J Anesth (2014) 28:924–927
DOI 10.1007/s00540-014-1831-9

CLINICAL REPORT

Pulsed radiofrequency under ultrasound guidance for the tarsal tunnel syndrome: two case reports

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Received: 3 December 2013 / Accepted: 31 March 2014 / Published online: 12 April 2014

Abstract Tarsal tunnel syndrome (TTS) is a compression neuropathy that results from entrapment of the posterior tibial nerve or its branches. TTS may be treated either by conservative measures, including physical therapy, medications, and steroid injections, or by surgical decompression. Despite a variety of treatments, a few cases of TTS will relapse, and many cases of recurrent TTS will require re-operation. Pulsed radiofrequency (PRF) is known to have a number of advantages for pain management, particularly as this technique does not cause neural compromise such as motor weakness. Here, we report a new application of ultrasound-guided PRF in two cases of intractable TTS. Both patients had a long duration of severe foot pain and had been treated with various therapeutic modalities without lasting relief. We applied ultrasound-guided PRF to the affected posterior tibial nerve in each patient, and both had significantly reduced pain intensity scores and analgesic requirements without any complications. Ultrasound-guided PRF for intractable TTS relieved severe foot pain. It may supersede surgery as a reliable treatment for intractable TTS.

Keywords Tarsal tunnel syndrome · Ultrasound · Pulsed radiofrequency

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Introduction

Tarsal tunnel syndrome (TTS) is caused by the entrapment of the posterior tibial nerve under the fibro-osseous tunnel and behind the medial malleolus [1, 2]. The symptoms of TTS include numbness, paresthesia, and burning pain on the medial aspect and sole of the foot, and motor deficits can develop. Although surgical outcomes for TTS are fairly good [1, 2], some patients will experience persistent pain despite surgical intervention.

Pulsed radiofrequency (PRF) is a safe and effective intervention for many types of intractable pain [3–5], but there are few reports on the use of PRF for treatment of peripheral nerves, particularly mixed motor and sensory nerves. This report describes the successful application of ultrasound-guided PRF for two patients with intractable TTS.

Case description

Case 1

A 67-year-old male patient with a complaint of left foot pain and numbness visited our clinic. He had been diagnosed with TTS 5 years previously and had since undergone two surgical decompressions of the tarsal tunnel, at 5 years and at 3 years before the present visit. After the first operation, he had had temporary relief lasting for about a year, but he required a revision operation 3 years ago, in spite of which the pain had become progressively worse. The patient described the pain as originating just in the area of the medial malleolus and occasionally into the medial aspect of the foot with an intensity of 8–9/10 on a visual analog scale (VAS). The pain was constant, aching,

and cold, and was provoked by standing and walking and relieved with rest. Hyperalgesia, cold allodynia, and paresthesia were accompanied by mild edema. Physical examination elicited tenderness with a positive Tinel's sign. There were no osteophytes or other structural abnormalities on plain radiography. Electromyography (EMG) after the previous two operations had confirmed left tibial nerve entrapment.

Pregabalin 150 mg/day, milnacipran 25 mg/day, and celecoxib 200 mg/day were prescribed, but these medications had no effect. Moreover, the patient was reluctant to take the medications because of gastrointestinal distress. A diagnostic posterior tibial nerve block was performed under ultrasound guidance with 0.5 % mepivacaine 2 ml and triamcinolone acetate 20 mg. This intervention resulted in significant relief of pain for 1–2 days, with VAS dropping from 8–9/10 to 1–2/10. Thus, PRF of the posterior tibial nerve under ultrasound guidance was scheduled. A 22-gauge, 100-mm RF cannula with a 5-mm active straight tip was advanced to the posterior tibial nerve just below the left medial malleolus using an in-plane ultrasound approach (Fig. 1). Sensory stimulation was performed at 0.4 V and 50 Hertz to identify the nerve, and PRF was then applied for 120 s at 42 °C. There were no complications. After the procedure, the patient's VAS was decreased to 2–3/10, and at the 12-month follow-up, the patient's VAS remained low, at 2–3/10, and he indicated satisfaction with the PRF treatment.

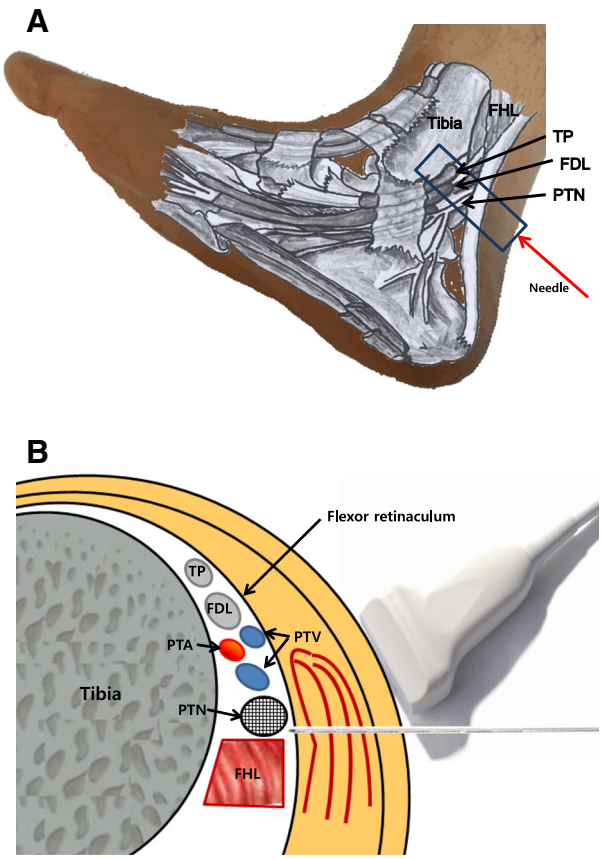

Fig. 1 Medial ankle. **a** Illustration of the medial ankle. **b** Transverse-oblique imaging shows the posterior tibial nerve, artery, veins, and tendons. *TP* tibialis posterior, *FDL* flexor digitorum longus, *PTA* posterior tibial artery, *PTV* posterior tibial vein, *PTN* posterior tibial nerve, *FHL* flexor hallucis longus

