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Selective Thermal Radiofrequency Ablation of the Deep Peroneal Articular Branches for Refractory Ankle Osteoarthritis: A Case Report

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Abstract

Patients with ankle osteoarthritis who do not respond to conservative treatment remain a therapeutic challenge. This report describes selective thermal radiofrequency ablation of the deep peroneal articular branches in a patient with refractory ankle osteoarthritis and predominantly anterior pain.

A 72-year-old man presented with refractory bilateral mechanical ankle pain, worse on the right side, centered on the anterior joint line, and rated 9/10 on the numeric pain rating scale (NPRS). Intra-articular treatment provided partial relief, whereas repeated pulsed radiofrequency of the deep peroneal nerve achieved greater but time-limited relief. A diagnostic deep peroneal nerve block produced complete right-sided relief during walking and weight-bearing dorsiflexion, without motor deficit. Thermal radiofrequency of the right deep peroneal articular branches was then performed under combined ultrasound and fluoroscopic guidance. At 12 months, pain had decreased from 7/10 to 3/10, with no motor deficit. The remaining pain was localized over a prominent anterior osteophyte and occurred mainly during prolonged standing and activities requiring increased ankle dorsiflexion, particularly uphill walking.

In refractory ankle osteoarthritis with predominantly anterior pain, correlating the pain distribution with the articular anatomy allowed selection of a single neural target. A positive diagnostic nerve block supported the analgesic target, and motor stimulation before ablation excluded motor fiber recruitment. In this patient, thermal radiofrequency near a mixed nerve provided prolonged analgesia without motor deficit. Residual pain after denervation should be reassessed, as it may reveal a mechanical component requiring a different therapeutic approach.

Categories: Pain Management, Physical Medicine & Rehabilitation
Keywords: ankle osteoarthritis, articular denervation, deep peroneal nerve, radiofrequency ablation, ultrasound-guided intervention

Introduction

Ankle osteoarthritis is less prevalent than hip or knee osteoarthritis but can be similarly disabling. Approximately 80% of cases are post-traumatic [1]. First-line management combines education, activity modification, exercise, bracing, and analgesics, with intra-articular injections used as an adjunct. Joint-preserving procedures, such as arthroscopic debridement or corrective osteotomy, may be considered in early disease, whereas arthrodesis or total ankle arthroplasty is generally reserved for end-stage disease [1,2]. However, many patients are not surgical candidates or decline surgery, leaving limited options when conservative measures fail.

Non-surgical options specific to the ankle remain poorly supported. A recent systematic review of randomized trials of intra-articular hyaluronic acid, platelet-rich plasma, and botulinum toxin found no clinically relevant benefit over control groups in ankle osteoarthritis [3]. Articular denervation may therefore represent a joint-preserving analgesic strategy for selected patients with refractory pain. This approach has been most extensively studied in the knee, where radiofrequency ablation of the genicular nerves has been evaluated in randomized controlled trials and systematic reviews [4]. In contrast, the ankle has a more complex pattern of articular innervation, involving the saphenous, tibial, sural, superficial peroneal, and deep peroneal nerves, whose articular branches vary considerably in location [5,6]. Partial surgical denervation of the ankle has also been described, using a positive diagnostic nerve block to select candidates [7]. Among the nerves supplying the ankle, the deep peroneal nerve provides articular branches to the anterior joint capsule [5,6]. Since it contains both motor and sensory fibers, selective targeting of its articular branches is particularly important. This approach aims to reduce nociceptive input from the anterior capsule while avoiding the motor deficit and cutaneous sensory loss that may follow broader nerve targeting.

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We describe a four-year stepwise treatment course in a patient with ankle osteoarthritis and predominantly anterior joint pain, progressing from an intra-articular injection to repeated pulsed radiofrequency of the deep peroneal nerve and, subsequently, thermal radiofrequency ablation of its articular branches. Pulsed radiofrequency is intended to modulate pain transmission without causing structural nerve damage, whereas thermal radiofrequency produces a controlled ablative lesion of the targeted nerve fibers. Radiofrequency denervation involving the deep peroneal nerve has previously been described as part of multi-nerve ankle denervation [8], but evidence regarding its selective use for ankle osteoarthritis remains limited.

