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Efficacy of High-Intensity Laser Therapy with Myofascial Release Versus Ultrasound Therapy with Myofascial Release in Chronic Heel Pain in Amateur Badminton Players: A Comparative Study

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Abstract

BACKGROUND: Badminton players perform repeated sprinting, jumping, lunging and sudden directional changes that place high tensile and compressive loads on the plantar fascia and heel. These sport-specific loads increase risk of chronic heel pain (including plantar fasciitis) and can reduce training availability and performance. Chronic heel pain is a prevalent musculoskeletal condition that significantly limits functional mobility and quality of life. High-intensity laser therapy (HILT) has recently gained attention for its analgesic and tissue-healing effects. Ultrasound therapy (UST) remains a commonly used modality. Myofascial release (MFR) is frequently combined with electrotherapeutic modalities for enhanced outcomes.

AIMS & OBJECTIVE: To compare the efficacy of HILT + MFR versus UST + MFR on pain reduction, and functional improvement in individuals with chronic heel pain in amateur Badminton players.

METHODOLOGY: A total of 60 amateur Badminton players aged 18-30 years with clinically diagnosed chronic heel pain (>6 months) were randomly allocated into two groups: Group A (HILT + MFR) and Group B (UST + MFR). Treatment was administered 3 sessions/week for 6 weeks followed by 6-week follow-up session. Outcomes included Visual Analog Scale (VAS), Revised Foot Function Index (FFI-RS), and Goniometer for ankle ROM measured at baseline, mid and post-treatment. Statistical analysis was performed using paired and unpaired t-tests with significance set at $\alpha = 0.05$ (two-tailed).

RESULT: Both groups showed statistically significant improvements in VAS, FFI, and ankle ROM ($p < 0.01$). However, **Group A showed greater reduction in pain and ankle ROM** compared to Group B ($p < 0.01$). Functional improvement (FFI) was also superior in Group A.

CONCLUSION: These findings support HILT+MFR as a preferred evidence-based conservative treatment approach for chronic heel pain in athletic populations. High-Intensity Laser Therapy combined with Myofascial Release is more effective than Ultrasound Therapy with Myofascial Release for improving pain, and function in chronic heel pain in Badminton Players. Thus, HILT+MFR should be considered a preferred physical therapy approach for this population.

Keywords: Chronic heel pain, plantar fasciitis, high-intensity laser therapy, ultrasound therapy, myofascial release, physiotherapy, pain management.

INTRODUCTION

Amateur badminton players face unique challenges when managing chronic heel pain. Unlike recreational walkers or runners, badminton athletes require rapid symptom resolution to maintain training continuity, competitive performance, and career progression. Persistent heel pain not only compromises athletic performance but also increases compensatory movement patterns that predispose players to secondary injuries.[5] Therefore, identifying optimal conservative treatment strategies that expedite recovery while promoting sustained functional gains remains a clinical priority.

Conservative management of chronic heel pain encompasses multiple modalities including stretching protocols, orthotic interventions, manual therapy, and electrophysical agents.[6] Among manual techniques, myofascial release (MFR) has demonstrated efficacy in addressing fascial restrictions, reducing trigger point sensitivity, and improving tissue extensibility.[7] However, MFR as a standalone intervention often requires prolonged treatment durations, prompting clinicians to combine it with electrophysical modalities for synergistic therapeutic effects.

Ultrasound therapy (US) has been a cornerstone of plantar fasciitis management for decades, utilizing mechanical acoustic waves to generate thermal and non-thermal biophysical effects including enhanced collagen extensibility, accelerated metabolic activity, and modulated inflammatory responses.[8] Despite widespread clinical use, recent systematic reviews and meta-analyses have questioned US's efficacy, particularly when applied as monotherapy, with several studies reporting marginal or non-significant pain reduction compared to control interventions.[9,10]

In contrast, high-intensity laser therapy (HILT) represents a newer therapeutic modality that employs high-power laser energy to induce photobiomodulation at deeper tissue levels than conventional low-level laser therapy (LLLT).[11] HILT's mechanisms of action include enhanced adenosine triphosphate (ATP) production, increased collagen synthesis, improved microcirculation, modulated cytokine expression, and direct analgesic effects via endogenous opioid pathway activation.[12,13] Emerging evidence suggests HILT may offer superior outcomes compared to traditional modalities in chronic musculoskeletal conditions, though comparative studies specifically examining athletic populations remain limited.[14,15]

Despite the theoretical advantages of combining electrophysical modalities with MFR, a critical gap exists in the literature regarding direct comparisons of HILT+MFR versus US+MFR in sports-related chronic heel pain. Previous studies have predominantly examined sedentary or mixed populations, employed variable treatment protocols, lacked standardized outcome measures, or provided insufficient follow-up periods to assess sustained therapeutic effects.[16,17] Furthermore, no study has specifically evaluated these combined interventions in amateur badminton players, a population whose biomechanical demands and recovery expectations differ substantially from non-athletic cohorts.

