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Treatment of Chronic Plantar Heel Pain With Radiofrequency Neural Ablation of the First Branch of the Lateral Plantar Nerve and Medial Calcaneal Nerve Branches

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ABSTRACT

From March 2012 to February 2013, 37 patients experiencing plantar heel pain for ≥6 months despite treatment with physical therapy and other conservative treatment modalities were followed up. If neurogenic heel pain originating from the first branch of the lateral plantar nerve was present, with or without the medial calcaneal nerve, diagnostic nerve blocks to these nerves were performed for confirmation. If the pain was determined to be of neurogenic origin, radiofrequency neural ablation (RFNA) was applied to the corresponding sensory nerve endings. Pain was evaluated using the visual analog scale, and patients were followed for at least one year. A total of 41 feet from 37 patients (30 [81.1%] females, 7 [18.9%] males; mean age, 50.7 ± 1.6 years; mean body mass index, 30.6 ± 0.7 kg/m^2) were included. The mean visual analog scale scores improved significantly from 1 to 6 to 12 months after the procedure relative to before the procedure, with 88% of all patients rating the treatment as either very successful or successful at 12 months postoperatively. RFNA applied to both the first branch of the lateral plantar nerve and the medial calcaneal nerve sensory branches (16 [39%] feet) and only the first branch of the lateral plantar nerve sensory branches (25 [61%] feet) showed similarly high levels of success. Of the 41 feet, 28 [68.3%] had received extracorporeal shockwave therapy, 35 [85.4%] had received steroid injections, and 22 [53.7%] had received both extracorporeal shockwave therapy and steroid injections before RFNA as an index procedure. All were unresponsive to these previous treatments. In contrast, almost all (88%) were treated successfully with RFNA. Despite a high incidence of neurologic variations, with a precise diagnosis and good application of the technique using the painful points, chronic plantar heel pain can be treated successfully with RFNA.

Plantar heel pain constitutes 11% to 15% of visits to professionals for foot pain in United States (1). The most common cause of plantar heel pain is plantar fasciopathy, for which the term *plantar fasciitis* has been widely used. However, because of degenerative histopathologic findings, the term *plantar fasciosis* has been used more frequently. In addition, the term *heel spur syndrome* has been used (2). To more broadly describe this condition and avoid confusion, we have used the term *plantar fasciopathy*. Some other less common causes of plantar heel pain are calcaneal stress fracture, plantar fascia rupture, and fat pad disorders (3). Entrapment of the first branch of the lateral plantar nerve (FBLPN) and lesions of the medial calcaneal nerve (MCN) branches can contribute to the symptoms (2).

Calcaneal bone spurs accompanied by plantar fascial enthesis have been observed in 50% of patients experiencing plantar heel pain (4). Calcaneal spur formation is an indication of sustained plantar fasciopathy, although the bone spurs will not be the primary source of pain (5). However, bone spurs can be large enough to cause pain and compress the FBLPN (6).

The biomechanical etiology is usually related to the windlass mechanism and increased tension on the plantar fascia. Obesity, overloading, or anatomic malformations can also contribute to the symptoms (7). Entrapment of the FBLPN occurs between the deep fascia of the abductor hallucis muscle and the medial head of the quadratus plantae muscle (8).

Excessive pronation of the subtalar joint leads to repetitive pressure on the MCN branches and can cause nerve sheath

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inflammation, resulting in neuritis (9). Furthermore, chronic irritation can lead to proliferation of perineural connective tissue. This can cause chronic nerve sheath thickening (10). Davidson and Copoloff (11) reported that neuromas in the MCN branches will lead to calcaneal heel pain.

To clarify the etiology of heel pain, a detailed history should be obtained and a careful physical examination performed. Typically, the pain of plantar fasciopathy will spread to the proximal plantar fascia and the plantar fascia origin at the calcaneal tuberosity (9). Such pain usually occurs in the patient's first few steps of the morning and disappears with walking. At times, the heel pain can be exacerbated by prolonged standing (12). Passive stretching of the plantar fascia or standing on the toes (tiptoe) could also increase the symptoms of plantar fasciopathy (13,14).

In most patients, plantar fasciopathy will respond to nonoperative treatment (15). Thus, conservative treatment should be the first choice for such patients, including treatment with nonsteroidal anti-inflammatory drugs, heel pads, night splints, physical therapy, and corticosteroid injections (16). However, for patients with persistent plantar heel pain, the treatment choice remains controversial. If conservative treatments fail, neurologic causes should be considered (2).

Heel pain originating from irritation or entrapment of the nerves that innervate the heel region is defined as neurogenic heel pain. Chronic plantar heel pain has been found to be related to entrapment of the FBLPN at a rate of 15% to 20% (17). Furthermore, it has been reported that chronic heel pain caused by entrapment of the FBLPN is the most common cause of plantar heel pain of neural origin, with lesions of the MCN the second most common (3).

Radiofrequency neural ablation (RFNA) can be used to provide relief from chronic pain and works by using lateral heat dissipation from the active electrode. An isolated electrode is placed on the sensitive region of the heel, an electrical generator source is connected to this electrode, and electromagnetic energy (radio waves) is transmitted to the surrounding tissue, leading to protein denaturation by heat energy. This results in ablation of the injured nerve endings (18). Cozzarelli et al (9) reported that, in patients with neurogenic heel pain, RFNA provides a long-term success rate of 89%.

The purpose of the present study was to evaluate the effectiveness of RFNA treatment on chronic plantar heel pain that has been unresponsive to physical therapy options, steroid injections, and/or extracorporeal shockwave therapy (ESWT).

