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Postamputation pain treatment by radiofrequency ablation of common peroneal nerve

Dear Editor,

An estimated 464,644 people undergo amputation every year in the United States [1]. Postamputation pain (PAP) affects 30% to 80% of these people chronically, with studies reporting 43% to 76% of patients suffering from residual limb pain (RLP) and 60% to 85% from phantom limb pain (PLP) [2–4]. RLP is believed to have a structural cause such as adhesive scar tissue, heterotopic ossification or neuroma [5]. The mechanisms responsible for PLP are poorly understood with some theories implicating central factors such as cortical somatosensory remapping and reorganization within the spinal cord, but ectopic foci from peripheral nerves may also be at play [4,5]. The pathophysiology of RLP and PLP may differ, but both forms of PAP can be extremely distressing to the patient, requiring medication or more invasive intervention.

Unfortunately, systematic reviews conclude that there is insufficient evidence to support recommendation of one medication over another for PAP [6–8]. This lack of reliable treatment has led to some patients undergoing more invasive interventions such as spinal cord stimulation, surgical revision, and even deep brain stimulation [5]. With all this in mind, the optimal strategy for managing PAP seems to be a multimodal treatment regimen that may include nonpharmacologic interventions. One intervention that has shown success as part of this multifaceted approach to address PAP is radiofrequency ablation (RFA). Furthermore, the literature consists of limited trials and cases of RFA supporting the hypothesis that this treatment modality may be a promising option for long-term relief of PAP [9–11]. Contributing to the sparse literature on interventions that provide long-term relief for PAP, particularly regarding the use of RFA for PAP, we present one of the few reported cases involving RFA to the common peroneal nerve (CPN). To the authors' knowledge, this case is the first ever reported RFA performed on the CPN without directly targeting a neuroma.

A 66-year-old K4 functional level male presented to our university pain clinic with persistent and uncontrolled PAP following a traumatic right transtibial amputation approximately 42 years ago. The patient reported multiple surgeries, including a revision one week post-amputation as well as surgery two years post-amputation to address heterotopic ossification in his residual limb. He then underwent a saphenous neuroma excision 5 years later that reduced PLP greatly but did not eliminate it.

Upon presentation to our clinic, he occasionally experienced PLP, but his biggest complaint was acute episodes of burning and aching pain over the lateral half of the distal portion of his residual limb and right buttocks. These pains were routinely provoked by activity and often reached an 8/10 NRS. Despite longstanding pain, he felt his PAP had markedly increased in the last 3 years, which he attributed partly to a neuroma of the right CPN.

Initial physical exam revealed a well-appearing gentleman who had a residual right lower extremity limb with intact skin that had no signs of wounds or pressure injury. Oral medications were discussed, but he did not want to risk potential cognitive side effects. Given the patient had exhausted conservative therapies, he was offered a diagnostic peripheral nerve block of the right CPN to assess candidacy for RFA. After an ultrasound-guided block of the right CPN with a 15 mL mixture of 0.25% bupivacaine and preservative-free normal saline yielded 100% pain reduction, the patient was quickly scheduled for RFA.

A combination of fluoroscopic and ultrasound guidance for this novel procedure was utilized to adequately identify CPN location. After the patient was placed in the prone position, a Fujifilm SonoSite X-Porte ultrasound machine was used to identify the neuroma of his right CPN and our target, which was approximately 1.5 cm proximal to the neuroma. The skin above this area was anesthetized with 2 mL of 1% lidocaine utilizing a 27G 1.5-inch needle. A Nimbus Electrosurgical RF Multi-tined Expandable Electrode (Tip Type: Black Bevel, Active Tip: 10mm, Tip OD: 1.47mm, length: 50mm, Ref NM-050-10BB) was advanced through the skin under ultrasound guidance. A second electrode was inserted in close proximity (Fig. 1A and B).

Motor stimulation up to 1.7V applied through the electrodes was consistent with peroneal nerve supply as we observed contraction of the tibialis anterior muscle. Once appropriate positioning was confirmed, a mixture of 0.25% bupivacaine and 2% lidocaine was injected through the cannulas. A Nimbus Probe Disposable RF Thermocouple Electrode (Length 5cm, Ref NDP-50-27-SS) was then inserted into each cannula. A Cosman G4 generator was set to bipolar, thermal ablation mode for 90 seconds at 80° Celsius. After the first cycle, the needles were moved ~3 mm laterally. Another lesion was performed here at the same settings (Fig. 3). After this, the needles were redirected more anterior to the nerve and 2 more thermal RFA cycles were completed, one medially (Fig. 2A and D) and one laterally (Fig. 2B and C). After a total of 4 locations were ablated, the needles were withdrawn uneventfully.