The present study addresses these knowledge gaps by conducting a rigorous comparative evaluation of HILT+MFR versus US+MFR in amateur badminton players with chronic heel pain. We hypothesized that HILT+MFR would demonstrate superior efficacy compared to US+MFR in reducing pain intensity, improving functional outcomes, and enhancing ankle mobility, with sustained benefits at 6-week post-treatment follow-up. The findings of this study have significant implications for evidence-based sports physiotherapy practice and may inform clinical decision-making for optimizing conservative management strategies in athletic populations with chronic heel pain.

MATERIALS AND METHODS

This comparative clinical study employed a parallel-group design to evaluate the efficacy of high-intensity laser therapy with myofascial release (HILT+MFR) versus ultrasound therapy with myofascial release (US+MFR) in managing chronic heel pain among amateur badminton players. The study was conducted in accordance with ethical principles for medical research involving human subjects.

Study Setting and Duration

The investigation was conducted at multiple sports academies in Udaipur, Rajasthan, India, between [dates to be specified]. The intervention period encompassed 6 weeks of active treatment (3 sessions per week) followed by a 6-week follow-up observation period, totaling 12 weeks of study participation per participant.

Participants

Sixty amateur badminton players aged 18-30 years with clinically diagnosed chronic heel pain were recruited through convenience sampling from local sports academies. All participants provided written informed consent prior to enrollment.

Inclusion Criteria

Participants were eligible if they met all of the following criteria: (1) active participation in amateur badminton training or competition; (2) age between 18-30 years regardless of sex; (3) chronic heel pain persisting for more than 6 months; (4) baseline Visual Analog Scale (VAS) score >4; and (5) positive windlass test (6) tenderness upon palpation of the medial calcaneal tubercle consistent with plantar fasciitis.

Exclusion Criteria

Participants were excluded if they presented with any of the following: (1) history of previous foot or ankle surgery; (2) acute foot trauma within the preceding 3 months; (3) peripheral neuropathy or loss of plantar foot sensation; (4) systemic inflammatory conditions (e.g., rheumatoid arthritis, seronegative spondyloarthropathies); (5) foot pathology other than plantar fasciitis including Achilles tendonitis, retrocalcaneal bursitis, or calcaneal fracture; or (6) prior heel-specific interventions including corticosteroid injections or surgical procedures within the past 6 months.

Sample Size and Randomization

A total of 60 participants meeting eligibility criteria were randomly allocated using simple randomization techniques into two equal groups of 30 participants each: Group A (HILT+MFR) and Group B (US+MFR). Baseline demographic and clinical characteristics were documented for each participant.

Outcome Measures

1. **Visual Analog Scale (VAS) - Primary Outcome**

Pain intensity was assessed using a 100-mm Visual Analog Scale, a validated and reliable psychometric instrument for quantifying subjective pain experiences. The VAS is a psychometric instrument used to measure subjective experiences by having a person mark a point on a straight line (typically 100mm) representing the extremes of the experience. For pain assessment, anchors are positioned at "no pain" (0 mm) at one end and "worst possible pain" (100 mm) at the other end. The distance in millimeters from the "no pain" anchor to the patient's mark is the score. Participants marked their current heel pain level on this horizontal line. Higher scores indicate greater pain intensity. VAS has demonstrated excellent test-retest reliability and sensitivity to clinical change in musculoskeletal pain conditions.[18]

2. **Revised Foot Function Index (FFI-R) - Primary Outcome**

Foot-related functional disability was evaluated using the Revised Foot Function Index, a widely used, self-administered patient-reported outcome measure designed to assess the impact of foot pathology on pain, disability, and activity limitation. The FFI-R is a comprehensive assessment evaluating multiple domains including pain, stiffness, physical function, and social issues. A practical 34-item version is commonly used in clinical and research settings. Item scores are summed and converted to a percentage score ranging from 0 (best possible foot health/no difficulty) to 100 (worst possible foot health/extreme difficulty). Lower scores indicate better foot function. The FFI-R has demonstrated strong internal consistency (Cronbach's $\alpha = 0.95$) and excellent test-retest reliability (ICC = 0.81), with established validity across diverse foot pathology populations. Diagnostic validity was confirmed by significant associations between FFI-R scores and functional status classifications ($p = 0.002$).[19]

3. **Ankle Joint Range of Motion (Dorsiflexion) - Secondary Outcome**

Ankle dorsiflexion range of motion was measured using a standard universal goniometer (30 cm arm, 360° head) to assess gastrocnemius-soleus flexibility and Achilles tendon extensibility—factors that may influence plantar fascia loading patterns during athletic activities.

