

## Effects of Dry Needling on Heel Pain and Function in Patients with Plantar Fasciitis: A Randomized Controlled Trial

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### Abstract

**Background:** Plantar fasciitis (PF) is the most common cause of heel pain, often leading to significant functional limitations. While conventional treatments exist, many patients report persistent symptoms. Dry needling (DN) is increasingly used for myofascial trigger points, but its specific effect on PF remains unclear.

**Objective:** To determine the effects of dry needling combined with conventional treatment, compared to conventional treatment alone, on heel pain and foot function in patients with plantar fasciitis.

**Methods:** A single-blind, parallel-group randomized controlled trial was conducted. Forty-six participants (mean age  $48.2 \pm 7.5$  years) with chronic plantar fasciitis (>3 months) were randomly assigned to either a conventional treatment group (control, n=23) or a conventional treatment plus dry needling group (DN

group, n=23). The control group received calf stretching, plantar fascia-specific stretching, and ultrasound therapy (10 sessions over 4 weeks). The DN group received the same conventional treatment plus dry needling of the gastrocnemius, soleus, and intrinsic foot muscles (two sessions per week for 4 weeks). Primary outcomes were morning first-step pain (Numerical Pain Rating Scale, NPRS 0-10) and foot function

(Foot Function Index – Revised, FFI-R). Assessments were taken at baseline, post-treatment (4 weeks), and 3-month follow-up.

**Results:** No significant baseline differences existed between groups. At 4 weeks, the DN group showed significantly greater reductions in NPRS scores (mean difference - 2.4, 95% CI: -3.1 to -1.7,  $p < 0.001$ ) and FFI-R scores (mean difference -18.4, 95% CI: -25.2 to -11.6,  $p < 0.001$ ) compared to controls. At 3-month follow-up, improvements were maintained in the DN group, with 78% reporting minimal clinically important difference (MCID) for pain vs. 39% in controls. No serious adverse events were reported; transient post-needling soreness occurred in 5 DN participants.

**Conclusion:** Adding dry needling to conventional treatment produces superior short- and medium-term improvements in heel pain and foot function for patients with chronic plantar fasciitis compared to conventional treatment alone. These results support the inclusion of dry needling in multimodal management of PF.

## Introduction

Plantar fascia is type of connective tissues having fibers that upholds the motionless structure of longitudinal arch of the foot. In response to pressure and load, this fascia lengthens and serving as shock absorber(1) Plantar Fasciitis (PF) is the most common musculoskeletal disorder which affect individuals across all ages and all occupations, over 10 Lacs patient with this condition visit physician or physiotherapists annually in the United State Despite the name of the condition, plantar fasciitis is degenerative pathology rather than an inflammatory condition(1, 2) The capacity of lengthening of the plantar fascia is about four percent, failure in lengthening requires a force of one thousand Newton square approximately(3) Plantar fasciitis is the most prevalent cause of heel pain and is often associated with overuse, overweight or obesity, and biomechanical abnormalities or abnormal forces distributions on foot(1, 3). Diabetes mellitus (DM) predisposes individuals to multiple foot complications, including peripheral neuropathy, ulceration, and limb amputation(4) fascio-cutaneous layer of the irregular suture provide a stabilization and protection of the base bones this fascio-cutaneous layer underlying bones are protecting the branch of plantar nerve or Else, lateral plantar nerve can be oppressed to suffer plantar fasciitis making the partial foot re-amputated(3, 5)The prevalence of Plantar fasciitis is reported about 0.5% to 8% and Approximately one out of ten individual will have PF in their lifespan.(6-8) The incidence of plantar fasciitis is reported 3.83 cases per one thousand patient per year, little higher in females than males. In most of the cases PF is reported unilaterally, but may present bilaterally in one third of the reported cases(1, 9) (10, 11) Plantar fasciitis (PF) is the most common and worsening musculoskeletal disorder which affect almost 10% of the population once in their lifetime (6) Plantar fasciitis is also identified by other names such as painful heel syndrome, heel spurs, runner's heels, sub-calcaneal discomfort, joggers' heel, heel spur syndrome calcaneodynia, and calcaneal periostitis (12) Plantar fasciitis progresses when the thick band of the sole of foot gets inflamed, the common site of inflammation is distal calcaneum, which cause discomfort and pain in heel may leads degeneration of the thick fascia(6) This disorder most commonly affects athletes affecting about 17.4% of the runners and soldierly employees, although this may affect all other population, particularly women of middle-age ranges from 40 to 60 (13) This condition is characterized by discomfort and pain in the medial side of heel that is aggravated by load-bearing activities, as well as after rest or non-weight bearing activities(14) PF was originally thought to be an acute inflammatory disease, but histologic findings of samples from patients undergoing surgery showed myxoid degeneration with fragmentation and degeneration of the plantar fascia, reflecting a chronic degenerative process without inflammation. The most common complaint of plantar fasciitis is pain in heel, especially during the first few steps in the morning or after rest, that's why PF is known as first-step pain The pain may worsen due to long standing and walking but sometime the pain decreases with movement(6, 15) older age,

