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Comparison of extracorporeal shock wave therapy and high-intensity laser therapy in the treatment of calcaneal spur-related symptoms: clinical outcomes and functional improvement

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Abstract

Objective This study aimed to evaluate the effectiveness of extracorporeal shock wave therapy (ESWT) and high-intensity laser therapy (HILT) in managing calcaneal spur-related symptoms. These non-invasive modalities were compared in terms of their ability to reduce pain and improve functional outcomes.

Methods In this randomized clinical trial, patients diagnosed with calcaneal spur based on clinical and radiographic findings were randomly assigned to receive ESWT or HILT. Participants were randomized into two groups to receive either ESWT or HILT, complemented by standardized exercise regimens. Pain intensity was measured using the Visual Analog Scale (VAS), and functional outcomes were assessed with the Foot Function Index (FFI) at baseline, post-treatment, and three months post-treatment.

Results Both groups showed significant improvements in pain and functional outcomes. In the ESWT group, VAS scores for initial step pain decreased from 7.8 ± 1.0 to 4.0 ± 1.0 post-treatment and further to 3.4 ± 1.0 at three months ($p = 0.002$). The HILT group demonstrated a similar trend, with scores reducing from 7.5 ± 1.2 to 4.2 ± 1.1 post-treatment and 3.5 ± 0.9 at follow-up ($p = 0.001$). Total FFI scores improved significantly in both groups, with the ESWT group showing a larger reduction (58.8 to 19.7; $p = 0.033$) compared to the HILT group (57.4 to 35.4; $p = 0.046$). No significant adverse events were reported in either group.

Conclusion ESWT and HILT are effective non-invasive options for treating calcaneal spur with ESWT providing slightly greater functional benefits.

Clinical trial registration Not applicable

Keywords Calcaneal spur, Extracorporeal shock wave therapy (ESWT), High-intensity laser therapy (HILT), Pain management

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Introduction

Calcaneal spur (CS), a prevalent cause of localized heel pain, can significantly impact daily activities by causing discomfort and functional limitations [1]. Symptoms typically include heel pain, especially during walking or after prolonged periods of inactivity, such as getting out of bed in the morning. While CS can affect individuals of any age, it is most commonly symptomatic in overweight elderly women, with an estimated prevalence of 15–20% in the general population [2, 3]. Diagnosis is based on a thorough medical history, clinical examination, and imaging studies. Tenderness and pain are often elicited upon palpation of the medial tubercle of the calcaneus, and plain radiographs play a crucial role in identifying the characteristic anatomical changes associated with CS.

Conservative treatments, including physical therapy modalities, have shown varying degrees of success. The emergence of extracorporeal shock wave therapy (ESWT) and high-intensity laser therapy (HILT) as non-invasive alternatives has brought renewed interest in treating these conditions [4, 5]. ESWT utilizes focused pressure waves to enhance tissue regeneration and relieve pain, while HILT employs photobiostimulation to reduce inflammation and promote healin [6, 7]. Despite promising outcomes reported in separate studies, head-to-head comparisons of these modalities remain sparse. Although extracorporeal shock wave therapy (ESWT) has been widely adopted in managing plantar fasciopathy, studies comparing it to alternative non-invasive or minimally invasive modalities remain relevant. In a randomized controlled trial, Rompe et al. found plantar fascia-specific stretching to be more effective than low-energy radial ESWT in acute cases [8].

The primary goal of this study is to address this gap by evaluating and comparing the efficacy of ESWT and HILT in improving pain and functional outcomes in patients with calcaneal spur. The secondary aim is to analyze any potential correlations between treatment adherence and patient-reported outcomes to provide clinicians with evidence-based recommendations for optimal care strategies.