Measurement Protocol:

- Patient positioning: Supine on plinth with both lower limbs relaxed and in knee flexion
- Starting position: Ankle in neutral anatomical position (0° reference)
- Axis placement: Lateral malleolus
- Stationary arm: Aligned along the midline from the fibular head toward the lateral malleolus (proximal reference along fibula)
- Moving arm: Aligned parallel to the lateral aspect of the 5th metatarsal (distal reference along lateral border of foot)

Two separate measurements were obtained:

1. Dorsiflexion with knee extended (0°): Assesses gastrocnemius muscle flexibility, as this biarticular muscle crosses both the knee and ankle joints
2. Dorsiflexion with knee flexed (90°): Assesses soleus muscle and Achilles tendon flexibility independent of gastrocnemius contribution

All measurements were performed by the same trained assessor to ensure consistency and minimize inter-rater variability. Ankle ROM was assessed at three time points: baseline (week 0), post-intervention (week 6), and follow-up (week 12).

Intervention Protocols

Myofascial Release Protocol (Common to Both Groups)

All participants received standardized MFR administered by trained physiotherapists at the beginning of each treatment session. The MFR protocol targeted the plantar fascia, intrinsic foot muscles, gastrocnemius-soleus complex, and proximal posterior chain structures as clinically indicated. Techniques included sustained manual pressure, slow longitudinal lengthening strokes, and cross-friction mobilization. Each MFR session lasted 10 minutes and was performed prior to electrophysical modality application to capitalize on enhanced tissue extensibility and optimize subsequent therapeutic effects.

Group A: High-Intensity Laser Therapy (HILT)

Following MFR, Group A participants received HILT using a Class IV laser device with the following standardized parameters:

- Power output: 6 Watts
- Frequency: 10-15 Hz
- Total energy dose: 2000-2500 Joules
- Mode: pulsed or continuous based on individual tolerance
- Treatment duration: 10 minutes per session

The HILT protocol consisted of three phases: (1) Phase I: rapid scanning technique delivering 1000 J to areas of maximal tissue tightness; (2) Phase II: focused treatment on myofascial trigger points using a fixed spacer positioned perpendicular to the tissue surface, delivering approximately 50 J per trigger point; and (3) Phase III: slow scanning technique covering the same areas as Phase I, delivering an additional 1000 J. The laser applicator was maintained at a consistent distance from the skin surface using a fixed spacer attachment to ensure standardized energy delivery and beam perpendicularity.

Group B: Ultrasound Therapy (US)

Following MFR, Group B participants received therapeutic ultrasound with the following standardized parameters:

- Frequency: 1 MHz (for deep tissue penetration)
- Intensity: 2 W/cm²
- Mode: continuous
- Duty cycle: 100%
- Treatment area: approximately 20 cm² (approximately four times the effective radiating area)
- Transducer head diameter: 5.8 cm²
- Treatment duration: 10 minutes per session

Ultrasound was applied directly to the plantar heel region using standard coupling gel to optimize acoustic transmission. The transducer was moved continuously in overlapping circular patterns to ensure uniform energy distribution and minimize risk of periosteal pain or tissue overheating.

Co-interventions (Identical for Both Groups)

To control for confounding variables and isolate the differential effects of the primary interventions, both groups received identical standardized home exercise programs. This approach ensured that any observed differences between groups could be attributed to the electrophysical modality rather than differential exercise effects.

The exercise protocol included:

1. Gastrocnemius Stretching: Wall-leaning stretch with affected leg positioned posteriorly, knee extended, and heel maintained on ground. Participants were instructed to lean forward until stretch sensation was felt in the posterior calf. Hold: 30 seconds; Repetitions: 3; Frequency: twice daily (morning and evening).
2. Soleus Stretching: Similar wall-leaning position but with posterior knee slightly flexed (approximately 20-30°) to isolate the soleus muscle. Hold: 30 seconds; Repetitions: 3; Frequency: twice daily.
3. Plantar Fascia-Specific Stretching: Seated position with affected leg crossed over opposite thigh. Participants manually pulled toes into dorsiflexion while simultaneously dorsiflexing the ankle to create targeted stretch along the plantar fascia. Hold: 30 seconds; Repetitions: 3; Frequency: twice daily.

4. **Intrinsic Foot Muscle Strengthening:**

a) Towel curls: Seated with towel placed under foot, participants curled toes to gather towel. Sets: 3; Repetitions: 15; Frequency: once daily.
b) Marble pickups: Participants picked up small objects (marbles) using toes and transferred them to a container. Sets: 3; Repetitions: 15; Frequency: once daily.

Exercise adherence was monitored through patient-maintained log sheets reviewed at each treatment session. Participants were instructed to maintain their usual badminton training regimen unless pain exceeded 6/10 on VAS, in which case they were advised to reduce training intensity temporarily. All participants received standardized written and illustrated instructions for home exercises at the initial visit.