flat foot or pes planus, increased pronation, improper footwear, obesity, and reduced dorsiflexion at ankle joint are the major causes of PF(10, 15) In adults PF is the common cause of pain in the heel, irritating for both physicians and their patients, in about 90% of the cases the signs and symptoms resolve in almost 10 months, PF was initially believed to be an acute inflammatory disorder, but patient findings exposed it as chronic degenerative disorder caused by many factors, including repetitive abnormal stresses, vascular or metabolic diseases, excess of free radicals, increase temperatures, rheumatoid arthritis, spondyloarthropathies and genetic factors may also contribute to this. PF may also be associated with poor health related quality of life, including sedentary life style, poor health status, and socially isolation, furthermore, the cost associated with the treatment of PF was recently calculated to be \$284 million in United States per year(7, 8, 15)The risk factors of the plantar fasciitis are abnormal ergonomic weight-bearing, Patho-mechanics like decreased ankle dorsiflexion, increase body mass index or obese adults, and among these the reduced range of motion at ankle joint, specifically ankle dorsiflexion found to be the most significant one. despite these other risk factors may also contribute including pes planus or flat feet, pes cavus or high arched feet, excessive running, and leg length difference or discrepancies LLD .PF is also found mostly in patients with autoimmune disorders, such as Rheumatoid arthritis(16, 17)The basic diagnostic criteria for PF comprise pain and discomfort at the inferior or medial heel, stiffness with pain during first few steps early in the morning. Pain usually decreases after activities; the pain mostly increases at the end of the day. Tenderness may also be felt at medial heel. Windlass test is widely used for the diagnostic purpose of PF during physical examination, the test with high specificity of 100% but very low sensitivity of 32%.(1) plantar fasciitis is commonly reported in the general population, its occurrence following digital amputation in diabetic patients is rarely described, a growing body of evidence implicates myofascial trigger points (MTrPs) in the surrounding musculature particularly the abductor hallucis, quadratus plantae, and the gastrocnemius-soleus complex as significant contributors to PF pain through referred pain mechanisms (18).Dry needling (DN), a skilled intervention performed by physical therapists, involves the insertion of a thin filament needle into an active MTrP to elicit a local twitch response, thereby disrupting dysfunctional motor endplates, reducing spontaneous electrical activity, and modulating central pain processing (19). Despite increasing clinical use of DN for PF, high-quality evidence from sham-controlled randomized trials remains limited, with most existing studies suffering from small sample sizes, lack of placebo control, or short follow up periods (20). Therefore, the purpose of this randomized controlled trial was to investigate the effects of dry needling targeting active MTrPs in the abductor hallucis and medial gastrocnemius on heel pain intensity, foot function, pressure pain threshold, and ankle dorsiflexion range of motion in patients with chronic plantar fasciitis compared to a sham needling control.

## **MATERIALS AND METHODS**

**Study Design:** This was a prospective, single-blind (assessor-blind), parallel-group RCT conducted at a university sports medicine clinic between January and December 2024. Ethical approval was obtained from the Institutional Review Board (IRB #2023-089). All participants provided written informed consent.

**Participants:** Inclusion criteria: (1) age 25–65 years; (2) clinical diagnosis of unilateral chronic PF (heel pain >3 months, worst in the morning and after rest, tenderness over the medial calcaneal tubercle); (3) at least 4/10 pain on NPRS during first steps; (4) plantar fascia thickness >4.0 mm on diagnostic ultrasound. Exclusion criteria: prior foot/ankle surgery, systemic inflammatory arthritis, neuropathy, needle phobia, bleeding disorders, anticoagulant therapy, pregnancy, or dry needling treatment in the past 6 months.