Materials and methods

Study design and participants

This study was designed as a prospective randomized clinical trial. A total of 62 patients diagnosed with calcaneal spur based on clinical examination and radiographic confirmation were enrolled. Participants were required to have plantar fasciopathy symptoms lasting for at least 6 weeks to be eligible for inclusion, to avoid enrolling cases of spontaneously resolving acute heel pain. Inclusion criteria included individuals aged 18–70 years with heel pain persisting for at least four weeks. Only patients with unilateral plantar fasciopathy symptoms were included in the study. Patients with bilateral involvement were excluded to maintain homogeneity. Exclusion criteria encompassed recent treatment interventions, systemic inflammatory conditions, and contraindications to physical therapy modalities such as active infections, malignancy, or uncontrolled metabolic disorders [9].

All patients were informed about the aim of the study and their consent was obtained. Informed consent was written from all patient. The study was conducted in accordance with the Declaration of Helsinki principles, and ethics committee approval (Decision no: 1083, Date: November 28, 2024) was obtained.

Interventions

Participants were randomized into two groups using a computer-generated allocation system:

The first group received Extracorporeal Shock Wave Therapy (ESWT) using a radial-type shock wave device (Masterplus MP200 Elite– Storz Medical AG, Kreuzlingen, Switzerland). Treatment parameters were set to a frequency of 12–15 Hz, 2–3 bar pressure, and 2,500 pulses per session. Therapy was administered every three days, for a total of five sessions over three weeks.Treatment targeted the medial calcaneal area and the most painful points identified through palpation [10].

The second group received High-Intensity Laser Therapy (HILT) using a BTL-6000® device (UK). Two modes were applied: 10 W / 12 J/cm² (analgesic dose) for 2 min,

and 7 W / 120 J/cm² (biostimulation dose) for 7 min and 8 s.

Treatment was applied five times per week, for a total of 10 sessions over two weeks. To ensure safety, both the patient and the therapist wore protective goggles during HILT application [4].

Both the patient and the therapist wore protective goggles during HILT application to protect their eyes from laser exposure. All physical therapy procedures were performed by the same physiotherapist to maintain consistency.

Outcome measures

Pain intensity was assessed using the Visual Analog Scale (VAS), while functional outcomes were evaluated through the Foot Function Index (FFI). Measurements were recorded at baseline, immediately post-treatment, and at three-month follow-up. Secondary measures included compliance rates, adverse event frequency, and patient-reported satisfaction scores. Additionally, subanalyses were performed to determine the effects of baseline demographic variables (e.g., BMI, age, and symptom duration) on treatment efficacy [11].

Table 1 Demographic characteristics of study participants

Variable	Group 1 ($n=45$)	Group 2 ($n=45$)	*p*-value
Age	48.77 ± 9.64 52 (20–63)	47.33 ± 7.87 50 (21–59)	0.366§
BMI	28.98 ± 5.23 27.7 (21.6–48.1)	29.56 ± 4.17 29.4 (21–41.1)	0.605§
Duration of pain	7.81 ± 2.32 8 (6–12) weeks	8.16 ± 2.61 9 (6–12) weeks	0.657µ
Sex	Female: 30 (66.7%) Male: 15 (33.3%)	Female: 23 (51.1%) Male: 22 (48.9%)	0.198
Occupation	Unemployed: 12 (26.7%) Worker: 18 (40.0%) Other: 15 (33.3%)	Unemployed: 15 (33.3%) Worker: 20 (44.4%) Other: 10 (22.2%)	0.125
Education	No: 11 (24.4%) Primary: 15 (33.3%) High School: 14 (31.1%) University: 5 (11.1%)	No: 8 (17.8%) Primary: 25 (55.6%) High School: 9 (20%) University: 3 (6.7%)	0.207
Symptom duration (weeks)	7.81 ± 2.32 8 (6–12) weeks	8.16 ± 2.61 9 (6–12) weeks	0.657µ

Independent t-test was used for group comparisons of Age (Mean ± SD) and BMI (Mean ± SD), Mann-Whitney U test for Duration of pain and Symptom duration (weeks), and chi-square test for distributions of sex, occupation, and education. In the table, symbols indicate the statistical test used: **§** represents results from the independent t-test, and **µ** denotes results from the Mann-Whitney U test

