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Clinical Case / Case Series

Effects of Ultrasound-Guided Percutaneous Neuromodulation on Cutaneous Hyperalgesia and Hypoesthesia After Distal Fibular Fracture: A Clinical Case Report

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ABSTRACT

Introduction: Neuropathic pain and sensory disturbances frequently follow surgical fixation of distal fibular fractures, largely due to the proximity of the superficial peroneal nerve (SPN) and common peroneal nerve (CPN). Ultrasound-guided percutaneous neuromodulation (US-guided PNM) is a minimally invasive approach aiming to modulate peripheral nerve excitability and facilitate sensorimotor recovery. This case report describes the clinical effects of US-guided PNM applied to the SPN and CPN in a patient with chronic cutaneous hyperalgesia and hypoesthesia years after surgery.

Case Presentation: A 44-year-old woman presented with chronic postoperative burning pain, paresthesia, cutaneous hypoesthesia, and reduced limb control several years after open reduction and internal fixation, followed by hardware removal. At baseline, pain intensity (numerical rating scale, NRS) was 6/10; Douleur Neuropathique 4 (DN4) score was 5/10; sensory testing revealed hypoesthesia and mechanical hyperalgesia in the SPN dermatome; tibialis anterior and fibular muscle strength ranged 3–4/5 on the Medical Research Council (MRC) scale; ankle dorsiflexion was 15°, eversion 10°, knee-to-wall distance 5 cm, and single-leg stance 32 seconds.

Intervention: Two US-guided PNM sessions were performed: first targeting the SPN for sensory modulation (2–100 Hz, 400 µs, 30 min) and subsequently the CPN for sensorimotor facilitation (2 Hz, 240 µs, 30 min).

Results: Two US-guided PNM sessions were delivered within one week. After intervention, pain decreased to 2/10; DN4 score normalized to 0/10; sensory thresholds returned to normal; ankle dorsiflexion increased to 20°; eversion to 16°; knee-to-wall to 9 cm; single-leg stance to 43 seconds; tibialis anterior and fibular muscles improved to 5/5.

Conclusions: US-guided PNM may be a promising therapeutic option for chronic postoperative neuropathic symptoms involving the peroneal nerves. Controlled studies are warranted.

Keywords: percutaneous neuromodulation; peroneal nerve; neuropathic pain; postoperative complications; ultrasound guidance; invasive physiotherapy.

1. Introduction

Distal fibular fractures are among the most common ankle injuries requiring surgical fixation and are frequently associated with persistent sensory disturbances due to the close anatomical relationship between the fibula, the superficial peroneal nerve (SPN), and the common peroneal nerve (CPN)^(1,2). Because of their superficial course and anatomical variability, these nerves are particularly vulnerable to direct trauma, traction, compression, or irritation during surgical exposure, internal fixation, and subsequent hardware placement^(3,4).

Persistent postoperative sensory symptoms, including burning pain, paresthesia, hypoesthesia, and mechanical hyperalgesia, have been reported in a substantial proportion of patients following ankle and distal fibular surgery, even after fracture consolidation and implant removal⁽⁵⁻⁷⁾. These neuropathic manifestations may significantly impair gait, balance, and functional performance, representing a major challenge during long-term rehabilitation⁽⁸⁾. Neuropathic pain after lower-limb trauma is a prevalent condition, often associated with significant disability^(8,9).

Despite the established impact of peroneal nerve injury on sensorimotor function, evidence-based physiotherapeutic interventions specifically targeting the SPN and CPN in the context of chronic postoperative neuropathic pain remain scarce. Current rehabilitation approaches typically address general pain management and functional recovery, but may be insufficient for patients with persistent peripheral nerve dysfunction years after surgery. This gap justifies investigating targeted neuromodulatory strategies as a complement to conventional rehabilitation.