Case Presentation

A 72-year-old man was evaluated in May 2022 for bilateral ankle pain, predominantly affecting the right side. The pain was mechanical, localized to the anterior ankle joint line, and exacerbated by weight-bearing and ankle dorsiflexion. Pain intensity was rated 9/10 on the numeric pain rating scale (NPRS), and nocturnal pain was absent. Past surgical history included a right calcaneal osteotomy approximately 15 years earlier for chronic lateral ankle instability and right ankle arthroscopy with lavage one year earlier. Previous conservative management had provided insufficient pain relief. This included a supervised rehabilitation program lasting several months, focusing on range-of-motion, strengthening, and proprioceptive exercises. At the time of evaluation, the patient used analgesic and anti-inflammatory medication only on an as-needed basis. Relevant medical history included dyslipidemia, gastritis, and benign prostatic hyperplasia, treated with atorvastatin, esomeprazole, and tamsulosin, respectively.

Physical examination showed bilateral cavovarus foot alignment, with no visible swelling, erythema, or other local inflammatory changes. Palpation elicited diffuse tenderness along the anterior ankle joint line. Right ankle range of motion was restricted, with dorsiflexion limited to 5° and plantar flexion to 20°. Ankle stability was preserved, with no clinical evidence of ligamentous laxity. Neurological examination of the distal lower limb was unremarkable. Strength of ankle dorsiflexion, plantar flexion, inversion, eversion, and hallux extension was graded 5/5 on the Medical Research Council scale. Sensation to light touch was intact throughout the foot, including the first dorsal web space. No neuropathic features, such as burning pain, dysesthesia, or allodynia, were reported or observed.

Radiographs of both ankles showed joint-space narrowing, subchondral sclerosis, and marginal osteophytes, consistent with Kellgren-Lawrence grade 3 on the right and grade 2 on the left [9] (Figure *1*). Ultrasound of the right ankle additionally showed mild synovitis.

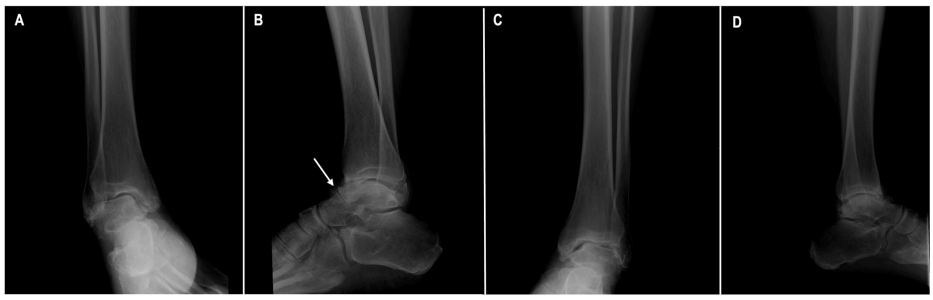


FIGURE 1: Radiographs of both ankles

Anteroposterior and lateral views of the right (A, B) and left (C, D) ankles showing joint-space narrowing, subchondral sclerosis, and marginal osteophytes, consistent with Kellgren-Lawrence grade 3 on the right and grade 2 on the left. The arrow indicates the anterior osteophyte of the right ankle.

In view of the mild synovitis, a right tibiotalar intra-articular injection was administered under ultrasound guidance. The ankle was positioned in slight plantar flexion, and a linear-array transducer was placed in an axial plane over the anterior joint line. A 25-gauge, 40-mm needle was advanced in-plane into the anterior tibiotalar recess, avoiding the adjacent neurovascular structures. A combination of 2 mL of hyaluronic acid and 80 mg of methylprednisolone was injected. No immediate complications were observed. Pain intensity decreased from 9/10 to 5/10 on the NPRS at three months and remained at 5/10 at six months.

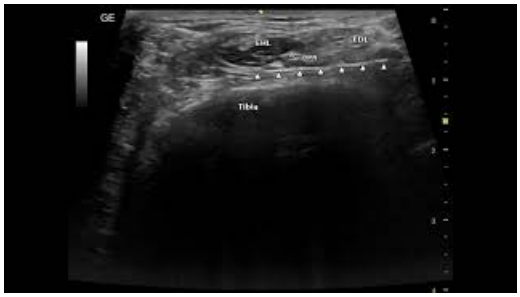
Despite this partial improvement, bilateral ankle pain remained disabling. Given the anterior distribution of pain, ultrasound-guided pulsed radiofrequency of the deep peroneal nerve was subsequently performed at two target sites on the right and one on the left. A 22-gauge, 6-cm radiofrequency cannula with a 10-mm active tip was connected to a G4 radiofrequency generator (Boston Scientific, Marlborough, Massachusetts, USA). The deep peroneal nerve was identified in short axis, and the cannula was advanced in-plane to an adjacent position, with the active tip oriented perpendicular to the nerve course. Sensory and motor stimulation were performed to confirm appropriate cannula position and assess for motor involvement. Pulsed radiofrequency was delivered at 100 V and 2 Hz, with a pulse width of 20 ms and a maximum temperature of 42 °C, for 6 minutes at each target site. At the end of each treatment cycle, 3 mL of 0.2%

ropivacaine was administered around the nerve at each site. The procedure was well tolerated, with no immediate complications.

