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Pulsed radiofrequency of the median nerve under ultrasound guidance for management of intractable neuropathic pain

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Abstract

A median nerve injury in the forearm may lead to devastating sequelae if left untreated. Even with appropriate treatments involving microsurgical techniques and postoperative care, patients may still experience lasting neuropathic pain that significantly reduces their quality of life. Pulsed radiofrequency (PRF) is widely performed to alleviate such neuropathic pain caused by trauma.

A 47-year-old man visited our pain clinic with allodynia, hyperalgesia, paresthesia, skin color changes, and atrophy in the right forearm. In the orthopedic department, the patient was treated by neurectomy of the median nerve to manage the intractable pain. However, the effect was unsatisfactory. The fourth median nerve block performed in our pain clinic after neurectomy produced good results, and ultrasound-guided PRF of the median nerve was performed.

The patient showed 80% relief of symptoms within 5 hours after the procedure. The visual analog scale score for the forearm decreased from 8/10 to 1/10. This case suggests that ultrasound-guided PRF can be a therapeutic option for the management of refractory neuropathic pain after neurectomy in patients with a median nerve injury.

Keywords

Pulsed radiofrequency, ultrasound, neuropathic pain, median nerve, nerve injury, neurectomy

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Introduction

Pulsed radiofrequency (PRF) has been successfully used to manage various chronic pain conditions. Many reports have indicated that PRF improves chronic pain when applied to the peripheral nerves.[1–3] PRF is a non- or minimally neuromodulated technique that sends short bursts of a high-frequency current into nervous tissue.[4] A median nerve injury in the forearm remains a potentially devastating injury for most patients. Despite microsurgical techniques and postoperative management efforts, patients still experience adverse sequelae and neuropathic pain.[5] Traumatic neuropathy is complex and multifactorial; thus, it cannot be resolved by surgery alone. Treatment of traumatic neuropathy should be multidisciplinary and begin with prevention; this should be followed by a proper diagnosis, pharmacological and neuropathic pain relief therapy, rehabilitation, and psychological support.[6] We herein report a case involving the management of intractable neuropathic pain due to a median nerve injury using PRF of the median nerve under ultrasound guidance as an effective therapeutic option.

Case report

The study protocol was approved by the Saint Vincent's Hospital Ethics Committee (IRB approval no. VC19ZES10044), and written informed consent was obtained from the patient.

A 47-year-old man visited our pain clinic with allodynia, hyperalgesia, paresthesia, motor weakness, skin color changes, and atrophy in the right forearm (Figure 1). The patient had injured his median nerve in a hydraulic linkage accident 1 year prior to the visit. His motor function in the right arm was decreased according to the results of an electromyography (EMG) study. Both a sensory and motor nerve conduction study (NCS) showed no evoked potential in the right median nerve. Needle EMG exhibited abnormal spontaneous activities at rest in all sampled muscles. These EMG/NCS findings were definitive for neuropathy of the right median nerve. Digital infrared thermal imaging results revealed that the affected arm was colder than the unaffected side by 2.23°C (Figure 2). The patient's pain was severe, scoring 8/10 on a visual analog scale (VAS). He was taking 1200 mg of gabapentin, 20 mg of oxycodone, and 10 mg of nortriptyline daily. He received a paravertebral block at the right T2 level, but this yielded no substantial reduction of his symptoms. In the orthopedic department, he underwent neurectomy of the median nerve as a radical means of relieving pain. However, the effect was limited. We performed a median nerve block in the right forearm, and his VAS score for the pain in the forearm decreased from 8/10 to 2/10. After four median nerve blocks, we decided to perform PRF of the median nerve.

The patient was positioned supine with his forearm and fingers resting on a table and palm facing upward. The skin was prepared with povidone and draped in a sterile fashion. The median nerve was identified at the proximal carpal tunnel at the level of the antecubital fossa under ultrasound guidance. A 12-mHz, 38-mm linear probe (SonoSite Inc., Bothell, WA, USA) was used to identify the median nerve in cross section, medial to the biceps tendon and brachial artery and located in the antecubital fossa area of the right arm (Figure 3(a)). A 22-gauge, 10-cm-long, 10-mm active-tip RFK needle (Radionics Inc., Burlington, MA, USA) was advanced using the in-plane technique toward the median nerve. Sensory and motor stimulation were tested after the needle tip was placed near the median nerve. Responses to sensory and motor stimulation were checked at 50 Hz,

