Clinical Case Report

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Management of refractory chronic migraine using ultrasound-guided pulsed radiofrequency of greater occipital nerve

Two case reports

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Abstract

Rationale: Although various oral medications and procedures are applied for managing migraine, their efficacy remains limited. To control migraine that does not respond to conventional treatments, we conducted pulsed radiofrequency (PRF) stimulation to the greater occipital nerve (GON) in 2 patients.

Patient concerns: Patients 1 and 2 complained of chronic throbbing, pulsating, and tight headaches. Their headache intensities scored 8 and 7 on a numeric rating scale (NRS), respectively. Patient 1 experienced the headache bilaterally in the frontal, retro-orbital, parietal, and occipital regions. The initial onset of the symptoms was more than 15 years ago. Patient 2 complained of headaches in the left frontal, retro-orbital, parietal, and occipital regions, which occurred first more than 14 years ago.

Diagnoses: According to the International Classification of Headache Disorder-3 beta criteria, the patients were diagnosed with chronic migraine.

Interventions: Oral medications, GON block with bupivacaine and dexamethasone, and botulinum toxin injections did not alleviate the patients' migraine.

The PRF stimulation on GON was performed under the guidance of ultrasound, at 5 Hz and 5-millisecond pulsed width for 360 seconds at 45 V. The electrode tip temperature was maintained at or below 42°C.

Outcomes: Two weeks after applying PRF, the pain was reduced to NRS 3 in both patients, who also reported that the headache became bearable after PRF. The effectiveness of PRF on GON lasted for at least 3 months in both patients, and no adverse effects were observed.

Lessons: Our findings suggested that the application of PRF on GON can be a useful option for treating refractory chronic migraine.

Abbreviations: GON = greater occipital nerve, NRS = numeric rating scale, PRF = pulsed radiofrequency, RF = radiofrequency.

Keywords: chronic pain, greater occipital nerve, migraine, pulsed radiofrequency, refractory pain

1. Introduction

Migraine is one of most common causes of headaches, and its cumulative incidence is 18% in men and 43% in women.[1] Moreover, chronic migraine accounts for about 7% of all patients with migraine.[2] Although various medications and techniques have been applied for the management of migraine, the condition often remains unresponsive to these treatments. The refractory migraine interferes with activities of daily living and reduces the quality of life.[2] Therefore, the treatment of refractory migraine still remains a major clinical challenge.

Pulsed radiofrequency (PRF), a technique first described by Sluijter in 1997,[3] is known to be safe and effective in alleviating pain. The technique works by delivering an electrical field and heat bursts to targeted nerves or tissues without damaging these structures.[4] Conventional radiofrequency (RF) exposes target nerves or tissues to a continuous electrical stimulation and ablates the structures by increasing the temperature around the RF needle tip.[4] In contrast to conventional RF, PRF applies a brief electrical stimulation followed by a long resting phase. Accordingly, PRF does not produce sufficient heat that results in structural damage.[5] The proposed mechanism of PRF is that the electrical field produced by PRF can alter pain signals.[6] Several studies on PRF treatment demonstrated its effectiveness on alleviating neuralgia and joint pain not responding to conventional therapies.[7–9] Furthermore, it was reported that PRF can effectively manage various types of headaches, including occipital neuralgia, cervicogenic headache, and intracranial hypotension headache, by applying it to the greater occipital

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nerve (GON).[10–17] However, little is known about the effect of PRF on managing headaches caused by migraine.

In this study, we reported a positive response to PRF stimulation on GON under the guidance of ultrasound in 2 patients with chronic migraine who were refractory to conventional treatments, such as oral medications, GON block, and botulinum toxin injection.

2. Case report

Two patients with refractory chronic migraine were recruited for this study. According to the International Classification of Headache Disorder-3 beta criteria,[18] the patients were diagnosed with chronic migraine. Written informed consent was obtained from the patients for publication of this case report. The study was approved by the local Institutional Review Board of our hospital.

