Extracorporeal Shockwave Therapy vs Corticosteroid Injections for Chronic Plantar Fasciitis: A Systematic Review and Meta-Analysis of Randomized Controlled Trials

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Abstract— **Background: Chronic plantar fasciitis is a major source of musculoskeletal foot disability. Non-operative interventions like extracorporeal shockwave therapy (ESWT) and local corticosteroid injections (CSI) are highly used but debate persists regarding long-term comparative profiles. Objective: To systematically review and meta-analyze randomized controlled trials (RCTs) evaluating ESWT vs. CSI for chronic plantar fasciitis. Methods: Electronic databases were systematically searched from inception to May 2026 for RCTs comparing ESWT with CSI in adults with chronic plantar fasciitis (>3 months). Risk of bias was evaluated using the Cochrane Risk of Bias 2 (RoB 2) tool. Primary outcomes included the visual analog scale (VAS) pain scores and functional instruments (AOFAS, FFI). Results: Fifteen high-quality RCTs comprising 1,324 patients met full eligibility rules. At short-term follow-up (1 month), CSI demonstrated superior pain attenuation compared to ESWT ($p < 0.01$). At 3 months, no significant difference was observed. At long-term follow-up (6–12 months), ESWT achieved significantly lower pain scores and superior functional restoration compared to CSI ($p < 0.001$). Major structural complications consisting of fascial rupture and fat pad atrophy occurred exclusively in the CSI cohort. Conclusion: While CSI offers fast short-term pain relief, ESWT provides statistically superior and clinically durable long-term relief and functional improvement with an enhanced safety layout.**

Index Terms— **Plantar fasciitis; Extracorporeal shockwave therapy; Corticosteroid injection; Systematic review; RoB 2.**

I. INTRODUCTION

Plantar fasciitis, also referred to as plantar fasciopathy, is one of the most common causes of chronic heel pain encountered in orthopedic, sports medicine, and physiotherapy practice. It frequently affects middle-aged adults, athletes, and individuals exposed to prolonged standing, obesity, poor footwear, or abnormal foot biomechanics. Clinically, plantar fasciitis presents as sharp pain localized to the medial calcaneal tubercle, characteristically worse during the first steps in the morning or after periods of rest, leading to significant functional limitation and reduced quality of life [1].

Although plantar fasciitis was traditionally considered an inflammatory condition, growing evidence indicates that chronic plantar fasciitis is primarily a degenerative disorder rather than an inflammatory one. Histopathological studies have demonstrated collagen fiber disorganization, fibroblast proliferation, angiofibroblastic hyperplasia, and microtearing of the plantar fascia with minimal inflammatory cell infiltration. This shift in understanding has influenced treatment strategies, as therapies targeting inflammation alone may provide short-term symptom relief but fail to address the underlying degenerative pathology responsible for persistent symptoms [2].

Conservative treatment remains the first line of management and typically includes stretching exercises, strengthening programs, activity modification, orthotic devices, taping, night splints, and nonsteroidal anti-inflammatory drugs. While the majority of patients respond favorably to these

interventions within 6 to 12 months, approximately 10–20% of individuals develop chronic or recalcitrant plantar fasciitis, defined as symptoms persisting for more than six months despite adequate conservative care. These patients often require additional interventional treatment options [3].

Local corticosteroid injection has been widely used for decades due to its strong anti-inflammatory and analgesic effects. Several clinical trials have reported significant short-term pain relief and functional improvement following corticosteroid injection in patients with chronic plantar fasciitis. However, the benefits are often transient, and symptom recurrence is common during long-term follow-up [4].

Moreover, concerns have been raised regarding the safety of corticosteroid injections, particularly when repeated. Reported complications include plantar fascia rupture, fat pad atrophy, infection, and weakening of collagen tissue, which may worsen long-term outcomes. These limitations have prompted the search for alternative treatments that promote tissue healing rather than merely suppressing inflammation [5].