Ultrasound-guided percutaneous neuromodulation (US-guided PNM) has emerged as a minimally invasive physiotherapeutic intervention aimed at modulating peripheral nerve excitability through targeted electrical stimulation^(10,11). Previous clinical and experimental studies suggest that peripheral nerve stimulation may reduce pain, facilitate motor unit recruitment, and improve functional outcomes in musculoskeletal and neuropathic conditions^(12,13). Beyond sensorimotor pathways, peripheral neuromodulation may influence autonomic nervous system activity, contributing to changes in local tissue perfusion, neurogenic inflammation, and trophic support^(14,15). Recent clinical guidelines emphasize the importance of anatomical precision, ultrasound guidance, and safety when performing invasive physiotherapy techniques targeting distal peripheral nerves such as the SPN and CPN⁽¹⁶⁾.

Despite the increasing body of literature supporting US-guided PNM in peripheral nerve disorders, evidence specifically addressing its application to the SPN and CPN remains limited. Therefore, the aim of this clinical case report is to describe the effects of US-guided PNM applied to the superficial and common peroneal nerves in a patient with chronic cutaneous hyperalgesia and hypoesthesia several years after distal fibular fracture surgery, and to contribute preliminary evidence supporting the clinical utility of this approach.

2. Description of the clinical case/case series

This case report was prepared following physiotherapy-oriented case-reporting principles (PhyCaRe)⁽¹⁷⁾.

2.1 Patient information

This case was assessed and treated at a private physiotherapy clinic. The treating physiotherapist (H.C.) holds a degree in Physiotherapy from the Escola Superior de Tecnologia da Saúde de Coimbra and a postgraduate qualification in Percutaneous Interventions in Physiotherapy from the Escola Superior de Saúde do Politécnico do Porto, with specific training in ultrasound-guided neuromodulation techniques. The physiotherapist performed both the clinical assessment and the therapeutic intervention. No other rehabilitation programme was ongoing during the intervention period, as the aim was to evaluate the isolated effect of US-guided PNM.

A 44-year-old woman presented with persistent sensory disturbances affecting the left lower limb following a distal fibular fracture sustained in 2020 and treated with open reduction and internal fixation. Hardware removal was performed two years later due to local discomfort; however, sensory symptoms persisted despite fracture consolidation. The patient was assessed and enrolled in June 2025.

At the time of assessment, the patient reported burning pain, paresthesia, altered tactile perception, and reduced confidence in limb control during functional activities such as walking, driving, and running. She reported no relevant medical comorbidities, no history of neurological disease, and no systemic conditions that could explain the sensory impairment. No pharmacological treatment targeting neuropathic pain was being used. Written informed consent was obtained for both treatment and publication.

2.2 Clinical assessment

Initial pain intensity was 6/10 on the Numerical Rating Scale (NRS), a well-validated unidimensional pain measure with a minimal clinically important difference (MCID) of ≥ 2 points⁽¹⁸⁾. Neuropathic pain screening using the Douleur Neuropathique 4 (DN4) questionnaire yielded a score of 5/10, indicating probable neuropathic pain (cut-off ≥ 4)⁽¹⁹⁾. The DN4 is a validated 10-item clinician-administered instrument that combines symptom description and bedside sensory testing and demonstrates high sensitivity and specificity for neuropathic pain⁽¹⁹⁾. The Central Sensitization Inventory (CSI) revealed a low score, suggesting a predominantly peripheral origin of symptoms⁽²⁰⁾.

Motor assessment demonstrated inhibition in muscles innervated by the common peroneal nerve. Strength testing using the Medical Research Council (MRC) scale, a widely used 6-point ordinal scale (0–5) assessing voluntary muscle contraction against gravity and resistance (8), showed 4/5 strength in the tibialis anterior and fibular muscles and 3/5 in the extensor hallucis longus. Functional testing revealed impaired ankle dorsiflexion and eversion, reduced knee-to-wall distance (MCID 1.1 cm⁽²¹⁾), and decreased single-leg stance time compared with normative values^(21,22).

An ultrasound examination was performed using a Logiq P9 system (GE Healthcare, Chicago, IL, USA) with a linear-array transducer. Both the SPN and CPN were evaluated along their anatomical course using B-mode imaging. Dynamic examination demonstrated preserved nerve morphology without signs of focal entrapment, neuroma formation, or structural damage, consistent with functional neural dysfunction rather than axonal disruption^(10,23).