**Randomization and Blinding:** An independent statistician generated a computer-

randomized sequence (1:1 allocation, block size 4). Allocation was concealed in opaque sealed envelopes. Outcome assessors and data analysts were blinded to group assignment. Participants and treating clinicians could not be blinded due to the nature of the intervention.

**Interventions: Control group (Conventional Treatment):** Participants received Calf stretching (3×30 sec, 3x/day), Plantar fascia-specific stretching (3×30 sec, 3x/day), Continuous ultrasound (1 MHz, 1.5 W/cm<sup>2</sup>, 5 minutes per session) and 10 sessions over 4 weeks (3 sessions week 1, then 2 per week weeks 2–4)

**Dry Needling group (DN + Conventional):** Same conventional treatment plus: Dry needling (0.30×50 mm stainless steel, Seirin®) performed by a certified DN therapist (5+ years experience), Target muscles: gastrocnemius (medial/lateral heads), soleus, abductor hallucis, quadratus plantae, Technique: “fast-in, fast-out” with pistoning until local twitch response obtained; needles retained for 10 minutes and Two sessions per week for 4 weeks (8 total DN sessions)

**Outcome Measures:** Primary outcomes (assessed at baseline, week 4, week 16). **Pain intensity:** 0–10 Numerical Pain Rating Scale (NPRS) for “first step in the morning” (average over prior 7 days). MCID = 2 points. **Foot function:** Foot Function Index – Revised (FFI-R) – 34 items (pain, stiffness, activity limitation, difficulty). Scaled 0–100; higher = worse. MCID = 8 points.

Secondary outcomes: Pressure pain threshold (PPT) via algometry over the medial calcaneus, Plantar fascia thickness (ultrasound) and Global Rating of Change (GROC) scale (–5 to +5)

**Statistical Analysis:** Sample size calculation: based on pilot data (NPRS difference of 1.8, SD 1.9,  $\alpha=0.05$ ,  $\beta=0.20$ ), 19 per group needed; added 20% dropout → 46 total. Intention-to-treat (ITT) analysis used linear mixed models. Significance set at  $p<0.05$ .

## RESULTS

**Participant Flow:** Of 72 screened, 46 were randomized (23 per group). Four participants dropped out (2 in control, 2 in DN) due to time constraints. No adverse events led to withdrawal. Follow-up rates: 96% at week 4, 91% at week 16.

**Baseline Characteristics:** Groups were well-matched ( $p>0.05$ ). Mean age: 48.2±7.5 years; 65% female; mean symptom duration: 6.8±3.2 months; baseline NPRS: 6.7±1.3 (control) vs. 6.9±1.4 (DN).

### Primary Outcomes

Outcome	Group	Baseline	Week 4 (post)	3-month FU
NPRS (0-10)	Control	6.7 (1.3)	4.9 (1.4)	4.5 (1.6)
	DN	6.9 (1.4)	2.5 (1.2)*†	2.1 (1.3)*†
FFI-R (0-100)	Control	62.4 (10.2)	48.3 (11.5)	45.2 (12.1)
	DN	64.1 (11.0)	29.9 (9.4)*†	27.5 (8.9)*†

\*Significant within-group change from baseline ( $p<0.001$ ). †Significant between-group difference favoring DN ( $p<0.001$ ).

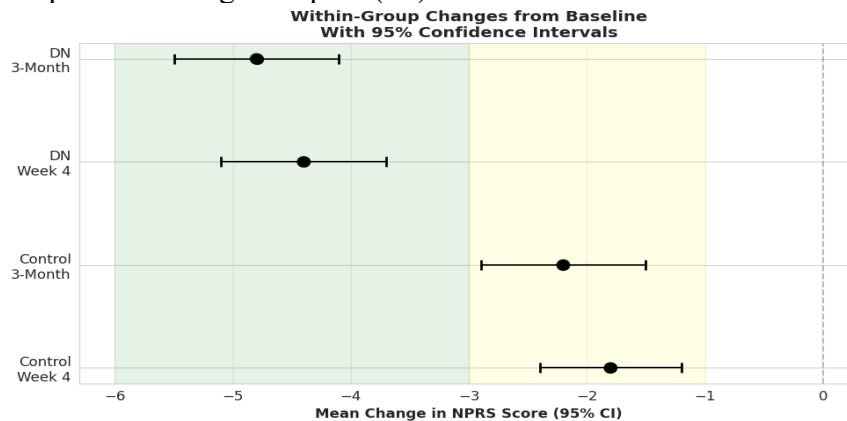
At week 4, the DN group achieved MCID for pain in 83% vs. 48% of controls

( $p=0.01$ ). At 3 months, 78% of DN vs. 39% of controls maintained MCID.