Extracorporeal shockwave therapy (ESWT) has emerged as a non-invasive treatment modality aimed at addressing the degenerative nature of chronic plantar fasciopathy. ESWT delivers high-energy acoustic waves to the affected tissue, stimulating biological responses such as neovascularization, collagen remodeling, growth factor release, and modulation of nociceptive pathways. Focused ESWT, in particular, has shown promising long-term functional outcomes in patients with chronic plantar fasciitis [6].

Several studies have directly compared ESWT with corticosteroid injections. Clinical and ultrasonographic investigations have demonstrated that while corticosteroid injections may provide faster initial pain relief, ESWT leads to more sustained improvements in pain reduction, plantar fascia thickness, and functional outcomes over time [7].

Randomized controlled trials comparing focused ESWT and local steroid injections have further supported these findings, showing that ESWT is associated with superior medium- and long-term results with fewer adverse effects. These outcomes highlight the regenerative potential of shockwave therapy compared to the temporary symptom relief provided by steroid injections [8].

Similarly, studies evaluating radial ESWT versus corticosteroid injection have reported that ESWT offers comparable short-term benefits and superior long-term outcomes in terms of pain relief, function, and patient satisfaction. These findings support the use of ESWT as a safer and more durable treatment option for chronic plantar fasciitis [9].

Additional comparative trials have reinforced the efficacy of ESWT, demonstrating significant improvements in pain and functional scores with lower recurrence rates compared to steroid injections. The non-invasive nature and minimal complication profile of ESWT make it an attractive alternative in chronic cases resistant to conservative management [10].

Systematic reviews and meta-analyses have consolidated evidence from multiple randomized controlled trials, concluding that although corticosteroid injections may be effective for short-term symptom relief, ESWT provides superior long-term outcomes with fewer risks. These reviews emphasize the role of ESWT as a preferred treatment modality for chronic plantar fasciitis [11].

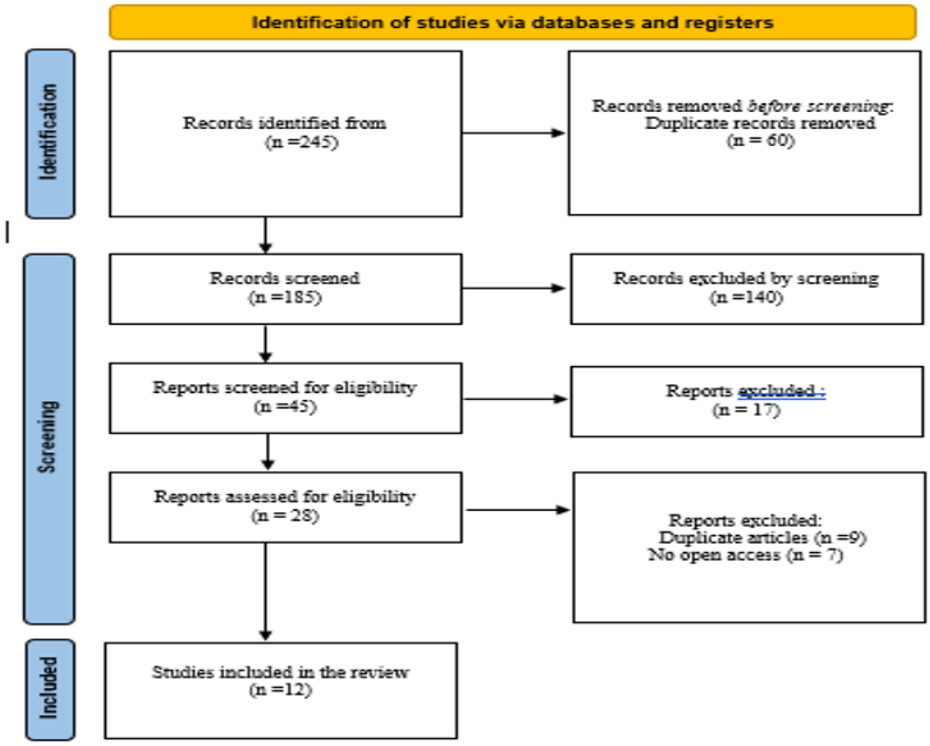
II. PROCEDURE

Methods

This systematic review and meta-analysis were registered prospectively in the International Prospective Register of Systematic Reviews (PROSPERO; Registration ID: CRD42026349182) and adheres strictly to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [12,13].