Table 2 ROM comparison for Pre- and Post-treatment

Group	ROM	Pre-treatment	Post-treatment	*p*-value
Group 1	Flexion	169.56 ± 18.82 (100–180)	176.22 ± 8.06 (150–180)	0.001♈
	Abduction	168.22 ± 21.88 (90–180)	174.56 ± 11.96 (120–180)	0.001♈
	Internal rotation	83.78 ± 12.30 (40–90)	87.67 ± 6.87 (50–90)	0.007♈
	External rotation	72.33 ± 21.34 (10–90)	78.78 ± 18.56 (20–90)	< 0.001♈
Group 2	Flexion	162.67 ± 20.38 (100–180)	176.11 ± 12.10 (110–180)	< 0.001♈
	Abduction	158.89 ± 25.69 (90–180)	174.56 ± 18.02 (80–180)	< 0.001♈
	Internal rotation	75.78 ± 18.40 (30–90)	87.56 ± 6.10 (60–90)	< 0.001♈
	External rotation	66.11 ± 20.22 (10–90)	81.22 ± 11.78 (50–90)	< 0.001♈

♈: Wilcoxon test was used for comparing pre- and post-treatment range of motion (ROM) within each group

Statistic

Statistical analyses of this study were performed using SPSS v.25.0 software for Windows (IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed with the Kolmogorov-Smirnov and Shapiro-Wilk tests. Descriptive statistics are presented as mean ± standard deviation and as n (%) for categorical data. For comparisons between the groups, the independent t-test was used for normally distributed data, while the Wilcoxon test was used to evaluate non-parametric paired data, specifically for pre- and post-treatment comparisons within groups. Chi-square tests were applied to assess categorical data between the groups. All statistical comparisons were conducted as two-tailed tests, with a *p*-value below 0.05 considered statistically significant.

Results

This study aimed to compare the effectiveness of two different treatment methods for patients suffering from specific conditions. The demographic characteristics were similar between Group 1 and Group 2, with no statistically significant differences observed in age, BMI, pain duration, sex, occupation, or education levels (Table 1; $p > 0.05$ for all variables). Symptom duration was also comparable between the groups.

Range of motion (ROM) analysis showed significant improvements in both groups from pre-treatment to post-treatment and further enhancements at the 3-month follow-up. Specifically, in Group 1, flexion, abduction, internal rotation, and external rotation all showed statistically significant increases after treatment (Table 2; $p < 0.05$ for all comparisons). Group 2 also demonstrated significant gains in ROM measurements across all assessed motions, with *p*-values below 0.001, indicating highly significant changes.

VAS (Visual Analogue Scale) scores decreased notably in both groups following treatment, with lower pain levels reported at rest, during activity, and in initial step measures post-treatment and at the 3-month follow-up (Table 3; $p < 0.05$). Additionally, AOFAS (American Orthopedic Foot & Ankle Society) scores increased significantly in both groups, suggesting improvements in function and quality of life.

Table 3 Expanded VAS with 3-Month Follow-up

Group	VAS Categories	Pre-treatment	Post-treatment	3-Month VAS	*p*-value
Group 1	Initial Step VAS	7.5 ± 1.2 (5–9)	4.2 ± 1.1 (3–6)	3.5 ± 0.9 (2–4)	0.001♈
	Activity VAS	7.3 ± 1.4 (4–9)	4.0 ± 1.1 (3–6)	3.6 ± 1.0 (2–5)	0.005♈
	Rest VAS	6.9 ± 1.2 (4–8)	3.8 ± 1.0 (2–5)	3.3 ± 0.8 (2–4)	0.004♈
Group 2	Initial Step VAS	7.8 ± 1.0 (6–9)	4.0 ± 1.0 (3–5)	3.4 ± 1.0 (2–5)	0.002♈
	Activity VAS	7.4 ± 1.2 (5–9)	3.9 ± 1.0 (2–5)	3.5 ± 1.1 (2–5)	0.006♈
	Rest VAS	7.0 ± 1.1 (5–8)	3.6 ± 1.1 (2–5)	3.2 ± 0.9 (2–4)	0.005♈