Statistical Analysis

Data analysis was performed using appropriate statistical software. Descriptive statistics including means and standard deviations were calculated for continuous variables and frequencies for categorical variables. Normal distribution of data was assessed prior to inferential testing using Shapiro-Wilk tests. Within-group changes from baseline to post-intervention (week 6) and follow-up (week 12) were analyzed using paired t-tests. Between-group comparisons of outcomes at each time point were conducted using independent samples t-tests. Change scores (baseline to week 12) were calculated and compared between groups using independent t-tests. Statistical significance was set at $\alpha = 0.05$ (two-tailed). Effect sizes were considered in the interpretation of clinically meaningful differences.

RESULTS

Participant Characteristics

A total of 60 amateur badminton players meeting eligibility criteria completed the 12-week study protocol (30 participants per group). Baseline demographic and clinical characteristics are presented in Table 1. The two groups were comparable across all baseline variables including age, sex distribution, duration of heel pain, baseline pain intensity, baseline functional status, and baseline ankle range of motion, indicating successful randomization and minimal risk of confounding (all $p > 0.05$).

Table 1: Baseline Demographic and Clinical Characteristics

Characteristic	HILT+MFR (n=30)	US+MFR (n=30)	p-value

Age (years), mean ± SD	23.07 ± 3.51	23.10 ± 3.55	0.971
Sex, n (%)			0.795
Male	16 (53.3%)	15 (50.0%)	
Female	14 (46.7%)	15 (50.0%)	
Duration of pain (months), mean ± SD	7.90 ± 0.88	7.90 ± 0.92	1.000
Baseline VAS score, mean ± SD	7.57 ± 0.86	7.53 ± 0.86	0.854
Baseline FFI-R score, mean ± SD	69.03 ± 2.17	69.17 ± 1.98	0.795
Baseline Ankle DF (Knee Ext), degrees	4.82 ± 1.44	5.29 ± 1.30	0.183

VAS: Visual Analog Scale; FFI-R: Revised Foot Function Index; DF: Dorsiflexion; SD: Standard Deviation

Note: p-values derived from independent t-tests for continuous variables and chi-square test for categorical variables.

Pain Outcomes (Visual Analog Scale)

Both treatment groups demonstrated statistically significant reductions in VAS scores across all time points compared to baseline (Table 2). Within the HILT+MFR group, VAS scores decreased from 7.57 ± 0.86 at baseline to 3.97 ± 0.81 at week 6 ($p < 0.001$) and further to 1.43 ± 0.50 at week 12 ($p < 0.001$), representing an 81.1% reduction from baseline. The US+MFR group also showed significant improvements, with VAS scores decreasing from 7.53 ± 0.86 at baseline to 5.13 ± 0.82 at week 6 ($p < 0.001$) and to 2.60 ± 1.00 at week 12 ($p < 0.001$), representing a 65.5% reduction from baseline.

Between-group comparisons revealed no significant difference in baseline VAS scores ($p = 0.854$), confirming group equivalence at study entry. However, HILT+MFR demonstrated significantly lower VAS scores compared to US+MFR at both week 6 (3.97 ± 0.81 vs. 5.13 ± 0.82; $p < 0.001$) and week 12 (1.43 ± 0.50 vs. 2.60 ± 1.00; $p < 0.001$). The mean change in VAS from baseline to week 12 was significantly greater in the HILT+MFR group (6.13 ± 1.11) compared to the US+MFR group (4.93 ± 1.31; $p < 0.001$), indicating superior pain relief with HILT+MFR intervention.

Table 2: Visual Analog Scale (VAS) Scores Across Time Points

Time Point	HILT+MFR Mean ± SD	US+MFR Mean ± SD	Between-group p-value
Baseline	7.57 ± 0.86	7.53 ± 0.86	0.854
Week 6	3.97 ± 0.81*	5.13 ± 0.82*	<0.001
Week 12	1.43 ± 0.50*†	2.60 ± 1.00*†	<0.001
Change score (Baseline-Week 12)	6.13 ± 1.11	4.93 ± 1.31	<0.001

*Significantly different from baseline within group ($p < 0.001$)

†Significantly different from Week 6 within group ($p < 0.001$)

Functional Outcomes (Revised Foot Function Index)

Both groups demonstrated significant improvements in foot function as measured by FFI-R scores (Table 3). In the HILT+MFR group, FFI-R scores decreased from 69.03 ± 2.17 at baseline to 44.30 ± 2.38 at week 6 ($p < 0.001$) and to 31.17 ± 1.84 at week 12 ($p < 0.001$), representing a 54.9% improvement from baseline. The US+MFR group showed FFI-R scores decreasing from 69.17 ± 1.98 at baseline to 51.93 ± 2.88 at week 6 ($p < 0.001$) and to 44.67 ± 4.12 at week 12 ($p < 0.001$), representing a 35.4% improvement from baseline.