Case 2

A 56-year-old female patient with 2 years of right foot pain was referred to our clinic by an orthopedic consultant. She was diagnosed with TTS by clinical symptoms and EMG. Her symptoms included severe pain (VAS 8/10) on the medial aspect of the foot, numbness, and electrical shock-like pains. The pain was aggravated after walking for more than 20 min. She had a positive Tinel's sign with tenderness over the affected area on physical examination, but no sign of motor weakness. Plain X-ray did not show structural abnormalities, and no cystic lesion was seen on ultrasound examination. The EMG findings suggested a right tibial nerve neuropathy. In spite of three steroid injections, the pain soon relapsed. The orthopedic surgeon had recommended surgery to the patient, but she refused. Therefore, we conducted two rounds of ultrasound-guided PRF. After the first trial, the VAS was decreased from 8/10 to 4/10. Two months later, the patient had a second PRF treatment, and the VAS dropped to 1–2/10. There were no complications at either treatment. As of an 8-month follow-up, the patient's VAS remained at 2/10, and she was not using analgesics.

Discussion

There are surgical and nonsurgical options for the treatment of TTS [6]. Nonoperative methods involve antiinflammatory medications, activity modifications, orthotic shoes, immobilization, aspiration of ganglia, corticosteroid injections, and physiotherapy [6]. When nonoperative treatments fail, surgical decompression to free the posterior tibial nerve from any entrapments is considered [6]. However, success rates of surgical treatment vary, ranging, as reported in the literature [7], from 44 % to 95 %. Causative factors related to failure of surgical treatment include incorrect initial diagnosis, incomplete release, adhesive neuritis, intraneural damage, and presence of a space-occupying lesion [8]. In the first case presented here, the patient had undergone two unsuccessful surgical decompressions. Because he underwent both operations at other hospitals, we could not ascertain exactly why his symptoms persisted, but based upon the medical history, symptoms, and EMG findings,

intraneural damage or adhesive neuritis by repeat surgery were suspected.

In the treatment algorithm for failed tarsal tunnel release, in cases in which all other treatment modalities have been ineffective, interventions including spinal cord stimulation (SCS), peripheral nerve stimulation (PNS), and intrathecal pumps are considered [8]. We approached the management of our patients in a stepwise manner. However, steroid injection and oral medications had little effect. Therefore, before attempting neuromodulation therapies, we recommended PRF for the affected posterior tibial nerves.

PRF has proven to be a very useful therapeutic modality for treatment of pain and other neuropathic syndromes. There are some differences between conventional RF and PRF. The most important difference between the two approaches is the needle tip temperature required for lesioning. In contrast to conventional RF, the needle tip temperature in PRF does not exceed 42 °C [9–11]; such a temperature does not cause tissue destruction but creates a pulsed electrical field [9, 10, 12]. Production of heat in conventional RF is caused by to ionic friction of RF current flow [10], and in PRF, RF energy is only applied during a pulsed time cycle of 2 × 2 ms/s [11]. PRF can disrupt internal ultrastructural components of axons, especially mitochondria, microfilaments, and microtubules [13]. PRF causes transient mild edema without affecting the structural integrity of the nerve via alterations in the function of the blood–nerve barrier, fibroblast activation, and collagen deposition. PRF also leads to nonstructural changes in gene expression or cytokine upregulation in injured tissue [14]. Because of these advantages, PRF is applied to a variety of pain treatments including arthritis, groin pain, orchialgia, complex regional pain syndrome, trigeminal neuralgia, glossopharyngeal neuralgia, radicular pain, occipital neuralgia, postherniorrhaphy neuralgia, postlaminectomy syndrome, and others [9].

The posterior tibial nerve is a mixed motor and sensory nerve, and therefore conventional RF carries a risk of motor weakness, whereas PRF seems to be comparatively safe based on reports involving suprascapular, median, axillary, phrenic, and pudendal nerves [4, 15–18]. In the current report, PRF was applied at 42 °C for 120 s and three cycles in both cases. There is no definite evidence regarding temperature, duration, and cycles, and we applied the PRF protocol empirically.

The success of PRF depends mainly on the gap between the target nerve and the RF needle tip. In this respect, ultrasound-guided procedures can offer many advantages, including direct visualization of the targeted nerve and the needle tip, with avoidance of neural trauma from repeat needling [4]. In a similar approach to that of Haider et al. [4], who performed PRF on ventral, medial, and dorsal surfaces of the median nerve, we made PRF lesions on four different surfaces of the posterior tibial nerve. The availability of ultrasound makes these detailed procedures possible.

In the cases presented here, we were able to treat two patients with intractable pain caused by TTS by using ultrasound-guided PRF. We propose that PRF offers considerable reliability as a therapeutic modality for TTS, and that ultrasound was essential for the afore-described PRF procedures. Further evaluation of the efficacy of PRF for various types of pain of peripheral origin is indicated.

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