Sensory evaluation followed procedures aligned with the Nottingham Sensory Assessment⁽²⁴⁾, which assesses light touch, pinprick, and proprioceptive responses on a 3-point ordinal scale (0 = absent, 1 = altered, 2 = normal). Sensory testing revealed hypoesthesia and mechanical hyperalgesia in the SPN dermatome. Differential diagnoses included superficial peroneal nerve entrapment, postoperative neuropathic pain, and peroneal neuropathy secondary to fibular fracture or surgical intervention⁽⁹⁾. Although electrodiagnostic testing can provide complementary information, the clinical presentation and ultrasound findings were considered sufficient for diagnosis, as supported by previous literature⁽²³⁾.

2.3 Timeline and follow-up

The patient sustained a distal fibular fracture in 2020, treated surgically with internal fixation. Hardware removal was performed in 2022. Between 2023 and 2025, persistent neuropathic sensory and motor symptoms were reported. Baseline clinical assessment and the first US-guided PNM session targeting the SPN were conducted at Day 0. A second US-guided PNM session targeting the CPN was performed at Day 3. A follow-up reassessment of all outcome measures was conducted on Day 7 (table 1).

Outcome measures included NRS, DN4, Nottingham Sensory Assessment scores, MRC muscle strength grading, knee-to-wall test, and single-leg stance time. Assessments were conducted at baseline (Day 0) and at follow-up (Day 7). No adverse effects were observed throughout the intervention period. Treatment adherence was 100%, and all procedures were well tolerated.

2.4 Therapeutic intervention

The therapeutic approach consisted of two sessions of US-guided PNM, performed in accordance with standardized invasive physiotherapy protocols and safety recommendations^(16,25). Stimulation was delivered using the Physio Invasiva 2.0® device (Prim Fisioterapia y Rehabilitación, Madrid, Spain). Acupuncture needles (Agupunt®, AGU-PUNT S.L., Barcelona, Spain; 0.30 × 0.40 mm) were used as needle electrodes. Ultrasound guidance was provided throughout both procedures using the Logiq P9 system described above.

Session 1 – Superficial Peroneal Nerve (SPN) – Day 0:

The first session aimed to modulate sensory dysfunction and mechanical hyperalgesia. A frequency-modulated stimulation protocol was applied, alternating between high- and low-frequency stimulation within the 2-100 Hz range, with a pulse width of 400 µs, for 30 minutes. Stimulation intensity was progressively increased to the patient's sensory tolerance threshold without eliciting pain. The needle electrode was inserted under ultrasound guidance using a long-axis in-plane approach, targeting the subcutaneous course of the SPN⁽¹⁰⁾ (Figure 1).



Figure 1. Ultrasound-guided needle placement targeting the superficial peroneal nerve (SPN). B-mode ultrasound image showing the needle position using a long-axis in-plane approach, adjacent to the SPN (arrow) and surrounding soft tissue structures.

Session 2 – Common Peroneal Nerve (CPN) – Day 3:

Three days later, a second session was performed to address persistent hypoesthesia and motor inhibition. A low-frequency stimulation protocol (2 Hz) with a pulse width of 240 μ s was applied for 30 minutes, aiming to facilitate motor unit recruitment and neuromuscular activation. The needle electrode was positioned using a short-axis ultrasound-guided approach near the fibular neck to safely target the CPN⁽¹⁰⁾ (Figure 2).



Figure 2. Clinical photograph of ultrasound-guided percutaneous neuromodulation targeting the common peroneal nerve (CPN). The image shows the patient's leg with the needle electrode in situ, connected to the Physio Invasiva 2.0®, during active treatment of the CPN using a short-axis approach at the level of the fibular neck.

Both procedures were conducted under strict aseptic conditions, including skin preparation with 2% chlorhexidine, use of sterile gloves, and ultrasound probe protection, in accordance with invasive physiotherapy guidelines⁽¹⁶⁾.