After the first procedure, pain intensity decreased to 3/10 on the NPRS, and the patient resumed regular walking, with residual pain limited to prolonged standing. The clinical benefit was maintained for approximately six months before symptoms gradually recurred, with pain increasing to 7/10. Bilateral pulsed radiofrequency was then repeated twice using the same parameters. The second procedure reduced pain to 3/10 for six months. The patient was next reassessed approximately 15 months after the second procedure. As pain had recurred to 7/10, the third procedure was performed. This procedure reduced pain to 3/10 for six months. At 12 months, the left ankle remained clinically satisfactory (NPRS 3/10), whereas right-sided pain recurred and increased to 7/10.

With further recurrence of right-sided symptoms, thermal radiofrequency ablation of the deep peroneal articular branches was considered. Because of their proximity to the motor fibers of the deep peroneal nerve, a diagnostic ultrasound-guided nerve block of the right deep peroneal nerve was first performed at the anterior ankle. The nerve was identified in short axis, adjacent to the anterior tibial artery, and a 25-gauge, 40-mm needle was advanced in-plane to a perineural position. A mixture of 2 mL of 2% lidocaine and 3 mL of 0.2% ropivacaine was then injected around the nerve. Following the block, the patient reported complete pain relief during walking and weight-bearing ankle dorsiflexion, which had previously reproduced his pain. The nerve block was therefore considered positive, with no motor deficit or immediate complications.

Approximately one month after the positive diagnostic nerve block, selective thermal radiofrequency ablation of the right deep peroneal articular branches was performed under combined ultrasound and fluoroscopic guidance. As the deep peroneal nerve supplies the anterior joint capsule, two target sites were selected using bony landmarks along the anterior distal tibial articular margin, one medially and one laterally, to cover the variable course of the articular branches. A 22-gauge, 6-cm radiofrequency cannula with a 10-mm active tip was connected to the same radiofrequency generator. Ultrasound allowed identification of the deep peroneal nerve and adjacent neurovascular structures and guided in-plane cannula placement deep to the neurovascular bundle, along the anterior tibial surface (Video *1*).



VIDEO 1: Ultrasound clip obtained during thermal radiofrequency ablation targeting the articular branches of the right deep peroneal nerve

Axial view of the anterior ankle showing the radiofrequency cannula (arrowheads) positioned in-plane along the anterior cortex of the distal tibia, deep to the anterior tibial artery (A), deep peroneal nerve (DPN), extensor hallucis longus (EHL), and extensor digitorum longus (EDL). The cannula tip lies on the tibial cortex, away from the deep peroneal nerve trunk, at the level of the articular branches to the anterior capsule.

View video here: https://youtu.be/MOZxWbVVHPw

Fluoroscopy was then used to confirm cannula position relative to the distal tibial articular margin and to orient the active tip along it, thereby increasing the area of capsular denervation (Figures *2A*, *2B*). Before ablation, sensory stimulation at 50 Hz elicited concordant paresthesia over the anterior ankle at less than 0.5 V, supporting appropriate targeting. Motor stimulation at 2 Hz up to 2 V produced no contraction of the muscles supplied by the deep peroneal nerve, excluding motor fiber recruitment. After administration of 2 mL of 2% lidocaine for local anesthesia, thermal radiofrequency was delivered as a single lesion at 80 °C for 90 seconds at each target site. At the end of the procedure, 1 mL of 0.2% ropivacaine was administered at each site. No immediate complications were observed.