♈ indicates Wilcoxon test used for comparing pre- and post-treatment VAS values

Table 4 Final numerical values for VAS, roles, Maudsley, and AOFAS scores

Group	VAS Categories	Pre-treatment	Post-treatment	3-Month Post-treatment	*p*-value
Group 1	Initial Step VAS	7.5 ± 1.2	4.2 ± 1.1	3.5 ± 0.9	0.001
	Activity VAS	7.3 ± 1.4	4.0 ± 1.1	3.6 ± 1.0	0.005
	Rest VAS	6.9 ± 1.2	3.8 ± 1.0	3.3 ± 0.8	0.004
	Roles & Maudsley Scores	3 ± 0.5	2 ± 0.5	1 ± 0.2	0.003
	AOFAS Score	85 ± 4	88 ± 3	90 ± 2	0.002
Group 2	Initial Step VAS	7.8 ± 1.0	4.0 ± 1.0	3.4 ± 1.0	0.002
	Activity VAS	7.4 ± 1.2	3.9 ± 1.0	3.5 ± 1.1	0.006
	Rest VAS	7.0 ± 1.1	3.6 ± 1.1	3.2 ± 0.9	0.005
	Roles & Maudsley Scores	3 ± 0.4	2 ± 0.3	1 ± 0.3	0.004
	AOFAS Score	84 ± 3	86 ± 4	89 ± 3	0.003

• **Wilcoxon test** was used to compare pre- and post-treatment as well as 3-month post-treatment values for VAS, Roles, Maudsley, and AOFAS scores between groups

• **Independent t-test** was applied where applicable for mean comparisons

For functional assessments, the Roles and Maudsley scores demonstrated statistically significant improvement in both groups from pre-treatment to post-treatment, with further gains at the 3-month follow-up. The *p*-values associated with these improvements were all below 0.05, confirming the effectiveness of the treatments (Table 4).

Overall, both treatment methods were effective in improving pain, range of motion, and functional outcomes, with statistically significant results across all evaluated metrics. The data suggest that both approaches can be beneficial for managing symptoms and enhancing function in the patient population studied.

Discussion

Since symptom duration influences treatment response, and acute symptoms may resolve spontaneously, we included only patients with a minimum duration of 6 weeks. This approach aimed to minimize the inclusion of self-limiting cases. This study demonstrated significant pain reduction and functional improvement in both ESWT and HILT groups, corroborating earlier findings on their efficacy [12]. Our results are in agreement with Rompe et al., who reported superior outcomes when radial ESWT was combined with fascia-specific stretching compared to ESWT alone in chronic plantar fasciopathy [13]. ESWT demonstrated slightly better functional improvement compared to HILT, although both modalities were effective for pain reduction and functional recovery. ESWT's capacity to mitigate neuronal hyperexcitability further supports its use for chronic heel pain [14].

In the treatment of calcaneal spur, both Extracorporeal Shock Wave Therapy (ESWT) and High-Intensity Laser Therapy (HILT) have demonstrated efficacy in reducing pain and improving function. A study comparing these modalities found that both treatments significantly decreased pain and disability in patients, with no substantial difference in effectiveness between the two [15].

Another systematic review concluded that HILT significantly reduces pain and disability in lower extremity tendinopathy and calcaneal spur-related symptoms in the short and medium term.

Additionally, research comparing ESWT and HILT in chronic calcaneal spur-related symptoms management reported that both therapies effectively reduced pain and improved function, with diagnostic ultrasound evaluations supporting these findings [16]. These studies suggest that both ESWT and HILT are viable options for calcaneal spur-related symptoms treatment, offering significant benefits in pain relief and functional improvement [17].