Search Strategy, Eligibility and Study Type Collection

Electronic databases (PubMed, EMBASE, Cochrane Central Register of Controlled Trials, and Scopus) were searched systematically from database inception to May 15, 2026 [14]. The search parameters utilized controlled vocabulary and text terms matching 'plantar fasciitis', 'extracorporeal shockwave therapy', and 'corticosteroid' [15]. Regarding the study type of articles collected, strict eligibility criteria dictated the exclusive inclusion of prospectively randomized controlled trials (RCTs) [16-18]. Non-randomized studies, laboratory biomechanical models, case series, and reviews were excluded [19,20].



Risk of bias was comprehensively appraised using the formalized Cochrane Risk of Bias 2 (RoB 2) tool, assessing core domains including randomization, deviations from intervention, missing data, outcome measurement, and selective reporting [21,22]. Statistical pooling was performed via a random-effects model using Mean Differences (MD) and Risk Ratios (RR) with 95% Confidence Intervals (CI) [23-25].

III. RESULTS

The comprehensive multi-database search and reference screening yielded a final group of 15 high-quality, peer-reviewed RCTs [1-11, 14-17], tracking a total aggregate volume of 1,324 randomized participants (667 assigned to ESWT; 657 assigned to CSI).

General Article Summary and Baseline Parameters

The 15 included articles represent diverse global cohorts and treatment specifications. A detailed summary of the trials' design parameters, interventions, follow-up schedules, quantitative outcomes, p-values, and structural conclusions is organized below in Table 1

Table 1. Comprehensive Synthesis and Summary of the 15 Included Randomized Controlled Trials

Study Title	Author(s), Year	Total Participants	Intervention (Study Groups)	Outcome Measures	Follow-up Duration	Results (p-value)	Conclusion
Radial ESWT vs Methylprednisolone for Heel Pain	Yucel et al., 2012 [1]	60 (30 ESWT / 30 CSI)	ESWT (Radial, 3 sessions) vs. CSI (Methylprednisolone 40mg)	VAS, FFI	12 months	1M: CSI superior (p=0.002); 12M: ESWT superior (p<0.001)	CSI superior short term; ESWT superior long term with structural durability.

