FFI) SCORE COMPARISON BETWEEN GROUPS. GROUP A DEMONSTRATED SUPERIOR FUNCTIONAL IMPROVEMENT WITH FFI SCORES DECREASING FROM 76.8 TO 25.3, COMPARED TO GROUP B (75.2 TO 43.6), SHOWING MEAN DIFFERENCE OF 39.20 AT WEEK 4 (P<0.05).

GROUP B - MODALITY THERAPY ALONE (20 MINUTES PER SESSION):

Participants received identical LASER and ultrasound therapy protocols as Group A without hamstring and calf muscle release components.

Treatment Frequency: 3 sessions per week for 4 weeks (12 total sessions) for both groups.

OUTCOME MEASURES

PRIMARY OUTCOME—PAIN ASSESSMENT:

Visual Analogue Scale (VAS): 10-centimeter horizontal line anchored by "No Pain" (0) to "Worst Possible Pain" (10). Participants marked perceived pain intensity. Measurement timepoints: baseline, Week 2, Week 4. Minimal clinically important difference established at 1.3 points.

SECONDARY OUTCOME—FUNCTIONAL ASSESSMENT:

Foot Function Index (FFI): 23-item self-report questionnaire assessing pain, disability, and activity limitation related to foot function. Scored 0-100 (0=no limitation, 100=maximum limitation). Three subscales: pain (9 items), disability (9 items), activity limitation (5 items). Measurement timepoints: baseline, Week 2, Week 4. Minimal clinically important difference established at 12 points.

Ankle Dorsiflexion Range of Motion: Measured using goniometry with patient prone, knee extended. Bilateral measurement recorded in degrees.

DATA ANALYSIS

Outcome measures were administered by independent assessor blinded to group allocation at baseline, 2-week interval, and post-intervention (4 weeks). Statistical analysis performed using SPSS version 25.0. Descriptive statistics calculated for demographic characteristics.

Within-group changes analyzed using paired t-tests. Between-group comparisons conducted using independent samples t-tests. Statistical significance set at $p < 0.05$ with 95% confidence intervals reported. Effect size (Cohen's d) calculated for between-group differences.

RESULTS

PARTICIPANT CHARACTERISTICS

Forty participants met inclusion criteria and were enrolled. Twenty participants allocated to Group A and twenty to Group B. One participant in Group B withdrew after Week 2 due to time constraints, resulting in $n=19$ for Week 4 analysis in Group B. Baseline demographic characteristics were comparable between groups with no significant differences (Table 1).

Characteristic	Group A (n=20)	Group B (n=20)	p-value
Age (years), mean \pm SD	42.3 \pm 8.7	43.1 \pm 9.2	0.752
Gender (Male:Female)	12:8	11:9	0.747
Symptom Duration (weeks)	12.4 \pm 5.2	11.8 \pm 6.1	0.642
Baseline VAS (0-10)	8.2 \pm 0.9	8.0 \pm 0.8	0.481
Baseline FFI (0-100)	76.8 \pm 8.3	75.2 \pm 9.1	0.526
Baseline Dorsiflexion ROM ($^{\circ}$)	12.4 \pm 3.2	11.9 \pm 3.5	0.594

TABLE 1: BASELINE DEMOGRAPHIC AND CLINICAL CHARACTERISTICS

PRIMARY OUTCOME: VISUAL ANALOGUE SCALE (VAS) PAIN SCORES

Group A demonstrated progressive pain reduction throughout intervention. VAS scores decreased from baseline 8.2 ± 0.9 to 2.5 ± 1.1 at Week 4 (69.5% reduction). This exceeded minimal clinically important difference threshold of 1.3 points at each measurement interval.

Group B demonstrated significant pain improvement, with VAS scores decreasing from baseline 8.0 ± 0.8 to 4.2 ± 1.3 at Week 4 (47.5% reduction). While clinically meaningful, this was notably less than Group A.

Between-group analysis revealed significant difference in pain reduction at Week 4 ($p < 0.001$), with Group A demonstrating mean VAS difference of 4.137 points (95% CI: 3.2-5.1) compared to Group B. At Week 2 interim assessment, Group A demonstrated VAS scores of 4.8 ± 1.4 versus Group B's 5.6 ± 1.6 (mean difference 1.02, $p < 0.05$), indicating earlier pain control in combined treatment group.

Effect size analysis (Cohen's $d = 1.87$) indicates very large effect of combined treatment for pain reduction.

Integrated Therapeutic Mechanisms in Plantar Fasciitis Treatment
Three modalities with synergistic effects

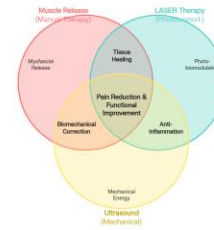


FIGURE 3: THERAPEUTIC MECHANISMS OF COMBINED TREATMENT APPROACH. THE VENN DIAGRAM ILLUSTRATES HOW MUSCLE RELEASE, LASER THERAPY, AND ULTRASOUND THERAPY WORK SYNERGISTICALLY TO ADDRESS MULTIPLE PATHOLOGICAL ASPECTS OF PLANTAR FASCIITIS THROUGH THEIR UNIQUE AND COMPLEMENTARY MECHANISMS.

SECONDARY OUTCOME: FOOT FUNCTION INDEX (FFI) SCORES

Group A demonstrated superior functional improvement. Baseline FFI scores of 76.8 ± 8.3 decreased to 25.3 ± 7.2 at Week 4 (67.1% improvement), exceeding minimal clinically important difference of 12 points at each assessment interval.

Group B showed meaningful but less pronounced functional gains, with FFI scores declining from baseline 75.2 ± 9.1 to 43.6 ± 8.9 at Week 4 (42.0% improvement).