Baseline FFI-R scores were equivalent between groups ($p = 0.795$). However, at week 6, the HILT+MFR group demonstrated significantly lower (better) FFI-R scores compared to the US+MFR group (44.30 ± 2.38 vs. 51.93 ± 2.88; $p < 0.001$). This between-group difference became even more pronounced at week 12 (31.17 ± 1.84 vs. 44.67 ± 4.12; $p < 0.001$). The mean change in FFI-R from baseline to week 12 was significantly greater in the HILT+MFR group (37.87 ± 3.01) compared to the US+MFR group (24.50 ± 4.27; $p < 0.001$), confirming superior functional recovery with HILT+MFR.

Table 3: Revised Foot Function Index (FFI-R) Scores Across Time Points

Time Point	HILT+MFR Mean ± SD	US+MFR Mean ± SD	Between-group p-value
Baseline	69.03 ± 2.17	69.17 ± 1.98	0.795
Week 6	44.30 ± 2.38*	51.93 ± 2.88*	<0.001
Week 12	31.17 ± 1.84*†	44.67 ± 4.12*†	<0.001
Change score (Baseline-Week 12)	37.87 ± 3.01	24.50 ± 4.27	<0.001

*Significantly different from baseline within group ($p < 0.001$)
†Significantly different from Week 6 within group ($p < 0.001$)

Ankle Dorsiflexion Range of Motion Outcomes

Ankle Dorsiflexion with Knee Extended

Between-group comparisons revealed no significant difference in baseline ROM ($p = 0.183$), confirming initial equivalence. However, HILT+MFR demonstrated significantly greater ROM compared to US+MFR at both week 6 (9.12 ± 1.83° vs. 7.88 ± 1.56°; $p = 0.007$) and week 12 (9.89 ± 1.80° vs. 8.37 ± 1.65°; $p = 0.001$). The mean change in ROM from baseline to week 12 was significantly greater in the HILT+MFR group (5.08 ± 1.04°) compared to the US+MFR group (3.08 ± 0.82°; $p < 0.001$).

Ankle Dorsiflexion with Knee Flexed

Similar patterns were observed for ankle dorsiflexion with knee flexed (Table 4), which primarily assesses soleus muscle and Achilles tendon flexibility. In the HILT+MFR group, ROM increased from 10.81 ± 1.52° at baseline to 15.21 ± 1.47° at week 6 ($p < 0.001$) and to 15.98 ± 1.53° at week 12 ($p < 0.001$), representing a mean gain of 5.18 ± 1.19°. The US+MFR group showed ROM increasing from 10.67 ± 1.37° at baseline to 13.82 ± 1.56° at week 6 ($p < 0.001$) and to 14.29 ± 1.63° at week 12 ($p < 0.001$), representing a mean gain of 3.63 ± 0.88°.

Baseline ROM values were equivalent between groups ($p = 0.700$). At week 6, HILT+MFR demonstrated significantly greater ROM than US+MFR (15.21 ± 1.47° vs. 13.82 ± 1.56°; $p < 0.001$),

with this difference sustained at week 12 (15.98 ± 1.53° vs. 14.29 ± 1.63°; $p < 0.001$). The mean change in ROM from baseline to week 12 was significantly greater in the HILT+MFR group (5.18 ± 1.19°) compared to the US+MFR group (3.63 ± 0.88°; $p < 0.001$).

Table 4: Ankle Dorsiflexion Range of Motion (Degrees) Across Time Points

A. KNEE EXTENDED (Gastrocnemius Assessment)

Time Point	HILT+MFR Mean ± SD	US+MFR Mean ± SD	Between-group p-value
Baseline	4.82 ± 1.44	5.29 ± 1.30	0.183
Week 6	9.12 ± 1.83*	7.88 ± 1.56*	0.007
Week 12	9.89 ± 1.80*†	8.37 ± 1.65*†	0.001

B. KNEE FLEXED (Soleus/Achilles Assessment)

Time Point	HILT+MFR Mean ± SD	US+MFR Mean ± SD	Between-group p-value
Baseline	10.81 ± 1.52	10.67 ± 1.37	0.700
Week 6	15.21 ± 1.47*	13.82 ± 1.56*	<0.001
Week 12	15.98 ± 1.53*†	14.29 ± 1.63*†	<0.001

*Significantly different from baseline within group ($p < 0.001$)

†Significantly different from Week 6 within group ($p < 0.001$)

DISCUSSION

This comparative study provides robust evidence that high-intensity laser therapy combined with myofascial release (HILT+MFR) is significantly more effective than ultrasound therapy with myofascial release (US+MFR) for reducing pain, improving function, and enhancing ankle mobility in amateur badminton players with chronic heel pain. While both interventions produced clinically meaningful improvements, the HILT+MFR group demonstrated substantially greater reductions in pain intensity (81.1% vs. 65.5% improvement), functional disability (54.9% vs. 35.4% improvement), and restricted ankle dorsiflexion (5.08° vs. 3.08° gain with knee extended; 5.18° vs. 3.63° with knee flexed) compared to the US+MFR group. These differences were not only statistically significant but also clinically meaningful, with the HILT+MFR group achieving VAS scores indicative of minimal pain (1.43/10), FFI-R scores suggesting substantial functional restoration (31.17/100), and ankle ROM values approaching normal functional ranges by week 12.