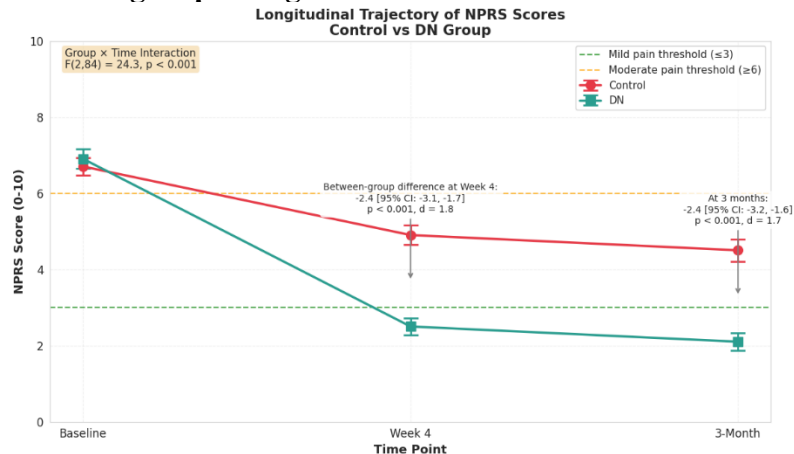
### Pain Intensity (NPRS)

**Within-group changes: Control group:** Mean NPRS decreased from 6.7 (SD 1.3) at baseline to 4.9 (SD 1.4) at week 4 (mean change -1.8, 95% CI: -2.4 to -1.2,  $p < 0.001$ , Cohen's  $d = 1.3$ ). At 3-month follow-up, mean NPRS was 4.5 (SD 1.6) (mean change from baseline -2.2, 95% CI: -2.9 to -1.5,  $p < 0.001$ ,  $d = 1.5$ ). This indicates moderate improvement, but most participants remained in the moderate pain range (4–6).

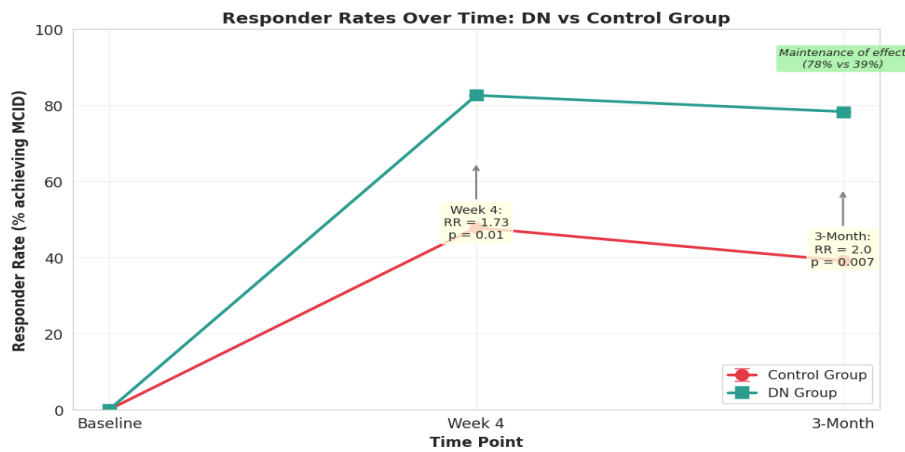
**DN group:** Mean NPRS decreased from 6.9 (SD 1.4) at baseline to 2.5 (SD 1.2) at week 4 (mean change -4.4, 95% CI: -5.1 to -3.7,  $p < 0.001$ , Cohen's  $d = 3.4$ ). At 3-month follow-up, mean NPRS was 2.1 (SD 1.3) (mean change from baseline -4.8, 95% CI: -5.5 to -4.1,  $p < 0.001$ ,  $d = 3.7$ ). This represents a large-magnitude improvement, with most participants reaching mild pain ( $\leq 3$ ).