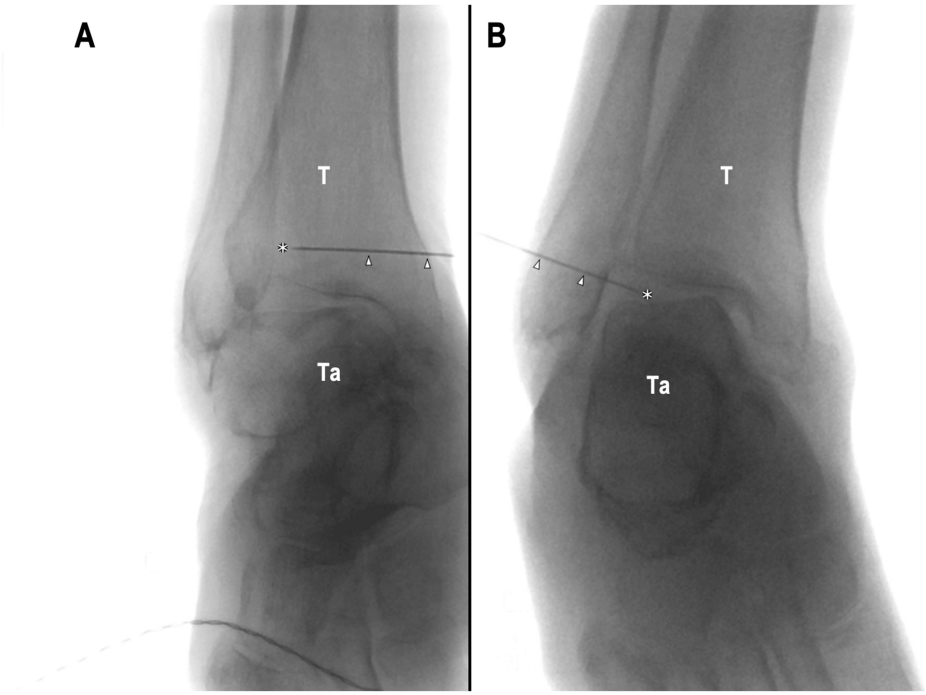


FIGURE 2: Fluoroscopic views of the right ankle during thermal radiofrequency ablation targeting the articular branches of the deep peroneal nerve

The radiofrequency cannula (arrowheads) is positioned along the anterior distal tibial articular margin, where the articular branches reach the anterior joint capsule, at the lateral (A) and medial (B) target sites. The asterisk indicates the cannula tip.

T, tibia; Ta, talus

At the 12-month follow-up, pain intensity had decreased from 7/10 to 3/10 on the NPRS, and the patient was no longer taking analgesic medication. Neurological examination remained unchanged, with no motor or sensory deficit in the deep peroneal nerve distribution. Residual pain was highly focal, consistently localized to the anterior ankle joint line, and occurred mainly during prolonged standing and activities requiring greater dorsiflexion, particularly uphill walking. Repeat radiographs of the right ankle showed progression of the anterior osteophytes, corresponding to the site of residual pain. The focal mechanical pain pattern, in association with these anterior osteophytes and restricted ankle range of motion, was considered consistent with anterior ankle impingement. Overall pain control remained satisfactory, but orthopedic assessment was requested to assess the symptomatic anterior osteophytes and the potential role of surgical resection. The clinical timeline is summarized in Table *1*.

Month	Intervention	Right ankle NPRS	Duration of effect
0	Ultrasound-guided intra-articular injection of hyaluronic acid and methylprednisolone (right)	9/10 → 5/10	Partial relief for 6 months
6	First bilateral pulsed radiofrequency of the deep peroneal nerve	5/10 → 3/10	6 months
12	Second bilateral pulsed radiofrequency	7/10 → 3/10	6 months
27	Third bilateral pulsed radiofrequency	7/10 → 3/10	6 months, followed by right-sided recurrence
39	Diagnostic deep peroneal nerve block (right)	7/10 → complete relief	Positive diagnostic block
40	Thermal radiofrequency ablation of the deep peroneal articular branches (right)	7/10 → 3/10	Sustained at 12-month follow-up
52	12-month follow-up: residual focal pain over the anterior osteophyte; orthopedic assessment requested	3/10	–

TABLE 1: Clinical timeline of interventions, right ankle pain scores, and duration of effect

Month, time from the initial evaluation; NPRS, numeric pain rating scale

Discussion

Articular denervation of the ankle is limited by the complexity and variability of its sensory innervation, which makes target selection particularly challenging. In this case, a predominantly anterior pain distribution helped identify a single articular target despite the contribution of five peripheral nerves to ankle innervation. The case also describes a motor-sparing approach to thermal denervation in close proximity to a mixed nerve. In addition, it illustrates how effective denervation may unmask a residual focal mechanical pain component that requires a different therapeutic approach.

Clinical evidence for radiofrequency-based interventions targeting peripheral nerves around the ankle remains limited to small case series and isolated case reports. A four-patient case series described partial ankle denervation using thermal radiofrequency of the deep peroneal, sural, and saphenous nerves, with clinical improvement in three patients at 12 months [8]. Other reports have focused predominantly on neuropathic pain conditions, including superficial peroneal nerve entrapment [10], complex regional pain syndrome [11], and neuropathic pain following total ankle arthroplasty [12]. Unlike these reports, the present case involved predominantly mechanical pain in a native osteoarthritic ankle, and thermal ablation was confined to the deep peroneal articular branches.