2.1. Case 1

Patient 1 was a 33-year-old man who visited the pain clinic at our university hospital due to chronic migraine over a period of 15 years. He complained of bilateral pain with a throbbing, pulsating, and tight nature. The headache occurred in the bilateral frontal, retro-orbital, parietal, and occipital regions. The tenderness was not examined in the regions overlying the occipital nerves. The numeric rating scale (NRS) score was 8 out of 10, and the pain was aggravated by routine physical activity. He experienced almost daily headaches. After the attacks, the headache was sustained for 12 to 48 hours. He had been followed up by the headache specialist at the neurology department of another university hospital. For treating the headaches, the patient was administered a daily dose of topiramate (100 mg), sodium valproate/valproic acid (666/290 mg), clonazepam (0.5 mg), and propranolol (20 mg). At first, we performed an ultrasound-guided GON block with 1.5 mL of 0.5% bupivacaine and 10 mg of dexamethasone. No pain relief effect had been presented. In addition, we injected 155 units of botulinum toxin type A into the frontalis, corrugator, procerus, occipitalis, temporalis, trapezius, and cervical paraspinal muscles. However, up until 2 months after the injection, no pain relief effect had been presented. Three months after the patient's first visit to our clinic, we performed PRF stimulation on the bilateral GONs to manage the headache resulting from chronic migraine (Fig. 1). The aseptic technique was applied during the PRF procedure. The patient was maintained in the prone position. We searched the GON using a 6 to 15 MHz linear probe (LOGIQ P6, General Electric, Seoul, Korea) following the method by Greher et al.[19] We located the ultrasound probe on the spinous process of C2, and subsequently moved the probe laterally to identify the obliquus capitis inferior muscle of the neck. The GON was found superficial to the obliquus capitis inferior muscle at this level. After identifying the GON, the catheter needle (22-gauge active curved-tip electrode) was inserted, and the sensory simulation test was carried out using an RF generator (RFG4, Cosman Medical, Burlington, Massachusetts). Under ultrasound guidance, the catheter needles were placed close to the right and left GONs, and the patient reported dysesthesia and a tingling sensation at the occipital area with less than 0.2 V. The PRF treatment was administered at 5 Hz and 5 milliseconds pulsed width for 360 seconds at 45 V under the constraint that the temperature of the electrode tips did not exceed 42°C. The patient was followed up for 3 months. Two weeks after the PRF procedure, the pain was reduced from NRS 8 to NRS 3, and the pain was reported to be bearable. However, the number of migraine attacks per month and the duration of headache attacks were not significantly changed. The degree of pain remained at NRS 3 at 1, 2, and 3 months after the PRF stimulation. No adverse effects of the procedure were reported.

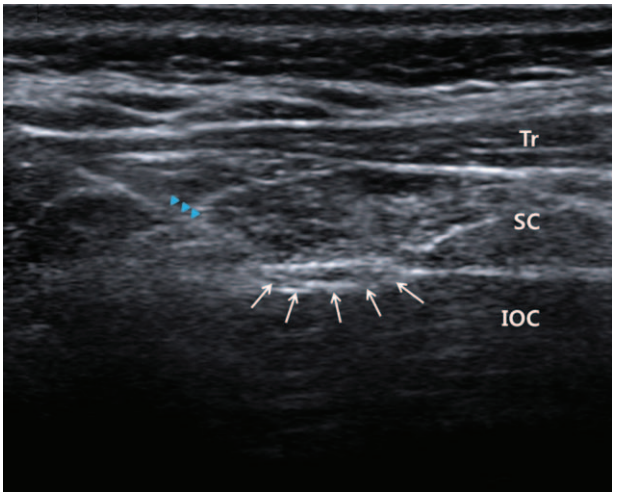

Figure 1. Transverse ultrasound image of the greater occipital nerve (arrows). The blue arrow heads correspond to the catheter needle. IOC = inferior oblique capitis, SC = splenius capitis, Tr = trapezius.

2.2. Case 2

Patient 2 was a 34-year-old woman who visited the pain clinic at our university hospital during 14 years due chronic migraine. She reported a left unilateral pain with a throbbing, pulsating, and tight nature. Her headaches occurred in the left frontal, retro-orbital, parietal, and occipital regions. Occipital nerve tenderness was not presented. The NRS score was 7 and headaches occurred almost every day. The duration of the headache attacks was 12 to 48 hours. The migraine was aggravated by routine physical activity. She was diagnosed with chronic migraine by the headache specialist at the neurology department of another university hospital, and was taking a daily dose of topiramate (100 mg), clonazepam (0.5 mg), and propranolol (20 mg). Before the PRF stimulation, left GON block with 1.5 mL of 0.5% bupivacaine and 10 mg of dexamethasone was conducted, but it had no effect. Subsequently, injection with 155 units of botulinum toxin type A was performed, but it had no effect on the severity of the headache. Two months after the botulinum toxin injection, we performed the PRF stimulation on the left GON under the guidance of ultrasound using the same procedure as in patient 1. We followed up the patient for 3 months. Two weeks after the PRF, the pain was reduced from NRS 7 to 3. At 1, 2, and 3 months after the PRF, the pain NRS score as 3. However, no significant changes in the number of headache days and the duration of headache attacks were observed. No adverse effects of PRF on GON were noted.