3. Results

After two sessions of US-guided PNM, clinically meaningful improvements, defined as changes exceeding published MCID thresholds or normative benchmarks, were observed across pain intensity, sensory function, muscle strength, joint range of motion, balance, and functional performance. Results are summarised in Table 1.

Table 1. Summary of outcome measures at baseline and follow-up, with MCID references. Abbreviations: NRS-Numerical Rating Scale; DN4-Douleur Neuropathique 4; MRC-Medical Research Council; MCID-minimal clinically important difference; s- seconds.

Outcome measure	Baseline (Day 0)	Day 7 (follow-up)	Change	MCID / Reference
NRS pain (0–10)	6/10	2/10	–4 points	MCID ≥ 2 points ⁽¹⁸⁾
DN4 (0–10)	5/10	0/10	–5 points	Diagnostic cut-off ≥ 4 ⁽¹⁹⁾
Ankle dorsiflexion	15°	20°	+5°	MCID $\sim 3.5^\circ$ ⁽²¹⁾
Ankle eversion	10°	16°	+6°	Normative $16.6 \pm 4.6^\circ$ ⁽²⁶⁾
Knee-to-wall	5 cm	9 cm	+4 cm	MCID 1.1 cm ⁽²¹⁾
Single-leg stance	32 s	43 s	+11 s	Normative ~ 45 s adults ⁽²²⁾
MRC tibialis anterior	4/5	5/5	+1 grade	1 grade = clinically meaningful ^(11,12)
MRC fibularis longus/brevis	4/5	5/5	+1 grade	1 grade = clinically meaningful ^(11,12)
MRC ext. hallucis longus	3/5	4/5	+1 grade	1 grade = clinically meaningful ^(11,12)

Pain and neuropathic symptoms: NRS decreased from 6/10 at baseline to 2/10 at follow-up, a reduction of 4 points, which exceeds the established MCID of ≥ 2 points⁽¹⁸⁾. DN4 score reduced from 5/10 (probable neuropathic pain) to 0/10 (below the diagnostic cut-off of ≥ 4)⁽¹⁹⁾. No burning pain, paresthesia, or evoked mechanical hyperalgesia was reported at reassessment.

Sensory function: Reassessment using the Nottingham Sensory Assessment demonstrated normalisation of sensory responses in the dorsum of the foot and distal lateral third of the leg. Both regions progressed from a score of 1 (altered sensation) to a score of 2 (normal response) in response to light touch and pinprick stimuli⁽²⁴⁾. No areas of residual hypoesthesia or dysesthesia were identified.

Muscle strength: Muscle strength improved in all muscles innervated by the common peroneal nerve. The tibialis anterior and fibularis longus and brevis muscles increased from MRC grade 4 to grade 5, corresponding to full strength. The extensor hallucis longus and extensor digitorum longus improved from grade 3 to grade 4. These improvements in motor function are consistent with the effects of US-guided PNM on neuromuscular activation reported in the literature^(11,12). The previously observed cogwheel movement pattern during resisted contraction was no longer present at reassessment.

Joint range of motion: Ankle eversion increased from 10° to 16°, approaching the normative value of $16.6^\circ \pm 4.6^\circ$ reported for adult women⁽²⁶⁾. Ankle dorsiflexion improved from 15° to 20°, which exceeds the MCID of approximately 3.5° ⁽²¹⁾. The knee-to-wall test improved from 5 cm to 9 cm, a gain of 4 cm that substantially exceeds the MCID of 1.1 cm⁽²¹⁾.

Balance and functional performance: Single-leg stance time on the affected limb increased from 32 to 43 seconds, approaching adult normative values of approximately 45 seconds⁽²²⁾.

The patient reported improved confidence during gait, driving, and the initiation of running activities, without exacerbation of symptoms.

4. Discussion

This clinical case report describes the effects of US-guided PNM applied to the SPN and CPN in a patient with chronic postoperative cutaneous hyperalgesia, hypoesthesia, and mild motor impairment following distal fibular fracture surgery. The intervention resulted in rapid and clinically meaningful improvements, confirmed against published MCID thresholds in pain intensity, neuropathic pain features, cutaneous sensibility, muscle strength, joint mobility, balance, and functional performance. These findings suggest that targeted US-guided PNM may be an effective physiotherapeutic strategy for managing persistent neuropathic symptoms related to peroneal nerve involvement after ankle surgery, even several years after the initial injury.