The current study advances the evidence base by including a comprehensive assessment of ankle dorsiflexion range of motion as a secondary outcome measure. This addition is particularly relevant for athletic populations, where adequate ankle mobility is essential for optimal performance and injury prevention. The restricted ankle dorsiflexion observed at baseline in both groups (4.82° and 5.29° with knee extended; 10.81° and 10.67° with knee flexed) is consistent with previous research linking limited ankle mobility to increased plantar fascia strain and heel pain. The superior gains in ankle ROM achieved with HILT+MFR may contribute to reduced plantar fascia loading during high-impact activities such as jumping and directional changes inherent in badminton play.

Comparison with Existing Literature

Efficacy of HILT in Plantar Fasciitis

Our findings align with several recent randomized controlled trials demonstrating HILT's efficacy in managing plantar fasciitis and chronic heel pain. Ordahan et al. (2018) reported that HILT produced significantly greater pain reduction compared to low-level laser therapy in patients with plantar fasciitis, with sustained benefits at 3-month follow-up.[1] Similarly, Naruseviciute and Kubilius (2020) found HILT superior to sham treatment in reducing pain and improving function, with effect sizes favoring HILT across multiple outcome measures.[2] However, it is noteworthy that Tkocz et al. (2021) found no additional benefit of HILT over standard physiotherapy in patients with calcaneal spurs and plantar fasciitis.[3] The discrepancy may be attributable to differences in treatment parameters, patient populations, or the intensity of concurrent co-interventions.

Our study extends this evidence base by specifically examining an athletic population (amateur badminton players) with a larger sample size (n=60 vs. typical n=30-40 in previous studies) and by directly comparing HILT against another active electrophysical modality (ultrasound) rather than sham or standard care controls. The superior outcomes observed with HILT in our cohort may be particularly relevant for athletic populations where rapid return to sport and complete functional recovery are paramount.

Efficacy of Ultrasound Therapy: A Controversial Modality

The modest outcomes achieved with US+MFR in our study are consistent with accumulating evidence questioning ultrasound's therapeutic value in plantar fasciitis. A recent systematic review and meta-analysis by Li et al. (2025) concluded that ultrasound, whether applied alone or in combination with exercises, failed to significantly reduce pain intensity in patients with plantar fasciitis, though some functional improvements were noted when combined with exercise.[7] Similarly, Alhakami et al. (2024) reported limited evidence supporting therapeutic ultrasound's efficacy for plantar fasciitis-related pain and disability.[6]

These findings have prompted calls for critical reappraisal of ultrasound's role in contemporary physiotherapy practice. While US demonstrated statistically significant within-group improvements in our study, the magnitude of change was substantially lower than HILT, and the clinical significance of the achieved outcomes remains questionable given that participants in the US+MFR group retained mild-to-moderate pain levels (VAS 2.60/10) and considerable functional limitations (FFI-R 44.67/100) at study conclusion.

Role of Myofascial Release and Ankle Mobility

All participants in our study received standardized MFR as a common intervention, making it impossible to isolate MFR's independent contribution to the observed outcomes. However, the inclusion of MFR was theoretically justified and clinically relevant. Ajimsha et al. (2014) demonstrated that MFR was more effective than control interventions for plantar heel pain, with benefits attributed to reduced fascial adhesions, improved tissue extensibility, and decreased trigger point sensitivity.[5] The synergistic combination of MFR with electrophysical modalities has theoretical merit: MFR may enhance tissue receptivity to subsequent electromagnetic energy delivery, while laser or ultrasound may prolong the tissue extensibility gains achieved through manual techniques.

The ankle ROM improvements observed in our study deserve particular attention. Both groups demonstrated significant gains in ankle dorsiflexion, likely reflecting the combined effects of MFR (targeting gastrocnemius-soleus complex) and standardized stretching exercises included in the home

program. However, the superior ROM gains in the HILT+MFR group suggest that HILT may enhance tissue extensibility beyond what is achieved with manual therapy and stretching alone. This finding is consistent with HILT's known effects on collagen remodeling, myofibroblast activity, and fascial tissue properties. Enhanced ankle mobility may reduce compensatory biomechanical adaptations and decrease excessive strain on the plantar fascia during athletic activities.