3. Discussion

In the present study, we demonstrated a positive response to PRF stimulation on GON in managing chronic migraine refractory to conventional treatment.

The occurrence of migraine is associated with the activation of the trigeminal and upper cervical nociceptive nerves.[20] Nociceptive signals from the fronto-oculotemporal region are transferred through the trigeminal nerve, and pain information from the occipital region is transmitted via the upper cervical nerve roots.[20] The nociceptive afferents from both the trigeminal and upper cervical nerves project centrally to the trigeminal nucleus caudalis neurons in the upper cervical spinal segments.[21–23] In these neurons, the anatomical and functional convergence of nociceptive inputs from these 2 sources occurs.[21–23] The GON is the branch of the second cervical root and the primary sensory nerve of the occipital area of the skull.[24] Considering the convergence in the trigeminal nucleus in the upper cervical segments, the inhibition of the transmission of nociceptive information from GON can control migraine-induced headaches. Because local anesthetics and corticosteroids block the transmission in the nociceptive C-fiber and reduce ectopic discharge,[25] several clinicians applied GON block with anesthetics with or without corticosteroids in patients with migraine, and reported that the GON block successfully reduced the degree of headaches.[24,26,27] However, in our cases, GON block was not effective in managing migraine. Therefore, we performed the PRF stimulation to manage our patients' pain. After the application of PRF on the GON, refractory migraine was reduced to the level of bearable pain, an effect that lasted for at least 3 months.

The mechanisms underlying the reduced pain following PRF stimulation have not been clearly demonstrated. However, Hagiwara et al[28] reported that PRF can modulate neuropathic pain through enhancing the descending noradrenergic and serotonergic pain inhibitory pathways. They also demonstrated that PRF can inhibit the excitation of the nociceptive C-fibers. Erdine et al[29] found a disruptive effect of PRF on the sensory nociceptive axons. The lesions occurring after PRF were selectively located in the smaller principal sensory nociceptors (C-fibers and A-delta fibers), but were rarely identified in the larger non-pain-related sensory fibers (A-beta fiber). Moreover, Cho et al[30] observed a downregulation of microglial activity in the spinal dorsal horn after PRF on the dorsal root ganglion. Because microglia releases several cytokines and chemokines that mediate pain signaling, the authors suggested that a down-regulation of microglia can block the pain signals.

Several previous studies reported that the PRF stimulation on GON is effective in controlling headaches.[10–17] In 2006, Navani et al[14] first applied PRF on GON in a patient with a 43-year history of left side greater occipital neuralgia. After PRF application, a 70% pain relief was observed during at least 4 months. Other subsequent studies involving larger cases demonstrated the effectiveness of PRF in managing occipital neuralgia.[10,11,13,16,17] Furthermore, Gabrhelík et al[12] performed PRF on GON in 15 patients with refractory cervicogenic headache. They reported a significant pain, and the therapeutic effect was sustained for at least 9 months. Niraj et al[15] reported a case of successful treatment of spontaneous intracranial hypotension headache with PRF on bilateral GONs. After PRF, the headaches were significantly reduced for approximately 10 months. Regarding migraine, Cohen et al[11] evaluated the effects of PRF on occipital neuralgia by including 45 patients with migraine. Since all the included patients had occipital neuralgia with migraine, the authors mainly focused on the effects of PRF on occipital neuralgia, but not on migraine-induced headaches. Therefore, to the best of our knowledge, the present study is the first to report a therapeutic efficacy of PRF in migraine-induced headaches.

In conclusion, we reported the cases of 2 patients with chronic migraine refractory to conventional treatment, such as oral medications, GON block, and botulinum toxin injection, who showed a good therapeutic response to ultrasound-guided PRF on the GON. Although further studies involving a larger number of patients with migraine are still needed, our findings indicated that PRF on GON can be an effective treatment option for controlling refractory migraine.

Author contributions

Conceptualization: So Young Kwak.
Data curation: So Young Kwak.
Methodology: Min Cheol Chang.
Supervision: Min Cheol Chang.
Writing – original draft: So Young Kwak, Min Cheol Chang.
Writing – review & editing: Min Cheol Chang.

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