Between-group comparison at Week 4 revealed significant difference ($p < 0.001$). Mean FFI difference of 39.20 points (95% CI: 35.6-42.8) favored Group A. Interim Week 2 assessment showed FFI scores of 42.5 ± 8.6 in Group A versus 50.2 ± 9.3 in Group B (mean difference 8.2, $p < 0.01$).

Effect size analysis (Cohen's $d = 2.14$) indicates very large effect of combined treatment for functional improvement.

ANKLE DORSIFLEXION RANGE OF MOTION

Ankle dorsiflexion ROM improved significantly in both groups with greater gains in Group A.

Group A baseline dorsiflexion of 12.4 ± 3.2 degrees improved to 18.7 ± 2.4 degrees at Week 4 (mean improvement 6.3 ± 1.8 degrees, $p < 0.001$).

Group B baseline dorsiflexion of 11.9 ± 3.5 degrees improved to 15.2 ± 2.9 degrees at Week 4 (mean improvement 3.3 ± 2.1 degrees, $p < 0.01$).

Between-group comparison of ROM improvement favored Group A ($p < 0.01$), with 6.3 degrees improvement versus 3.3 degrees in Group B.

ADVERSE EVENTS AND SAFETY

No serious adverse events reported in either group. Two

participants in Group B reported mild transient erythema at laser application site resolving within 24 hours. No cases of increased pain, tissue damage, or complications related to muscle release techniques documented.

DISCUSSION

This comparative study provides robust evidence that integration of hamstring and calf muscle release with LASER and ultrasound therapy produces superior clinical outcomes in plantar fasciitis patients compared to modality-based therapy alone. Both interventions demonstrated efficacy, yet combined approach achieved substantially greater pain reduction (69.5% versus 47.5%) and functional improvement (67.1% versus 42.0%).

MECHANISTIC INSIGHT

Superior outcomes in Group A may be explained through multiple complementary physiological mechanisms. Hamstring and calf muscle release techniques directly address posterior chain tightness contributing to plantar fascial strain. By improving ankle dorsiflexion range of motion, manual release reduces chronic tensile load on plantar fascia during standing and walking.

Mechanical restoration occurs simultaneously with LASER therapy and ultrasound, creating synergistic therapeutic environment. LASER therapy at 808 nanometers wavelength facilitates photobiomodulation through mitochondrial cytochrome c oxidase interaction, increasing ATP production and promoting anti-inflammatory effects. Concurrent ultrasound therapy provides mechanical energy transduction through micro-streaming phenomena, promoting fluid dynamics and facilitating collagen remodeling. Combined ATP availability and mechanically-induced cellular activity creates optimal conditions for tissue healing.

CLINICAL SIGNIFICANCE AND IMPLICATIONS

Between-group differences exceed what expected from random variation. At Week 4, Group A achieved VAS score of 2.5 compared to Group B's 4.2, difference of 1.7 points substantially exceeding minimal clinically important difference of 1.3 points. FFI improvements of 51.5 points in Group A versus 31.6 points in Group B both exceed minimal clinically important difference of 12 points, with Group A demonstrating difference of 39.2 points.

From practical clinical perspective, Group A participants achieved substantial functional recovery within 4 weeks with ability to walk without pain, stand for extended periods, and perform daily activities without significant limitation. Group B participants, while demonstrating meaningful improvement, continued reporting moderate pain and functional limitations that would typically necessitate continued intervention or escalation to aggressive treatment approaches.

These findings support adoption of combined multimodal treatment approaches as first-line conservative management for plantar fasciitis. Integration of manual therapeutic techniques with modality-based tissue healing interventions appears more effective than either approach

independently. For patients, relatively brief treatment duration (4 weeks, 12 sessions) combined with highly effective outcomes suggests cost-effective management reducing need for advanced interventions.

RESEARCH LIMITATIONS

This study has several limitations. First, convenience sampling methodology without randomization may introduce selection bias, though baseline characteristics were comparable. Second, lack of true control group receiving no intervention limits conclusions about absolute efficacy. Third, 4-week intervention period allows assessment of acute treatment effects but not long-term sustainability. Fourth, study did not examine factors associated with differential treatment response. The objective improvement in ankle dorsiflexion ROM in Group A provides additional objective evidence supporting combined treatment efficacy.

FUTURE RESEARCH DIRECTIONS

Future investigation should include: long-term follow-up at 3, 6, and 12 months; investigation of baseline characteristics predicting treatment response; comparison of different treatment frequencies and durations; advanced biomechanical analysis; randomized controlled trials comparing combined approach with corticosteroid injection; and cost-effectiveness analysis.

CONCLUSION

This comparative study provides evidence that combination of hamstring and calf muscle release with LASER and ultrasound therapy produces superior pain reduction and functional improvement in plantar fasciitis patients compared to modality-based therapy alone. Group A achieved 69.5% pain reduction and 67.1% functional improvement versus Group B's 47.5% pain reduction and 42.0% functional improvement.

Mean differences of 4.137 in VAS scores and 39.20 in FFI scores at Week 4 substantially exceed established minimal clinically important differences, indicating combined approach produces clinically meaningful superior outcomes. Synergistic integration of mechanical restoration through manual release, cellular energy enhancement through photobiomodulation, and tissue-level healing through ultrasound therapy addresses multiple pathological mechanisms underlying plantar fasciitis.

These findings support adoption of comprehensive multimodal treatment incorporating manual therapeutic techniques with modality-based interventions as first-line conservative management for plantar fasciitis. The 4-week treatment duration combined with substantial functional improvement suggests multimodal conservative approach effectively prevents progression to invasive interventions while rapidly restoring functional capacity and quality of life.

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