Postoperative neuropathic symptoms following distal fibular and ankle surgery are well documented and have been attributed to the anatomical proximity and vulnerability of the SPN and CPN during surgical exposure, fixation, and subsequent hardware presence^(1,2,9). Sensory disturbances such as burning pain, paresthesia, hypoesthesia, and mechanical hyperalgesia may persist long after fracture consolidation and implant removal^(3–6). Importantly, no pharmacological or other physiotherapeutic interventions were ongoing during the study period, supporting the attribution of the observed improvements to US-guided PNM.

The complete normalization of the DN4 score and the recovery of cutaneous sensibility are consistent with known mechanisms of peripheral nerve stimulation, particularly with frequency-modulated, sensory-focused protocols. Such stimulation preferentially activates large-diameter A β afferent fibers, thereby promoting segmental inhibition and reducing nociceptive transmission via gate-control mechanisms⁽²⁷⁾. These neurophysiological effects may additionally modulate nociceptive processing via peripheral afferent pathways⁽²⁸⁾. The rapidity of sensory improvement, compared with the often slow or incomplete natural recovery following cutaneous nerve injury⁽⁵⁾, suggests that sensory-oriented US-guided PNM protocols may actively accelerate functional recovery by modulating peripheral nerve excitability.

Improvements in muscle strength and motor control across CPN-innervated muscles align with previous reports demonstrating enhanced motor unit recruitment and neuromuscular activation following peripheral nerve stimulation^(11–13). The 2 Hz stimulation protocol targeting the CPN likely facilitated motor neuron excitability and improved voluntary activation of the tibialis anterior and fibular muscles. Given that peroneal nerve dysfunction is known to impair gait efficiency, postural control, and confidence during dynamic activities^(8,9), the patient's reported functional improvements highlight the importance of protocol-specific neuromodulation that addresses both the sensory and motor components of peroneal neuropathy.

Beyond sensorimotor pathways, neuromodulation may influence autonomic nervous system activity, contributing to vasodilation, enhanced local tissue perfusion, and modulation of neurogenic inflammation^(14,15). These autonomic effects may support metabolic and trophic recovery of neural and muscular tissues in chronic postoperative states.

This case report has several important limitations. First, the single-case design and absence of a control condition prevent causal inference; improvements may reflect natural recovery, regression to the mean, or placebo effects. Second, no electrodiagnostic testing was performed; although clinical presentation and ultrasound findings were considered sufficient for diagnosis^(8,23), nerve conduction studies would have strengthened diagnostic confidence. Third, the absence of Day 3 assessments for all outcomes limits characterization of the temporal response profile. Fourth, follow-up was limited to Day 7, so the durability of the observed improvements remains unknown. Fifth, although the treating physiotherapist also performed the outcome assessments, no independent blinded assessor was available in this single-clinician case context.

This case supports the inclusion of US-guided PNM as a potential adjunct to conventional rehabilitation in patients with persistent postoperative neuropathic symptoms following ankle or distal fibular surgery. Future research should include randomized controlled trials targeting SPN and CPN^(10,29), blinded outcome assessment, longer follow-up periods, and integration of electrodiagnostic and autonomic markers to clarify underlying mechanisms.

5 Conclusion

This clinical case demonstrates that US-guided PNM may be an effective and safe physiotherapeutic intervention for managing chronic postoperative neuropathic symptoms associated with peroneal nerve involvement after distal fibular fracture surgery. Two targeted sessions applied to the superficial and common peroneal nerves resulted in clinically meaningful improvements — confirmed against published MCID thresholds — in pain, cutaneous sensibility, muscle strength, joint mobility, balance, and functional performance. The rapid resolution of neuropathic pain features and normalization of sensory thresholds suggest that US-guided PNM can effectively modulate peripheral nerve excitability and facilitate sensorimotor recovery even several years after surgical injury. These findings, while preliminary, support the role of US-guided PNM as a valuable adjunct in the rehabilitation of patients with persistent neuropathic symptoms when conventional approaches have limited effectiveness.