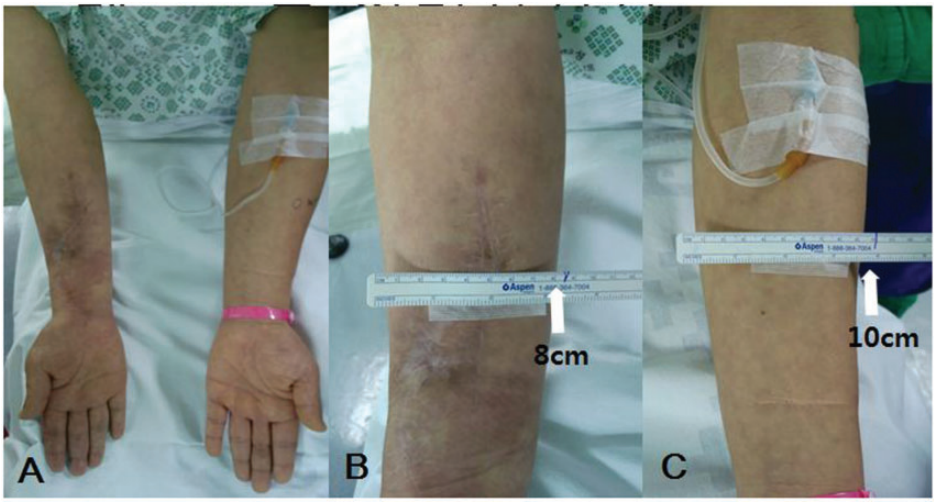

Figure 1. Comparison between affected and unaffected forearms. (a) The right forearm exhibited skin color changes and atrophy. The width of the (b) affected forearm was 2 cm less than that of the (c) unaffected forearm.

Figure 2. Skin temperature of affected limb. The skin temperature of the affected limb was 2.23°C colder than that of the unaffected limb.

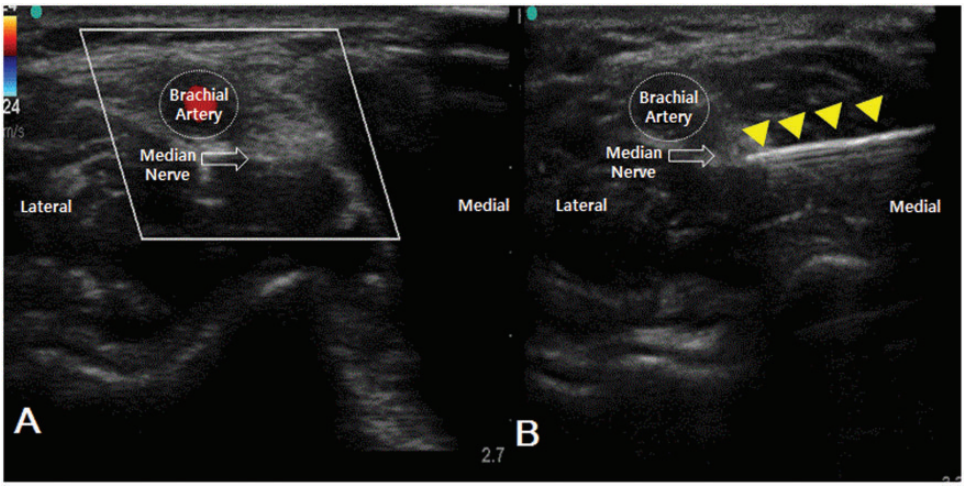

Figure 3. Ultrasound-guided radiofrequency ablation of the median nerve. (a) The brachial artery was examined with color Doppler. (b) The pulsed radiofrequency needle (arrowheads) was placed in the median nerve.

0.5 V and at 2 Hz, 1 V. PRF was conducted for 120 s at a frequency of 2 Hz and a pulse width of 20 ms at 42°C. For additional lesioning, the median nerve was identified at the elbow level using ultrasound. PRF of the median nerve at this level was repeated with the same frequency and pulse width as at the wrist level (Figure 3(b)). After the procedure, the patient developed no complications such as pain, bleeding, or ongoing paresthesia. He reported a significant relief in his symptoms within the next 5 hours; his pain had been reduced by 80%. The VAS score decreased from 8/10 to 1/10. This lower VAS score for the forearm was maintained beyond 6 months.