The patient tolerated the procedure very well; he was able to walk with minimal discomfort before being discharged and was advised to call the pain clinic or seek emergency care in case of unexpected extremity weakness, paresthesia, or other worsening of his clinical condition. While previous pain upon activity was rated 8/10 on NRS, RFA of the right CPN was followed by 0/10 pain upon activity with no return of symptoms for 9 months. Despite the procedure resulting in total paralysis of the tibialis anterior and partial paralysis of other residual limb muscles, the patient expressed he was able to use his prosthetic with dramatically improved function throughout this time. His pain eventually recurred 9 months later, but intensity and frequency were still much lower than prior to RFA.

This letter describes the first case of a patient with years of refractory RLP and PLP successfully treated with RFA of the CPN without directly targeting a neuroma, achieving 9 months of 100% pain relief with no adverse events or loss of function. Although RFA is most used to target

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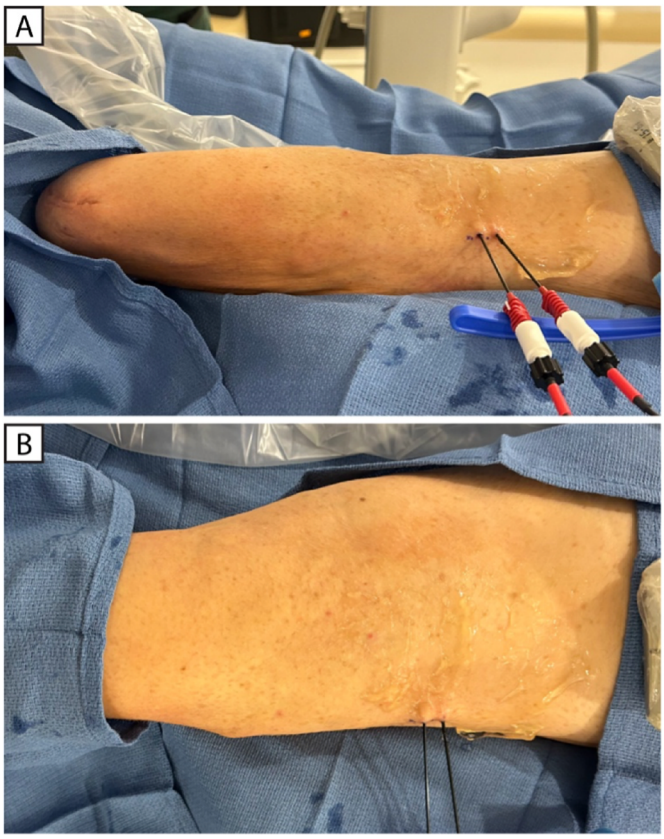

Fig. 1. Lateral (1A) and superior (1B) view of electrode placement for RFA

nerves originating from the facet joints of the lumbar, thoracic, and cervical spine, its application has expanded to address a variety of other pain generators, including those in the knees, sacroiliac joints, hips, and shoulders. The major commonality is that the procedure most often targets nerves that are either purely sensory or whose motor fibers do not affect limb movement (such as vertebral medial branches innervating posterior spinal muscles). This is largely based on the assumption that targeting mixed nerves with sensory and motor fibers would be detrimental to patient function. In many cases, this assumption would hold true; however, for patients who have undergone amputations, their downstream muscles have already lost their traditional functions. This patient who received RFA to CPN hoped the main message his story would convey is that "the world needs a different way of thinking about pain management for amputees."

While there is a general paucity of literature regarding strategies for long-term relief from PAP, the limited number of reports on RFA for PAP is especially surprising considering that the value of RFA for intractable pain was discovered nearly 100 years ago. Nevertheless, the results of limited trials and cases of RFA for PAP support the hypothesis that this intervention may be one of the most promising options for long-term relief of PAP.

A case series published by Guo et al. demonstrated that 3 months after RFA for PAP in individuals with residual limb neuromas, 6 of 9 individuals had greater than 50% pain reduction with no adverse effects [9]. Another study used the NRS to analyze effects of RFA to residual limb neuromas in 18 patients. Those with RLP had their pain ratings improve from 8.6 ± 1.0 to 1.9 ± 1.9 at 6 months ($p < 0.001$, vs preoperatively) and to 2.2 ± 2.1 at 12 months ($p < 0.001$, vs preoperatively). Patients with PLP had similarly promising results, with not only statistically significant but also dramatic reductions in both intensity and frequency of their pain maintained at 6-month and 12-month follow-ups [10]. Considering the lack of consensus on best treatments for PAP, these results suggest that more amputees with intractable pain should be offered a diagnostic nerve block to assess candidacy for RFA.

PAP is already an uncontrolled problem for many patients, and the overall amputation prevalence is expected to double between 2005 and 2050 [12]. Larger trials are needed to further evaluate RFA for PAP, but the results presented here and in other reports suggest that RFA may be an efficacious long-term strategy for these patients. Further exploration of RFA certainly appears to be a promising step toward redefining the approach to pain management in amputees.

Author disclosures

None.