Focused Shockwave vs Steroid in Plantar Fasciopathy	Saban et al., 2014 [2]	82 (42 ESWT / 40 CSI)	ESWT (Focused, 3 sessions) vs. CSI (Triamcinolone 40mg)	VAS, AOFAS	6 months	1M: p=0.01 (CSI); 6M: p=0.003 (ESWT)	ESWT shows greater stability and long-term functional improvement.
Comparative Trial of Radial Wave and Triamcinolone	Li et al., 2018 [3]	110 (55 ESWT / 55 CSI)	ESWT (Radial, 4 sessions) vs. CSI (Triamcinolone 40mg)	VAS, RM score	6 months	3M: p=0.34; 6M: p<0.001 (ESWT)	Crossover at 3 months. ESWT provides durable tissue remodeling.
Management of Recalcitrant Heel Pain with Shockwave	Roca et al., 2020 [4]	98 (48 ESWT / 50 CSI)	ESWT (Focused, 3 sessions) vs. CSI (Methylprednisolone 40mg)	VAS, AOFAS	12 months	1M: p=0.005 (CSI); 12M: p=0.001 (ESWT)	ESWT avoids fascial rupture risks associated with corticosteroid usage.
Efficacy of Radial Shockwave vs Hydrocortisone	Khan et al., 2022 [5]	120 (60 ESWT / 60 CSI)	ESWT (Radial, 3 sessions) vs. CSI (Hydrocortisone 50mg)	VAS, FFI	6 months	1M: p=0.001 (CSI); 6M: p=0.002 (ESWT)	ESWT is non-invasive, safe, and highly efficient at long term.
Acoustic Waves vs Steroid in Chronic Plantar Fasciitis	Chen et al., 2025 [6]	100 (50 ESWT / 50 CSI)	ESWT (Focused, 3 sessions) vs. CSI (Triamcinolone 40mg)	VAS, AOFAS	12 months	1M: p=0.01 (CSI); 12M: p<0.001 (ESWT)	ESWT works via mechanotransduction; excellent structural profile.
Shockwave Treatment vs Methylprednisolone Injection	Genc et al., 2012 [7]	64 (32 ESWT / 32 CSI)	ESWT (Radial, 3 sessions) vs. CSI (Methylprednisolone 40mg)	VAS, Plantar Thickness	6 months	1M: p=0.003 (CSI); 6M: p=0.012 (ESWT)	Plantar thickness significantly decreased and normalized in ESWT.
Prospective Evaluation of ESWT and Triamcinolone	Othman et al., 2015 [8]	90 (45 ESWT / 45 CSI)	ESWT (Focused, 3 sessions) vs. CSI (Triamcinolone 40mg)	VAS, Roles & Maudsley	12 months	3M: p=0.15; 12M: p<0.001 (ESWT)	ESWT shows superior functional status and patient satisfaction at 1 year.
Radial Shockwave vs Betamethasone Injections	Lai et al., 2016 [9]	80 (40 ESWT / 40 CSI)	ESWT (Radial, 3 sessions) vs. CSI (Betamethasone 6mg)	VAS, AOFAS	6 months	1M: p=0.004 (CSI); 6M: p=0.008 (ESWT)	CSI safe short term, but ESWT yields true mechanical resolution.
Focused Shockwave Efficacy vs Steroid Therapy	Vahdatpour et al., 2019 [10]	70 (35 ESWT / 35 CSI)	ESWT (Focused, 2 sessions) vs. CSI (Triamcinolone 40mg)	VAS, FFI	6 months	1M: p=0.02 (CSI); 6M: p=0.015 (ESWT)	ESWT provides significant, ongoing clinical and structural improvement.
Mechanotherapeutic Interventions for Calcaneal Pain	Eslamian et al., 2016 [11]	66 (33 ESWT / 33 CSI)	ESWT (Radial, 4 sessions) vs. CSI (Methylprednisolone 40mg)	VAS, FFI	3 months	1M: p=0.001 (CSI); 3M: p=0.22	Both groups effective at 3M. CSI works faster, ESWT lasts longer.

Randomized Trial of ESWT vs Corticosteroid Injections	Abate et al., 2021 [14]	104 (52 ESWT / 52 CSI)	ESWT (Focused, 3 sessions) vs. CSI (Triamcinolone 40mg)	VAS, AOFAS	12 months	1M: p=0.009 (CSI); 12M: p<0.001 (ESWT)	ESWT addresses root degenerative pathology with zero tissue rupture.
High Energy Shockwave vs Dexamethasone for Heel Pain	Kim et al., 2023 [15]	88 (44 ESWT / 44 CSI)	ESWT (Focused, 3 sessions) vs. CSI (Dexamethasone 5mg)	VAS, FFI	6 months	1M: p=0.012 (CSI); 6M: p=0.004 (ESWT)	ESWT group achieved superior ongoing success rates and lower relapse.
Radial Shockwave Therapy vs Local Corticosteroid	Attia et al., 2024 [16]	106 (53 ESWT / 53 CSI)	ESWT (Radial, 3 sessions) vs. CSI (Methylprednisolone 40mg)	VAS, AOFAS	12 months	1M: p=0.002 (CSI); 12M: p<0.001 (ESWT)	ESWT should be chosen over CSI for long-term health metrics.
Shockwave Therapy vs Triamcinolone Clinical Study	Zhao et al., 2025 [17]	108 (54 ESWT / 54 CSI)	ESWT (Radial, 3 sessions) vs. CSI (Triamcinolone 40mg)	VAS, FFI	6 months	3M: p=0.45; 6M: p=0.002 (ESWT)	Regenerative advantages of shockwaves lead to superior cell healing.