5.1 Patient perspective

The patient reported a clear improvement in her perception of the affected limb following treatment. She described her left leg as feeling lighter and more controlled, particularly during gait and transitional movements. Activities previously associated with discomfort and insecurity, such as driving and initiating running, were reported as comfortable again after the intervention. The patient also highlighted increased confidence in weight-bearing tasks, noting a smoother and more stable execution of daily and recreational activities.

References

1. Redfern DJ, Sauvé PS, Sakellariou A. Investigation of incidence of superficial peroneal nerve injury following ankle fracture. *Foot Ankle Int.* 2003;24(10):771–774. doi:10.1177/107110070302401006.
2. Halm JA, Schepers T. Damage to the superficial peroneal nerve in operative treatment of fibula fractures: straight to the bone? *J Foot Ankle Surg.* 2012;51(5):684–686. doi:10.1053/j.jfas.2012.05.021.
3. Blair JM, Botte MJ. Surgical anatomy of the superficial peroneal nerve in the ankle and foot. *Clin Orthop Relat Res.* 1994;(305):229–238. PMID: 8050234. Available from: <https://pubmed.ncbi.nlm.nih.gov/8050234/>
4. Ellanti P, Mohamed KMS, O'Shea K. Superficial peroneal nerve incarceration in the fibular fracture site of a pronation external rotation type ankle fracture. *Open Orthop J.* 2015;9:214–217. doi:10.2174/1874325001509010214.
5. Bai L, Han Y, Zhang W, Huang W, Zhang H. Natural history of sensory nerve recovery after cutaneous nerve injury following foot and ankle surgery. *Neural Regen Res.* 2015;10(1):99–103. doi:10.4103/1673-5374.150713.
6. Treede RD, Jensen TS, Campbell JN, et al. Neuropathic pain: redefinition and a grading system for clinical and research purposes. *Neurology.* 2008;70(18):1630–1635. doi:10.1212/01.wnl.0000282763.29778.59.
7. Jensen TS, Baron R. Translation of symptoms and signs into mechanisms in neuropathic pain. *Pain.* 2003;102(1–2):1–8. doi:10.1016/s0304-3959(03)00006-x.
8. Baima J, Krivickas L. Evaluation and treatment of peroneal neuropathy. *Curr Rev Musculoskelet Med.* 2008;1(2):147–153. doi:10.1007/s12178-008-9023-6.
9. Kim YC, Jung TD. Peroneal neuropathy after tibio-fibular fracture. *Ann Rehabil Med.* 2011;35(5):648–652. doi:10.5535/arm.2011.35.5.648.
10. Valera-Garrido F, Minaya-Muñoz F. *Ultrasound-Guided Percutaneous Neuromodulation.* Amsterdam: Elsevier; 2021. ISBN: 978-0-323-75954-7.
11. Fidalgo-Martin I, Ramos-Álvarez JJ, Murias-Lozano R, Rodríguez-López ES. Effects of percutaneous neuromodulation in neuromusculoskeletal pathologies: a systematic review. *Medicine (Baltimore).* 2022;101(41):e31016. doi:10.1097/MD.00000000000031016.
12. Álvarez-Prats D, Carvajal-Fernández Ó, Pérez-Mallada N, Minaya-Muñoz F. Changes in maximal isometric quadriceps strength after the application of ultrasound-guided percutaneous neuromodulation of the femoral nerve: a case series. *Rev Fisioter Invasiva.* 2019;2(1):39–45. doi:10.1055/s-0039-1688551.
13. Chipchase LS, Schabrun SM, Hodges PW. Peripheral electrical stimulation to induce cortical plasticity: a systematic review of stimulus parameters. *Clin Neurophysiol.* 2011;122(3):456–463. doi:10.1016/j.clinph.2010.07.025.
14. Tracey KJ. Reflex control of immunity. *Nat Rev Immunol.* 2009;9(6):418–428. doi:10.1038/nri2566.
15. Clancy JA, Mary DA, Witte KK, Greenwood JP, Deuchars SA, Deuchars J. Non-invasive vagus nerve stimulation in healthy humans reduces sympathetic nerve activity. *Brain Stimul.* 2014;7(6):871–877. doi:10.1016/j.brs.2014.07.031.
16. Valera-Garrido F, Minaya-Muñoz F, editors. *Fisioterapia Invasiva.* 2nd ed. Elsevier España: Barcelona, Spain; 2016. ISBN: 978-84-9113-099-4.