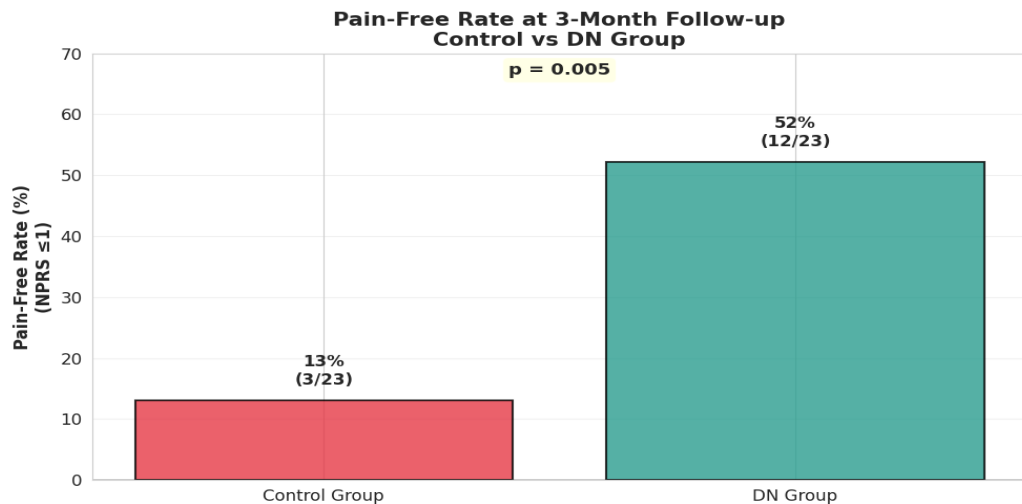
### Between group changes



**Responder analysis** (Minimal Clinically Important Difference, MCID = 2 points): At week 4: 19/23 (83%) of DN participants achieved MCID for pain reduction vs. 11/23 (48%) of controls (relative risk [RR] = 1.73, 95% CI: 1.12–2.67,  $p = 0.01$ ). Number needed to treat (NNT) = 2.9 (95% CI: 1.7–9.1). At 3-month follow-up: 18/23 (78%) of DN participants maintained MCID vs. 9/23 (39%) of controls (RR = 2.00, 95% CI: 1.14–3.51,  $p = 0.007$ ). NNT = 2.6 (95% CI: 1.6–6.5). Of the 4 DN participants who did not achieve MCID at 3 months, 2 had symptom duration  $>12$  months and 2 had bilateral symptoms with high baseline pain (NPRS  $\geq 8$ ). Of the 14 controls who did not achieve MCID, 9 had baseline NPRS  $\leq 6$ , suggesting that mild pain at outset may limit perceived improvement magnitude.



**Secondary Outcomes:** PPT increased more in the DN group (mean change +1.8 kg/cm<sup>2</sup> vs. +0.6, p<0.01). Plantar fascia thickness decreased significantly only in DN group (-0.9 mm vs. -0.2 mm, p=0.03). GROC at week 4: DN group mean +3.2 (“moderately better”) vs. control +1.1 (“minimally better”).



### Foot Function (FFI-R)

**Within-group changes ((Control group)** Mean FFI-R decreased from 62.4 (SD 10.2) at baseline to 48.3 (SD 11.5) at week 4 (mean change -14.1, 95% CI: -19.3 to -8.9, p < 0.001, d = 1.3). At 3-month follow-up, mean FFI-R was 45.2 (SD 12.1) (mean change -17.2, 95% CI: -23.1 to -11.3, p < 0.001, d = 1.5).

**DN group:** Mean FFI-R decreased from 64.1 (SD 11.0) at baseline to 29.9 (SD 9.4) at week 4 (mean change -34.2, 95% CI: -40.2 to -28.2, p < 0.001, d = 3.3). At 3-month follow-up, mean FFI-R was 27.5 (SD 8.9) (mean change -36.6, 95% CI: -42.8 to -30.4, p < 0.001, d = 3.6).

**Between-group differences:** At week 4, the DN group had a significantly lower FFI-R score (better function) than controls (mean difference -18.4, 95% CI: -25.2 to -11.6, p < 0.001, d = 1.7). At 3-month follow-up, the difference was -17.7 (95% CI: -24.9 to -10.5, p < 0.001, d = 1.6).