Declaration of competing interest

The authors declare that they have no known competing financial

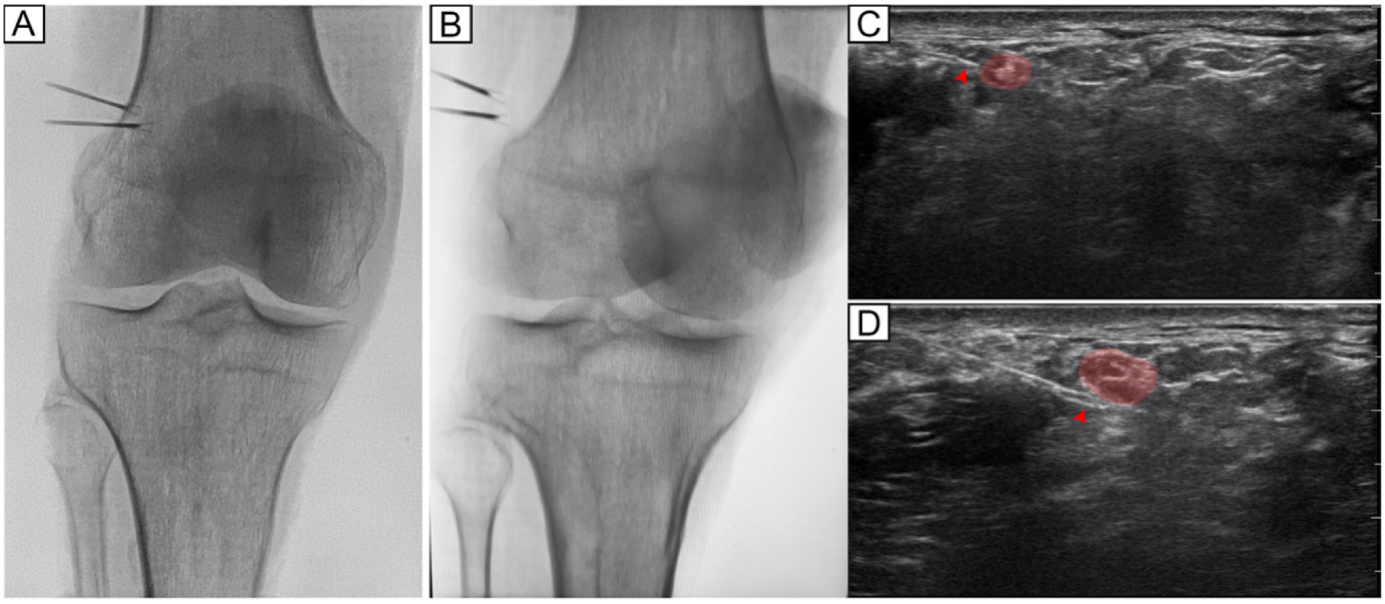

Fig. 2. Fluoroscopic (2A, 2B) and ultrasound-guided (2C, 2D) images of RFA with multi-tined expandable electrodes.

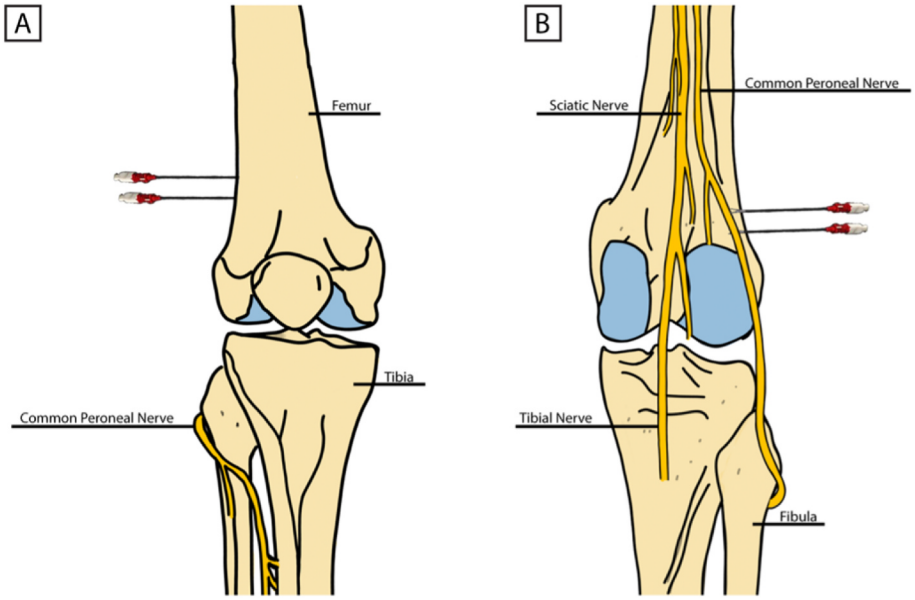

Fig. 3. Anterior (A) and posterior (B) views of pertinent anatomy for RFA of CPN.

interests or personal relationships that could have appeared to influence the work reported in this paper.

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