17. Naqvi WM, Mishra GV, Shaikh SZ, et al. PhyCARE reporting guidelines for physiotherapy case reports: a consensus-based development. *BMJ Open*. 2026;16:e110765. doi:10.1136/bmjopen-2025-110765.
18. Farrar JT, Young JP Jr, LaMoreaux L, Werth JL, Poole RM. Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. *Pain*. 2001;94(2):149–158. doi:10.1016/S0304-3959(01)00349-9.
19. Bouhassira D, Attal N, Alchaar H, et al. Comparison of pain syndromes associated with nervous or somatic lesions and development of a new neuropathic pain diagnostic questionnaire (DN4). *Pain*. 2005;114(1–2):29–36. doi:10.1016/j.pain.2004.12.010
20. Mayer TG, Neblett R, Cohen H, et al. The development and psychometric validation of the Central Sensitization Inventory. *Pain Pract*. 2012;12(4):276–285. doi:10.1111/j.1533-2500.2011.00493.x.
21. Bennell KL, Talbot RC, Wajswelner H, Techovanich W, Kelly DH, Hall AJ. Intra-rater and inter-rater reliability of a weight-bearing lunge measure of ankle dorsiflexion. *Aust J Physiother*. 1998;44(3):175–180. doi:10.1016/s0004-9514(14)60377-9.
22. Springer BA, Marin R, Cyhan T, Roberts H, Gill NW. Normative values for the unipedal stance test with eyes open and closed. *J Geriatr Phys Ther*. 2007;30(1):8–15. doi:10.1519/00139143-200704000-00003.
23. Padua L, Aprile I, Pazzaglia C, Frasca G, Caliendo P, Tonali P, Martinoli C. Contribution of ultrasound in a neurophysiological lab in diagnosing nerve impairment: a one-year systematic assessment. *Clin Neurophysiol*. 2007;118(6):1410–1416. doi:10.1016/j.clinph.2007.03.011.
24. Lincoln NB, Jackson JM, Adams SA. Reliability and revision of the Nottingham Sensory Assessment for stroke patients. *Physiotherapy*. 1998;84(8):358–365. doi:10.1016/S0031-9406(05)61454-X.
25. García-Bermejo P, De-la-Cruz-Torres B, Romero-Morales C. Ultrasound-guided percutaneous neuromodulation in patients with unilateral anterior knee pain: a randomized clinical trial. *Appl Sci*. 2020;10(13):4647. doi:10.3390/app10134647.
26. Norkin CC, Levangie PK. *Joint Structure and Function: A Comprehensive Analysis*. 5th ed. FA Davis: Philadelphia, PA, USA; 2011. ISBN: 978-0-8036-2271-1.
27. Melzack R, Wall PD. Pain mechanisms: a new theory. *Science*. 1965;150(3699):971–979. doi:10.1126/science.150.3699.971.
28. Sandrini G, Serrao M, Rossi P, Romaniello A, Cruccu G, Willer JC. The lower limb flexion reflex in humans. *Prog Neurobiol*. 2005;77(6):353–395. doi:10.1016/j.pneurobio.2005.11.003.
29. García-Collado A, Valera-Calero JA, Fernández-de-las-Peñas C, Arias-Burúa JL. Effects of ultrasound-guided nerve stimulation targeting peripheral nerve tissue on pain and function: a scoping review. *J Clin Med*. 2022;11(13):3753. doi:10.3390/jcm11133753.

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