Patients and Methods

Patients with neurogenic chronic plantar heel pain were included in the present study. The inclusion and exclusion criteria are reported in Table 1. From March 2012 to February 2013, 41 feet of 37 patients experiencing plantar heel pain for ≥6 months despite treatment with physical therapy and other conservative treatment modalities were followed up. We carefully examined each patient to diagnose the presence of any neurogenic component. If neurogenic heel pain was diagnosed, RFNA was applied to the sensory branches of the FBLPN and/or the MCN terminal branches. Pain was evaluated using the 100-mm visual analog scale (VAS), and the patients were followed up for ≥1 year. The institutional review board approved the present study, and all the patients provided informed consent before treatment. The Plantar Heel Pain Treatment Ladder developed by the American College of Foot and Ankle Surgeons was used in the present study (2).

All enrolled patients had been referred from the physical therapy department, where ESWT (2000 to 2500 impulses at 7 to 11 Hz and 2 to 3 bars, 3 times weekly; DolorClast®, EMS, Nyon, Switzerland) had been applied to 28 feet, steroid injections had been given to 35 feet, and both steroid injections and ESWT had been performed to 22 feet. A detailed historical evaluation (Supplemental Fig. S1) and a careful physical examination were performed, including a weightbearing radiograph and, for some patients, magnetic resonance imaging. Electromyography was performed for peripheral neuropathy, tarsal tunnel syndrome, and/or radiculopathy. The FBLPN is a motor nerve that innervates the abductor digiti minimi and contains the sensory branch to the periosteum of the calcaneal tuberosity. Therefore, a cutaneous sensory deficit in the case of FBLPN entrapment is not expected. If sensibility is present at the heel region, an entrapment proximal to the FBLPN should be considered (19). In the case of tarsal tunnel syndrome, sensation deficits such as tingling and numbness are often present (20), and a positive Tinel's test for the posterior tibial nerve and its branches and abnormal sensibility of the toes and hallux (19). In contrast, the Tinel test will be negative for FBLPN entrapment (21), although MCN entrapment can give positive results. Accordingly, a careful physical examination and evaluation of patients with suspected entrapment to discriminate the presence of MCN entrapment due to tarsal tunnel syndrome were performed. Patients with positive abnormal sensibility of the toes and hallux were excluded. Diagnostic nerve blocks were conducted with 1 mL of lidocaine ≥1 week before the RFNA procedure (Fig. 1).

Before the RFNA procedure, the most sensitive points were marked on the heel with ink, and the possible trace of the FBLPN and MCN were drawn with a pen (Fig. 2). Under sterile conditions, superficial anesthesia was administered with 0.5 mL of lidocaine at the entry points. The radiofrequency probe was placed just medially to the calcaneal tuberosity under fluoroscopy with palpation of the medial heel. Impedance values <100 Ω indicated bleeding into the tissue. In such cases, the probe was cleaned and the position changed. First, low-energy impulses were applied at 2 Hz. The voltage was increased from 0 V and the occurrence of any stimulation,

Table 1
Inclusion and exclusion criteria

Inclusion Criteria	Exclusion Criteria
>6 mo of persistent plantar heel pain	Age <18 y
Treatment with oral anti-inflammatory drugs, heel cups, and physical therapy	Diabetes mellitus
Treatment with ≥2 of following	Inflammatory diseases (e.g., ankylosing spondylitis, rheumatoid arthritis, Reiter syndrome)
Stretching exercises	Previous foot or ankle fractures
Home cryotherapy	Tarsal tunnel syndrome
Shoe modifications	Intolerance to injections
Arch support	
Arch support	
Limiting activities	
Limiting activities	
Night splints	
Orthotic device	
Immobilization	
Steroid injection or extracorporeal shock wave therapy, or both	
Diagnostic nerve block positivity	

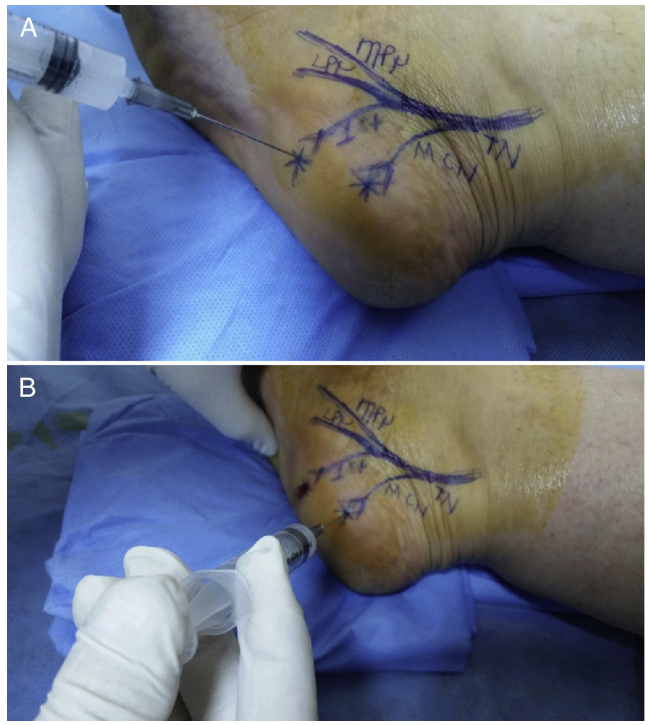

Fig. 1. (*A* and *B*) Diagnostic nerve block. LPN, lateral plantar nerve; MCN, medial calcaneal nerve; MPN, medial plantar nerve; TN, tibial nerve.