Discussion

PRF has been established as an effective therapy for chronic pain since the first PRF procedure was performed on a lumbar dorsal root ganglion (DRG) in 1996.[7,8] Unlike conventional high-temperature radiofrequency, PRF can stimulate a DRG or a sensory nerve by a short, high-frequency electrical current, minimizing nerve damage; this makes the procedure less destructive.[9,10] PRF may change neuronal membranes and selectively affect the C- and A-δ fibers.[11] Moreover, PRF near a DRG or sensory nerve may modify the biological activity of synaptic transmission and even the cell morphology.[12,13] PRF applied to a rat cervical DRG increased c-Fos immunoreactivity for 7 days after the treatment.[14] Low-voltage PRF may attenuate mechanical allodynia and thermal hyperalgesia by affecting the phosphorylation of extracellular signal-regulated kinase as shown in a rat model of neuropathic pain produced by spinal nerve ligation.[15]

PRF has been used to treat radicular pain (including cervical radicular pain), facial pain (including trigeminal neuralgia), sacroiliac joint pain, facet arthropathy, shoulder pain, postsurgical pain, groin pain, and myofascial pain conditions. Furthermore, PRF is reportedly a safe and effective procedure, even when other treatment modalities have failed.[16] PRF is nondestructive, safe, repeatable, and

long-lasting.[17,18] PRF can also effectively treat hyperalgesia triggered by injured peripheral nerves. In one study, PRF at the impaired sciatic nerve relieved neuropathic pain due to a chronic constriction injury by regulating the expression of the glial cell line-derived neurotrophic factor in the nervous tissues.[19] However, the exact mechanism of PRF action remains unclear.[11]

Traumatic neuropathies are mostly commonly caused by minor traffic accidents, injuries at the workplace, or accidents at home. An estimated 6% to 8% of the population has chronic neuropathic pain.[20,21] Despite advances in surgical techniques, the prognosis of traumatic neuropathies is poor.[22] A great majority of injuries to peripheral nerves occur in the upper extremities, most commonly the radial, ulnar, and median nerves.[23,24] Although proper treatment performed in a timely manner should produce a satisfactory outcome in most patients with a median nerve injury, some patients may be left with adverse functional sequelae despite microsurgery; additionally, appropriate postoperative management and recovery from these nerve injuries in both adults and children are difficult and time-consuming.[5] Persistent pain is the most frequent complaint after peripheral nerve damage,[4] and it significantly devastates the general well-being of the individual.

Nerve-related procedures for chronic neuropathic pain include neurolysis/decompression, neurectomy, and nerve repair/reconstruction. After failed neurolysis of a sensory nerve, neurectomy can induce numbness of the sensory nerves instead of painful dysesthesia.[26] The exact pathophysiology of neuropathic pain has not yet been clarified, but multiple mechanisms contribute to nerve damage, including compression, transection, contusion, stretch, and crush injuries. The physician may choose from diverse treatment options that correlate with the mechanism of injury.[26] However, navigating through these treatment modalities may be stressful for physicians and is not cost-effective for patients. A substantial percentage of patients undergo more than one treatment before obtaining a reasonable outcome. The patient in the present case first underwent neurectomy of the median nerve but obtained suboptimal results. However, because the median nerve block effectively relieved his pain, PRF was considered as the next therapeutic option and fortunately provided a satisfactory effect.

Ultrasound-guided nerve blocks help to shorten the procedural time and reduce the number of needle passes to the target. The occurrence of paresthesia is also reduced with the aid of ultrasound.[24] In the present case, the operator was able to advance the PRF needle toward the median nerve by confirming the location of the needle tip in real time while easily avoiding nearby vessels.

Conclusion

PRF can be an effective therapeutic option for managing intractable neuropathic pain due to a traumatic injury of the median nerve and can be easily performed using ultrasound guidance.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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References