Selection of a single neural target requires careful correlation between the clinical presentation and the underlying anatomy. In our patient, pain was consistently localized to the anterior ankle joint line, where the anterior capsule receives articular branches from the deep peroneal nerve [5,6]. Furthermore, symptoms were exacerbated by weight-bearing and ankle dorsiflexion, which increase anterior tibiotalar joint loading, further pointing to an anterior source of pain.

The response to treatment also supported this target, as pulsed radiofrequency of the deep peroneal nerve provided a greater response than intra-articular treatment (3/10 versus 5/10 on the NPRS). This suggested that the anterior capsular region supplied by the deep peroneal nerve was a major source of the patient's pain. The benefit was reproducible but time-limited with repeated pulsed radiofrequency procedures. The positive diagnostic nerve block, with complete analgesia and no motor deficit, then supported the target before proceeding to selective thermal radiofrequency ablation of the deep peroneal articular branches.

Progression from pulsed to thermal radiofrequency raised an additional safety concern regarding the risk of motor injury. Pulsed radiofrequency delivers intermittent electrical fields while limiting tissue temperature. It is generally considered neuromodulatory rather than neurodestructive, although its mechanisms of action remain incompletely understood [13]. In contrast, thermal radiofrequency produces a controlled neuroablative lesion and may provide more sustained analgesia. As the deep peroneal nerve contains both sensory and motor fibers, selective targeting of its articular branches was essential to minimize this risk. This differs from genicular radiofrequency at the knee, where the targeted articular branches are predominantly sensory and course at the periosteal level, away from major mixed nerve trunks, resulting in a lower risk of motor involvement [14].

To address this risk, specific safety and technical measures were adopted before and during thermal ablation. A diagnostic nerve block was first used to support selection of the analgesic target. During the ablation procedure, ultrasound allowed identification of the nerve and adjacent neurovascular structures, while fluoroscopy confirmed cannula position and allowed the active tip to be oriented along the anterior articular margin. This maximized the area of denervation per lesion, increasing the likelihood of capturing articular branches with variable locations. Immediately before ablation, motor stimulation provided the main safeguard against motor fiber involvement, while sensory stimulation helped confirm appropriate targeting. No motor or sensory deficit was observed during follow-up.

As overall pain decreased after thermal ablation, residual pain became highly localized to the anterior osteophyte. This pain showed a mechanical pattern, being provoked by activities requiring increased ankle dorsiflexion, particularly uphill walking, which is consistent with anterior bony impingement [15]. The radiographic progression of the anterior osteophytes further supported a structural cause. In this context, denervation provided sustained analgesia by reducing nociceptive input. However, its effect was limited to pain relief, without restoring joint function or correcting the underlying structural abnormality and restricted ankle range of motion. Consequently, this residual mechanical pain prompted orthopedic assessment for possible osteophyte resection rather than further radiofrequency treatment.

The main limitation of this case report is its design, which restricts interpretation of treatment efficacy and does not exclude a placebo effect. Outcomes were primarily based on patient-reported pain and clinical functional assessment, without systematic use of validated functional outcome measures. In addition, the sequential use of multiple interventions limits attribution of benefit to any single treatment. Despite the same pulsed radiofrequency parameters used in both ankles, differences in the number of target sites, baseline symptom severity, and subsequent treatment preclude meaningful within-patient comparison. The diagnostic block was performed proximal to the articular branches and may therefore have also anesthetized other structures supplied by the deep peroneal nerve. For this reason, its result was interpreted together with the pain distribution and the previous response to pulsed radiofrequency. Follow-up after thermal ablation was also limited to 12 months. Furthermore, selective radiofrequency treatment of the deep peroneal articular branches is not yet standardized, as the optimal targets, procedural parameters, and patient-selection criteria remain to be established. Finally, the absence of motor complications in this patient supports the feasibility of the procedure, but larger studies are needed to establish its safety.

Conclusions

In refractory ankle osteoarthritis with predominantly anterior pain, selective thermal radiofrequency ablation of the deep peroneal articular branches to the anterior capsule may offer prolonged pain relief, with no motor deficit observed in this patient. This case highlights the potential value of combining pain distribution, articular anatomy, and the response to diagnostic and therapeutic interventions to guide neural target selection. When thermal ablation is considered near a mixed nerve, a diagnostic nerve block supporting the analgesic target, combined with motor stimulation before ablation, may provide an additional safeguard before treatment. Residual pain after denervation should be reassessed according to its clinical characteristics, as it may reflect a persistent mechanical component requiring a different therapeutic approach. Further anatomical and prospective clinical studies are needed to define optimal targets, procedural parameters, patient selection, safety, and functional outcomes.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

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