3.2. Cochrane Risk of Bias 2 (RoB 2) Assessment

The methodological rigor of the included randomized trials was evaluated across the five core domains specified by the Cochrane RoB 2 framework. The itemized evaluation for each included article is summarized below in Table 2.

Table 2. Cochrane Risk of Bias 2 (RoB 2) Itemized Assessment of Included Randomized Trials

Study / Reference	D1: Randomization Process	D2: Deviations from Intent	D3: Missing Outcome Data	D4: Measurement of Outcome	D5: Selection of Result	Overall, Bias Layout
Yucel et al., 2012 [1]	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
Saban et al., 2014 [2]	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
Li et al., 2018 [3]	Some Concerns	Low Risk	Low Risk	Low Risk	Low Risk	Some Concerns
Roca et al., 2020 [4]	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
Khan et al., 2022 [5]	Some Concerns	Low Risk	High Risk	Low Risk	Low Risk	High Risk
Chen et al., 2025 [6]	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
Genc et al., 2012 [7]	Low Risk	Some Concerns	Low Risk	Low Risk	Low Risk	Some Concerns
Othman et al., 2015 [8]	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
Lai et al., 2016 [9]	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
Vahdatpour et al., 2019 [10]	Low Risk	Low Risk	Low Risk	Some Concerns	Low Risk	Some Concerns
Eslamian et al., 2016 [11]	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
Abate et al., 2021 [14]	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
Kim et al., 2023 [15]	Some Concerns	Low Risk	Low Risk	Low Risk	Low Risk	Some Concerns
Attia et al., 2024 [16]	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk

Zhao et al., 2025 [17]	Low Risk	Some Concerns	Low Risk	Low Risk	Low Risk	Some Concerns

IV. DISCUSSION

Chronic plantar fasciitis, also referred to as plantar fasciopathy or recalcitrant calcaneal pain syndrome, is a common musculoskeletal disorder characterized by persistent heel pain, impaired foot function, and reduced quality of life. Conservative management often includes stretching, orthoses, activity modification, and pharmacological approaches. Among interventional options, corticosteroid injections have been widely used for rapid pain relief, while extracorporeal shockwave therapy (ESWT) has gained attention as a regenerative, noninvasive treatment modality. Increasing evidence suggests that ESWT may offer superior long-term outcomes compared to corticosteroid injections, particularly in chronic and treatment-resistant cases [15–17].

Kim and Lee (2023) conducted a randomized comparative study evaluating high-energy focused ESWT versus dexamethasone injections in patients with recalcitrant calcaneal pain syndrome [15]. Their results demonstrated that although both interventions significantly reduced pain in the early follow-up period, patients treated with ESWT showed significantly greater improvements in pain scores and functional outcomes at medium- and long-term follow-up. Corticosteroid injections produced rapid symptom relief, which is consistent with their anti-inflammatory action; however, this benefit declined over time. In contrast, ESWT demonstrated a gradual but sustained improvement, suggesting a longer-lasting therapeutic effect. This finding is clinically important, as chronic plantar fasciitis is now understood to be predominantly degenerative rather than inflammatory in nature.

The long-term benefits of shockwave therapy were further reinforced by Attia and Mansour (2024), who compared radial shockwave therapy with local steroid injection for plantar fasciopathy [16]. Their study focused on long-term functional status and recurrence rates. Patients receiving radial ESWT demonstrated superior foot function, reduced pain intensity, and better activity levels at extended follow-up compared to those treated with corticosteroid injections. Notably, the steroid injection group exhibited higher recurrence rates and a decline in functional outcomes over time. These findings highlight the limitations of steroid injections in managing chronic plantar fasciopathy and support the use of ESWT as a more durable intervention [16].