1. Gabrhelik T, Michalek P, Adamus M, et al. Effect of pulsed radiofrequency therapy on the suprascapular nerve in shoulder pain of various aetiology. *Ir J Med Sci* 2010; 179: 369–373.
2. Kim ED, Kim YH, Park CM, et al. Ultrasound-guided pulsed radiofrequency of the third occipital nerve. *Korean J Pain* 2013; 26: 186–190.
3. Vas L, Pai R, Khandagale N, et al. Pulsed radiofrequency of the composite nerve supply to the knee joint as a new technique for relieving osteoarthritic pain: a preliminary report. *Pain Physician* 2014; 17: 493–506.
4. Cosman ER Jr and Cosman ER Sr. Electric and thermal field effects in tissue around radiofrequency electrodes. *Pain Med* 2005; 6: 405–424.
5. Pederson WC. Median nerve injury and repair. *J Hand Surg Am* 2014; 39: 1216–1222.
6. Attal N, Cruccu G, Haanpaa M, et al. EFNS guidelines on pharmacological treatment of neuropathic pain. *Eur J Neurol* 2006; 13: 1153–1169.
7. Sluijter ME and van Kleef M. Pulsed radiofrequency. *Pain Med* 2007; 8: 388–389; author reply 390–381.
8. Sluijter ME. Pulsed radiofrequency. *Anesthesiology* 2005; 103: 1313; author reply 1313–1314.
9. Sluijter ME, van Kleef M, Barendse GA, et al. Thermal transport during radiofrequency current therapy of the intervertebral disc. *Spine (Phila Pa 1976)* 1998; 23: 745.
10. Canpolat DG, Soylu E, Dogruel F, et al. Comparison of the analgesic effects of pulse radiofrequency and cryoablation in rabbits with mental nerve neuropathic pain. *Niger J Clin Pract* 2018; 21: 585–590.
11. Chua NH, Vissers KC and Sluijter ME. Pulsed radiofrequency treatment in interventional pain management: mechanisms and potential indications-a review. *Acta Neurochir (Wien)* 2011; 153: 763–771.
12. Van Zundert J, de Louw AJ, Joosten EA, et al. Pulsed and continuous radiofrequency current adjacent to the cervical dorsal root ganglion of the rat induces late cellular activity in the dorsal horn. *Anesthesiology* 2005; 102: 125–131.
13. Cahana A, Vutskits L and Muller D. Acute differential modulation of synaptic transmission and cell survival during exposure to pulsed and continuous radiofrequency energy. *J Pain* 2003; 4: 197–202.
14. Erdine S, Bilir A, Cosman ER, et al. Ultrastructural changes in axons following exposure to pulsed radiofrequency fields. *Pain Pract* 2009; 9: 407–417.
15. Protasoni M, Reguzzoni M, Sangiorgi S, et al. Pulsed radiofrequency effects on the lumbar ganglion of the rat dorsal root: a morphological light and transmission electron microscopy study at acute stage. *Eur Spine J* 2009; 18: 473–478.
16. Cohen SP and Van Zundert J. Pulsed radiofrequency: rebel without cause. *Reg Anesth Pain Med* 2010; 35: 8–10.
17. Lakemeier S, Lind M, Schultz W, et al. A comparison of intraarticular lumbar facet joint steroid injections and lumbar facet joint radiofrequency denervation in the treatment of low back pain: a randomized, controlled, double-blind trial. *Anesth Analg* 2013; 117: 228–235.
18. Gofeld M, Restrepo-Garces CE, Theodore BR, et al. Pulsed radiofrequency of suprascapular nerve for chronic shoulder pain: a randomized double-blind active placebo-controlled study. *Pain Pract* 2013; 13: 96–103.
19. Lin ML, Lin WT, Huang RY, et al. Pulsed radiofrequency inhibited activation of spinal mitogen-activated protein kinases and ameliorated early neuropathic pain in rats. *Eur J Pain* 2014; 18: 659–670.
20. Jia Z, Ren H, Li Q, et al. Pulsed radiofrequency reduced neuropathic pain behavior in rats associated with upregulation of GDNF expression. *Pain Physician* 2016; 19: 49–58.
21. Torrance N, Smith BH, Bennett MI, et al. The epidemiology of chronic pain of predominantly neuropathic origin. Results from a general population survey. *J Pain* 2006; 7: 281–289.
22. Bouhassira D, Lanteri-Minet M, Attal N, et al. Prevalence of chronic pain with

neuropathic characteristics in the general population. *Pain* 2008; 136: 380–387.
23. Ciaramitaro P, Mondelli M, Logullo F, et al. Traumatic peripheral nerve injuries: epidemiological findings, neuropathic pain and quality of life in 158 patients. *J Peripher Nerv Syst* 2010; 15: 120–127.
24. Taylor CA, Braza D, Rice JB, et al. The incidence of peripheral nerve injury in extremity trauma. *Am J Phys Med Rehabil* 2008; 87: 381–385.
25. Lipinski LJ and Spinner RJ. Neurolysis, neurectomy, and nerve repair/reconstruction for chronic pain. *Neurosurg Clin N Am* 2014; 25: 777–787.
26. Kouyoumdjian JA. Peripheral nerve injuries: a retrospective survey of 456 cases. *Muscle Nerve* 2006; 34: 785–788.