A recent study highlighted that both therapies are non-invasive and provide an alternative to surgical interventions, making them viable options for patients who prefer conservative management. However, treatment effectiveness may vary depending on individual patient characteristics, chronicity of symptoms, and treatment protocols

[18]. For patients unresponsive to conservative therapies, endoscopic plantar fascia release has demonstrated long-term efficacy in pain reduction and functional improvement, making it a valuable minimally invasive surgical option [19]. While conservative methods remain first-line treatments, alternative options such as GOLDIC® injection [20] or percutaneous plantar fascia release [21] have emerged for refractory cases.

The available literature suggests that ESWT and HILT are both effective treatment options for calcaneal spur-related symptoms, with comparable pain reduction and functional improvement. ESWT works by inducing microtrauma, promoting neovascularization and tissue regeneration, while HILT enhances cellular metabolism, reduces inflammation, and modulates pain at the biochemical level. The advantages of ESWT include its ability to stimulate healing through mechanical stimulation, while HILT offers a pain-free and well-tolerated option for patients who may not tolerate shock wave therapy. However, optimal treatment parameters (such as dosage, frequency, and duration) still require further research to establish standardized protocols [22–24].

Moreover, studies have shown that combining ESWT with other conservative treatments (such as stretching, orthotics, or physical therapy) may enhance outcomes, while HILT is often used as an adjunct to conventional treatments rather than a standalone therapy [25].

Conversely, HILT's photobiostimulation facilitates tissue repair by enhancing ATP production and cellular metabolism, which likely underpins its comparable efficacy in pain alleviation [26]. These findings are consistent with prior studies demonstrating HILT's ability to reduce inflammation and promote healing [27, 28]. This study aligns with prior findings indicating the effectiveness of extracorporeal shock wave therapy (ESWT) and hig-intensity laser therapy (HILT) in managing calcaneal spur-related pain and functional limitations. A recent randomized clinical trial demonstrated that both ESWT and HILT significantly improved Visual Analog Scale (VAS) and Foot Function Index (FFI) scores post-treatment, with ESWT showing slightly superior outcomes in functional scores [29]. These findings support the use of these non-invasive modalities as viable treatment options for calcaneal spur, particularly for patients who do not respond to conservative methods.

Our results suggest that demographic factors, including BMI and symptom duration, may influence treatment outcomes. Higher BMI was correlated with delayed recovery in both groups, likely due to increased mechanical stress on the plantar fascia [30]. Symptom duration also emerged as a predictor, with shorter durations associated with better pain relief and functional improvement [31].

This study has some limitations, including a relatively small sample size and the lack of long-term follow-up. Additionally, individual variability in adherence to the exercise regimen may have influenced the outcomes. Further larger-scale prospective studies are needed to confirm these findings. Another limitation of this study is the lack of assessor blinding, which may have introduced observer bias during the evaluation of outcome measures. Additionally, the absence of a control group limits the ability to attribute observed improvements exclusively to the physical modalities applied, as conventional therapies may have contributed to the outcomes.

Conclusion

Both ESWT and HILT are effective non-invasive options for managing calcaneal spur-related symptoms. While ESWT may offer slight advantages in functional recovery, HILT remains a viable alternative with distinct mechanistic benefits. These findings provide a foundation for clinicians to tailor treatments based on patient-specific needs and preferences, balancing efficacy with patient comfort and accessibility.

Abbreviations

ESWT	Extracorporeal shock wave therapy
HILT	High-intensity laser therapy
VAS	Visual analog scale
BMI	Body mass index
ROM	Range of motion
SD	Standard deviation
SPSS	Statistical package for the social sciences
CI	Confidence interval
SD	Standard deviation
ANOVA	Analysis of variance

Author contributions

Conception: ZKG Design: ZKG Supervision:,ZKG Fundings: ZKG Materials:,ZKG Data collection and/or Processing: ZKG Analysis and/or interpretation: ZKG Literature review: ZKG Writer: ZKG Critical review ZKG.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki principles, and ethics committee approval (Decision no: 1083, Date: November 28, 2024) was obtained.

Consent for publication

All patients were informed about the aim of the study and their consent was obtained. Informed consent was written from all patient.

Competing interests

The authors declare no competing interests.

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