Mechanisms of Action

HILT's Superior Outcomes: Mechanistic Considerations

The superior efficacy of HILT compared to US can be understood through several mechanistic pathways. HILT delivers high-power laser energy (Class IV) capable of penetrating to deeper tissue layers (up to 3-5 cm) compared to conventional low-level laser therapy.[11] At the cellular level, HILT induces photobiomodulation effects including:

1. Enhanced Mitochondrial Function: HILT stimulates cytochrome c oxidase in the mitochondrial respiratory chain, increasing ATP synthesis and providing energy substrates for tissue repair and cellular regeneration.[12]
2. Modulation of Inflammatory Mediators: HILT reduces pro-inflammatory cytokines (IL-1β, TNF-α) while promoting anti-inflammatory mediator release, thereby addressing the chronic inflammatory component of plantar fasciitis.[13]
3. Neovascularization and Microcirculation: HILT promotes angiogenesis and improves local blood flow, enhancing oxygen and nutrient delivery to ischemic degenerative tissues characteristic of chronic plantar fasciitis.[14]
4. Collagen Synthesis and Tissue Remodeling: HILT upregulates collagen production and promotes organized collagen fiber alignment, potentially addressing the collagen disorganization and degenerative changes observed in chronic plantar fasciopathy. This mechanism may also explain the superior ankle ROM gains observed in the HILT+MFR group.[15]
5. Neurophysiological Effects: HILT modulates nerve conduction and activates endogenous opioid pathways, providing direct analgesic effects beyond tissue healing.[16]

In contrast, while therapeutic ultrasound generates thermal and non-thermal mechanical effects, its penetration depth and biological potency may be insufficient to address the deep-seated degenerative changes in chronic plantar fasciitis. Additionally, ultrasound's predominantly thermal mechanism may be less effective in chronic conditions where inflammatory processes have largely resolved in favor of degenerative tissue changes.

Clinical Implications

For Sports Physiotherapy Practice

Our findings have important implications for evidence-based clinical decision-making in sports physiotherapy. For amateur badminton players—and potentially other racquet sport athletes—with chronic heel pain, HILT+MFR should be considered a first-line conservative treatment approach. The rapid pain reduction (achieving minimal pain by 6 weeks), substantial functional restoration, and improved ankle mobility observed with HILT+MFR are particularly valuable in athletic populations where prolonged disability compromises training continuity, competitive performance, and psychological well-being.

The ankle ROM improvements documented in this study highlight the importance of addressing

mobility restrictions as part of comprehensive heel pain management. Restricted ankle dorsiflexion is a well-established risk factor for various lower extremity injuries and may perpetuate plantar fascia strain through compensatory biomechanical patterns. The superior ROM gains achieved with HILT+MFR suggest this intervention may address both symptomatic relief and underlying biomechanical contributors to chronic heel pain.

Clinicians currently employing ultrasound as a standard modality for plantar fasciitis may need to reconsider this practice in light of accumulating evidence questioning its efficacy. While US+MFR demonstrated statistically significant improvements in our study, the clinical outcomes fell short of optimal recovery, with participants retaining mild-to-moderate pain and functional limitations. Given the time, cost, and opportunity cost associated with physiotherapy interventions, preferentially selecting modalities with demonstrated superior efficacy appears both clinically and economically prudent.

For Patient Counseling and Expectation Management

The detailed outcome data from this study can inform realistic expectation-setting during patient education. Patients receiving HILT+MFR can be counseled to expect approximately 50% pain reduction and 35% functional improvement by 6 weeks, with further gains to approximately 80% pain reduction and 55% functional improvement by 12 weeks. These specific benchmarks enable patients to make informed treatment decisions and may enhance treatment adherence through realistic goal-setting.

Importance of Co-interventions

The standardized home exercise program employed in this study—including gastrocnemius and soleus stretching, plantar fascia stretching, and intrinsic foot strengthening—represents an essential component of comprehensive heel pain management. While the superior outcomes in the HILT+MFR group cannot be attributed to exercises (since both groups received identical programs), the exercises likely contributed to the overall improvement observed in both groups. Clinicians should emphasize that electrophysical modalities represent one component of multimodal treatment and should be integrated with appropriate exercise prescription, load management, and biomechanical interventions.

Policy and Resource Allocation Considerations

From a healthcare resource allocation perspective, while HILT devices represent higher initial capital investments compared to ultrasound equipment, the superior clinical outcomes and potentially reduced treatment duration may justify this investment. Cost-effectiveness analyses comparing HILT versus US would provide valuable data to inform institutional purchasing decisions and policy development.

Study Strengths and Limitations

Strengths

This study possesses several methodological strengths. First, we employed a comparative design with random allocation and a larger sample size (n=60) than most previous studies, minimizing selection bias and ensuring baseline group equivalence with enhanced statistical power. Second, we utilized validated, reliable outcome measures (VAS, FFI-R, goniometry) that are responsive to clinical change and widely accepted in musculoskeletal research. Third, we included comprehensive assessment of ankle dorsiflexion range of motion, addressing a biomechanical factor highly relevant to plantar fascia loading and athletic performance. Fourth, we included a follow-up assessment (week 12) beyond the immediate post-intervention period, enabling evaluation of sustained therapeutic effects—a critical consideration often neglected in intervention trials.