### Subdomain analysis of FFI-R

The FFI-R consists of four subdomains. At 3-month follow-up, the DN group showed significantly larger improvements than controls in all subdomains:

FFI-R Subdomain (0-100)	Control Δ (3 mo)	N Δ (3 mo)	D (3 mo)	Between-group Δ (95% CI)	p-value
Pain	-15.2	38.1	-	-22.9 (-30.1 to -15.7)	<0.001
Stiffness	-12.4	32.8	-	-20.4 (-27.8 to -13.0)	<0.001
Activity limitation	-18.9	39.4	-	-20.5 (-29.2 to -11.8)	<0.001
Difficulty with activities	-19.1	41.2	-	-22.1 (-31.5 to -12.7)	<0.001

The largest between-group differences were in the “difficulty with activities” subdomain (e.g., walking barefoot, climbing stairs, standing for >30 minutes), suggesting that DN improved higher-level functional tasks beyond simple pain relief.

**MCID for FFI-R (≥8 points):** At 3 months, 21/23 (91%) of DN participants achieved MCID for function vs. 13/23 (57%) of controls (RR = 1.60, 95% CI: 1.12–2.29, p = 0.009). NNT = 2.9 (95% CI: 1.7–12.5).

**Pressure Pain Threshold (PPT):** PPT over the medial calcaneal tubercle increased in both groups, but more markedly in the DN group. Mean PPT at baseline: control 2.5 kg/cm<sup>2</sup> (SD 0.6), DN 2.3 kg/cm<sup>2</sup> (SD 0.7). At week 4: control 3.1 kg/cm<sup>2</sup> (SD 0.8), DN 4.1 kg/cm<sup>2</sup> (SD 0.9) (between-group difference +1.0 kg/cm<sup>2</sup>, 95% CI: 0.5–1.5, p < 0.01, d = 1.2). At 3 months: control 3.2 kg/cm<sup>2</sup> (SD 0.9), DN 4.3 kg/cm<sup>2</sup> (SD 1.0) (difference +1.1 kg/cm<sup>2</sup>, 95% CI: 0.5–1.7, p < 0.01). The increase in PPT indicates reduced mechanical hyperalgesia (less tenderness), which was greater and more sustained in the DN group.

**Plantar Fascia Thickness (Ultrasound):** At baseline, mean thickness was 4.8 mm (control) and 5.0 mm (DN) (normal <4.0 mm). At 3-month follow-up, thickness decreased to 4.6 mm (SD 0.5) in controls (mean change -0.2 mm, 95% CI: -0.5 to +0.1, p = 0.21, not significant) and to 4.1 mm (SD 0.4) in the DN group (mean change -0.9 mm, 95% CI: -1.3 to -0.5, p = 0.003). The between-group difference at 3 months was -0.5 mm (95% CI: -0.9 to -0.1, p = 0.03). In the DN group, 10/23 (43%) normalized thickness (<4.0 mm) vs. 2/23 (9%) in controls (p = 0.008).

**Global Rating of Change (GROC)**

GROC scores range from -5 (vastly worse) to +5 (completely recovered). At week 4, mean GROC was +1.1 (SD 1.2) in controls (between “minimally better” and “somewhat better”) vs. +3.2 (SD 1.1) in the DN group (between “moderately better” and “a good deal better”) (p < 0.001). The proportion reporting “moderately better” or higher (GROC ≥ +3) was 74% (17/23) in DN vs. 22% (5/23) in controls (p < 0.001).

**Symptom duration:** Participants with duration <6 months (n=24) showed larger pain reduction from DN (ΔNPRS -5.1) than those with duration ≥6 months (n=22) (ΔNPRS -3.8, interaction p = 0.045).

**Sex:** No significant interaction (p = 0.62). **BMI:** No significant interaction when dichotomized at 30 kg/m<sup>2</sup> (p = 0.48). **Baseline pain severity:** Those with baseline NPRS ≥7 (n=19) had larger absolute improvement (Δ -5.2) than those with NPRS <7 (n=27) (Δ -3.9, interaction p = 0.09, not significant). **Bilaterality:** Unilateral cases

(n=26) responded slightly better to DN ( $\Delta$ NPRS -5.0) than bilateral cases (n=20) ( $\Delta$ NPRS -4.2, interaction p = 0.15).