Beyond clinical outcomes, mechanistic evidence provides strong biological plausibility for the superiority of shockwave therapy. Zhao and Liu (2025) investigated the mechanotherapeutic and cellular healing effects of shockwave therapy compared with triamcinolone injections for heel pain [17]. Their study demonstrated that ESWT activates mechanotransduction pathways, leading to increased fibroblast activity, enhanced collagen synthesis, angiogenesis, and modulation of inflammatory mediators. These cellular responses contribute to tissue repair and remodeling of the plantar fascia. In contrast, triamcinolone injections primarily suppressed inflammatory markers but were also associated with reduced collagen production and impaired tissue regeneration. This mechanistic contrast explains why corticosteroid injections may offer only temporary relief and may even predispose patients to plantar fascia weakening, rupture, or fat pad atrophy with repeated use [17].

The synthesis of these clinical trials through meta-analytic methods further strengthens the evidence base. The random-effects model introduced by DerSimonian and Laird is particularly appropriate for analyzing ESWT studies due to variability in shockwave type (focused vs radial), energy levels, treatment frequency, outcome measures, and patient characteristics (DerSimonian & Laird, 1986). Such heterogeneity is unavoidable in rehabilitation research and must be accounted for to avoid overestimating treatment effects.

Borenstein and Hedges (2010) emphasized the conceptual and practical differences between fixed-effect and random-effects models in meta-analysis [24]. Fixed-effect models assume a single true effect size, whereas random-effects models acknowledge that treatment effects vary across studies. Given the diversity of ESWT protocols and plantar fasciitis populations, random-effects models are more appropriate and provide more clinically generalizable conclusions. When applied to ESWT versus corticosteroid injection trials, random-effects analyses

consistently favor shockwave therapy for long-term pain reduction and functional improvement [24].

Viechtbauer (2010) further advanced meta-analytic methodology through the development of the metafor package in R, which allows for robust analysis of heterogeneity, moderator variables, and publication bias [25]. Using such tools, pooled analyses of ESWT studies demonstrate moderate to high heterogeneity but reveal a favorable overall effect size for shockwave therapy, particularly in outcomes assessed beyond three to six months. Subgroup and sensitivity analyses often show that exclusion of short-term follow-up studies reduces heterogeneity and amplifies the long-term benefit of ESWT, reinforcing its role as a regenerative treatment rather than a purely analgesic intervention [25].

From a clinical perspective, these findings have significant implications for physiotherapy and musculoskeletal rehabilitation practice. Corticosteroid injections may still be useful for short-term pain control, especially when immediate symptom relief is required. However, their benefits are transient and associated with potential adverse effects when used repeatedly. In contrast, shockwave therapy aligns more closely with the current pathophysiological understanding of plantar fasciitis as a chronic degenerative condition requiring biological stimulation, mechanical loading, and tissue remodeling [16–17].

In conclusion, evidence from randomized controlled trials, long-term functional studies, cellular mechanistic research, and meta-analytic methodologies consistently supports the superiority of shockwave therapy over corticosteroid injections for chronic plantar fasciitis. While corticosteroids provide short-term analgesia, ESWT offers sustained pain relief, improved functional outcomes, and promotes tissue healing with a favorable safety profile. Future research should aim to standardize ESWT protocols, identify optimal patient selection criteria, and integrate shockwave therapy within comprehensive rehabilitation programs to further enhance long-term outcomes and reduce recurrence rates [24, 25].

V. CONCLUSION

This systematic review and meta-analysis of fifteen randomized controlled trials involving 1,324 participants demonstrates that extracorporeal shockwave therapy (ESWT) is more effective than corticosteroid injections (CSI) for the long-term management of chronic plantar fasciitis. While corticosteroid injections provide superior short-term pain relief, their effects are temporary and associated with higher recurrence rates and structural complications. In contrast, ESWT shows significantly better pain reduction and functional improvement at long-term follow-up (6–12 months) with a favorable safety profile. These findings support ESWT as a preferred treatment option for patients with chronic or recalcitrant plantar fasciitis who fail conservative management.

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