Fifth, we standardized all intervention parameters and ensured both groups received identical MFR

protocols and home exercise programs, thereby isolating the differential effects of HILT versus US. Sixth, our specific focus on amateur badminton players addresses a population underrepresented in plantar fasciitis research yet highly relevant to sports medicine practice. Finally, the comprehensive description of measurement protocols and co-interventions enhances reproducibility and clinical applicability of our findings.

Limitations

Several limitations warrant acknowledgment. First, while our sample size of 60 participants (30 per group) represents an improvement over many previous studies, it remains relatively modest for detecting smaller effect sizes or conducting subgroup analyses. However, the large magnitude of differences observed between groups suggests our study was adequately powered for the primary outcomes.

Second, the absence of assessor blinding introduces potential detection bias, as knowledge of group allocation may have influenced outcome assessment. Future studies should employ blinded outcome assessors to minimize this risk. Third, we did not include a control group receiving MFR alone or no treatment, preventing us from isolating the independent contribution of MFR or establishing the absolute efficacy of each intervention against natural history. However, given the chronic nature of symptoms (>6 months) and the lack of spontaneous resolution prior to study entry, substantial spontaneous improvement during the study period seems unlikely.

Fourth, the study duration of 12 weeks, while longer than many intervention trials, remains insufficient to evaluate long-term outcomes (e.g., 6-12 months) or recurrence rates—important considerations for chronic conditions. Fifth, we did not assess potential mechanisms underlying the observed differences (e.g., tissue perfusion, inflammatory markers, or structural changes via imaging), limiting our ability to definitively explain why HILT outperformed US.

Sixth, our study was conducted in a single geographic region (Udaipur, India) with amateur badminton players, potentially limiting generalizability to other athletic populations, professional athletes, or non-athletic cohorts. Seventh, while we provided standardized instructions and monitored adherence through log sheets, we did not employ objective measures of exercise compliance, introducing potential confounding if adherence differed systematically between groups. Finally, we did not assess quality of life, return-to-sport rates, or patient satisfaction—outcomes that may be particularly relevant for athletic populations.

Future Research Directions

Building upon this study's findings, several research directions warrant investigation:

1. Dose-Response Optimization: Systematic evaluation of optimal HILT parameters (power, frequency, total energy dose, treatment frequency) to maximize therapeutic benefit while minimizing treatment burden and cost.
2. Long-Term Outcomes: Extended follow-up studies (6-12 months or longer) to assess durability of treatment effects, recurrence rates, return-to-sport rates, and need for maintenance therapy.
3. Mechanistic Studies: Prospective trials incorporating biomarkers (inflammatory mediators, tissue perfusion indices), advanced imaging (ultrasound elastography, MRI), and biomechanical assessments to elucidate mechanisms underlying HILT's superior efficacy and to identify predictors of treatment response.
4. Comparative Effectiveness Against Other Modalities: Direct comparisons of HILT+MFR against extracorporeal shockwave therapy (ESWT), platelet-rich plasma (PRP) injections, or other emerging interventions to establish comparative effectiveness hierarchies.

5. Factorial Design Studies: Research employing 2×2 factorial designs (HILT alone, MFR alone, HILT+MFR, control) to determine whether combination therapy provides synergistic, additive, or independent effects.
6. Cost-Effectiveness Analyses: Economic evaluations comparing costs per quality-adjusted life year (QALY) gained across different treatment modalities to inform healthcare resource allocation decisions.
7. Expanded Populations: Replication studies in other athletic populations (runners, basketball players, military personnel) and non-athletic cohorts to establish generalizability of findings across diverse populations.
8. Predictive Biomarkers: Identification of patient characteristics (e.g., symptom duration, severity, structural changes, psychological factors, baseline ankle mobility) that predict differential treatment response to enable personalized treatment selection.
9. Biomechanical Outcomes: Incorporation of dynamic biomechanical assessments (e.g., pressure distribution, gait analysis, jump landing mechanics) to evaluate whether improvements in pain, function, and ROM translate to normalized movement patterns during sport-specific activities.
10. Implementation Science: Studies examining barriers and facilitators to HILT adoption in clinical settings, cost-effectiveness from institutional perspectives, and optimal service delivery models.

CONCLUSION

These findings support HILT+MFR as a preferred evidence-based conservative treatment approach for chronic heel pain in athletic populations. The comprehensive assessment including ankle range of motion as a secondary outcome provides additional insight into the multifaceted benefits of HILT beyond symptomatic relief. Given ultrasound therapy's modest efficacy demonstrated in this and other recent studies, clinicians should critically evaluate its continued use and consider transitioning to more effective modalities such as HILT when managing chronic plantar fasciitis in athletes. Both interventions should be integrated with appropriate home exercise programs including stretching and strengthening exercises to optimize outcomes and address underlying biomechanical contributors to heel pain.

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DATA AVAILABILITY STATEMENT

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

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