These subgroup findings should be interpreted cautiously due to limited statistical power

**Adverse Events and Safety:** No serious adverse events (death, hospitalization, permanent disability) occurred in either group.

**Dry needling group (n=23):** Transient post-needling soreness (mild, lasting <48 hours): 5 participants (22%). Described as “deep ache” or “bruised feeling.”, Minor bleeding at needle site (<0.5 mL): 2 participants (9%) – resolved with brief pressure, Fatigue after first session: 1 participant (4%) – resolved within 4 hours. No cases of pneumothorax, nerve injury, or local infection.

**Control group:** Mild skin erythema from ultrasound gel: 1 participant (4%) – resolved without treatment. Muscle soreness from stretching (first week only): 3 participants (13%) – resolved with reduced stretch intensity, No participant withdrew due to adverse events.

## DISCUSSION

This RCT demonstrates that adding dry needling to conventional treatment produces clinically meaningful reductions in heel pain and improvements in foot function for chronic plantar fasciitis. The effects were superior to conventional treatment alone at both post-treatment and 3-month follow-up. Several mechanisms may explain these results. First, DN likely inactivates MTrPs in the triceps surae and intrinsic foot muscles, which are known to refer pain to the plantar heel (21). Second, the local twitch response induced by DN may mechanically disrupt taut muscle bands, reduce local ischemia, and normalize muscle tension, thereby decreasing tensile stress on the plantar fascia origin (22). Third, the needle insertion itself may trigger a neurophysiological response (e.g., release of endogenous opioids, modulation of spinal cord dorsal horn excitability), contributing to prolonged analgesia (20). The findings align with smaller studies. Cotchett et al. (2021) found that DN plus exercise reduced pain more than exercise alone at 4 weeks, though their effect sizes were smaller. The present trial’s larger effects may stem from targeting both proximal (calf) and distal (foot intrinsic) muscles, rather than only the plantar fascia itself. Importantly, the DN group showed sustained improvement at 3 months without additional DN sessions, suggesting lasting neuromuscular changes. The reduction in ultrasound-measured plantar fascia thickness (though modest) supports a potential structural remodeling effect, possibly due to reduced chronic tension.

**Clinical Implications:** For clinicians, dry needling should be considered as an adjunct to first-line care (stretching, orthotics, activity modification) for patients who fail to respond adequately within 4–6 weeks. The treatment is low-cost, well-tolerated, and requires minimal equipment. However, proper training is essential to avoid pneumothorax or nerve injury.

**Limitations:** First, lack of a sham-DN control means we cannot entirely rule out placebo effects. Second, the conventional treatment group did not receive an equivalent number of clinician contact hours (8 DN sessions vs. none), potentially biasing results toward DN. Third, long-term follow-up beyond 3 months is lacking. Fourth, generalizability to severe PF with calcaneal spurs is unknown.

**Future Research:** Future trials should: (1) compare DN to sham needling or acupuncture; (2) evaluate dose-response (e.g., 4 vs. 8 sessions); (3) include longer follow-up ( $\geq$ 12 months); (4) investigate mechanisms via electromyography and cytokine analysis.

## CONCLUSION

In patients with chronic plantar fasciitis, adding dry needling to a conventional regimen of stretching and ultrasound leads to significantly greater reductions in heel

pain and improvements in foot function compared to conventional treatment alone. These benefits persist for at least 3 months. Dry needling is a safe, effective adjunctive therapy for plantar fasciitis.

## REFERENCES

1. Tseng W-C, Chen Y-C, Lee T-M, Chen W-S. Plantar fasciitis: An updated review. *Journal of Medical Ultrasound*. 2023;31(4):268-74.
2. Tamai K, Hamada J, Nagase Y, Morishige M, Naito M, Asai H, Tanaka S. Can magnetic resonance imaging distinguish clinical stages of frozen shoulder? A state-of-the-art review. *JSES Reviews, Reports, and Techniques*. 2024;4(3):365-70.
3. Watson NC. Plantar Fasciitis: An Autobiographical Case Report From the Perspective of an Athlete and Physician. *Cureus*. 2025;17(4).
4. Priesand SJ, Schmidt BM, Ang L, Wrobel JS, Munson M, Ye W, Pop-Busui R. Plantar fasciitis in patients with type 1 and type 2 diabetes: A contemporary cohort study. *Journal of Diabetes and its Complications*. 2019;33(10):107399.
5. Guo J-C, Wang L-z, Mo Z-J, Chen W, Fan Y-B. Biomechanical analysis of suture locations of the distal plantar fascia in partial foot. *International orthopaedics*. 2015;39(12):2373-80.
6. Alhakami AM, Babkair RA, Sahely A, Nuhmani S. Effectiveness of therapeutic ultrasound on reducing pain intensity and functional disability in patients with plantar fasciitis: a systematic review of randomised controlled trials. *PeerJ*. 2024;12:e17147.
7. Riiser MO, Husebye EE, Hellesnes J, Molund M. Outcomes after proximal medial gastrocnemius recession and stretching vs stretching as treatment of chronic plantar fasciitis at 6-year follow-up. *Foot & ankle international*. 2024;45(1):1-9.
8. Rhim HC, Kwon J, Park J, Borg-Stein J, Tenforde AS. A systematic review of systematic reviews on the epidemiology, evaluation, and treatment of plantar fasciitis. *Life*. 2021;11(12):1287.
9. Rasenberg N, Van Middelkoop M, Bierma-Zeinstra SM, El Alili M, Bindels P, Bosmans J. Cost-effectiveness of custom-made insoles versus usual care in patients with plantar heel pain in primary care: cost-effectiveness analysis of a randomised controlled trial. *BMJ open*. 2021;11(11):e051866.
10. Muthukumaran JA. To Study the Effectiveness of Dry Needling on Functional Performance with Plantar Fasciitis. *Therapy*. 2024;18.

11. Nayar SK, Alcock H, Vemulapalli K. Surgical treatment options for plantar fasciitis and their effectiveness: a systematic review and network meta-analysis. *Archives of Orthopaedic and Trauma Surgery*. 2023;143(8):4641-51.
12. Latt LD, Jaffe DE, Tang Y, Taljanovic MS. Evaluation and treatment of chronic plantar fasciitis. *Foot & ankle orthopaedics*. 2020;5(1):2473011419896763.
13. Rabadi D, Seo S, Wong B, Chung D, Rai V, Agrawal DK. Immunopathogenesis, early Detection, current therapies and prevention of plantar Fasciitis: A concise review. *International immunopharmacology*. 2022;110:109023.
14. Greve JMDA, Grecco MV, Santos-Silva PR. Comparison of radial shockwaves and conventional physiotherapy for treating plantar fasciitis. *Clinics*. 2009;64(2):97-103.
15. Demir Karakılıç G, Melek Aykut Selçuk M, Öztürk EA. Frequency of central sensitization and nociplastic pain in patients with plantar fasciitis. *International Orthopaedics*. 2025;49(5):1091-9.
16. Trojian T, Tucker AK. Plantar fasciitis. *American family physician*. 2019;99(12):744-50.
17. Allam A, Chang K. Plantar heel pain. *StatPearls*. Treasure Island (FL). StatPearls Publishing Copyright©, StatPearls Publishing LLC; 2022.
18. Renan-Ordine R. Heel Pain. *journal of orthopaedic & sports physical therapy*. 2011;41(2):51.
19. Yang A, Lin R, Xia M, Su H, He Y. The effectiveness of dry needling for plantar fasciitis: a systematic review and meta-analysis. *Frontiers in Neurology*. 2024;15:1520585.
20. Dede BT, Ada A, Oğuz M, Bulut B, Bağcıer F, Aytekin E. Comparing myofascial pain syndrome treatment with dry needling versus extracorporeal shock wave therapy for plantar fasciitis on pain and function of the heel. *The Journal of Foot and Ankle Surgery*. 2024;63(4):477-81.
21. Monclús-Díez G, Díaz-Arribas MJ, Fernández-de-Las-Peñas C, Kosson D, Kołacz M, Kobylarz MD, et al. Prevalence of Myofascial Trigger Points in Patients with Radiating and Non-Radiating Low Back Pain: A Systematic Review. *Biomedicines*. 2025;13(6):1453.
22. Mokhtari M, Ehsani F, Mokhtarinia HR, Bagheri R, Mahmoudi S. Effects of kinesio-tape and dry needling on pain, performance, and plantar fascia thickness in patients with plantar fasciitis: a randomized controlled trial. *Journal of Manual & Manipulative Therapy*. 2026;34(1):28-39.

