Case Report

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Disclosure: The author received editorial support in writing this manuscript.

Abstract

Objective. To examine the effects of noninvasive pulsed radio frequency energy (PRFE) on recurrent migraine headache associated with occipital neuralgia.

Methods. Four patients who were receiving long-term treatment with repeated greater and lesser occipital nerve blocks (GLONBs) to control recurrent migraine resistant to other treatment underwent treatment with noninvasive PRFE at home as a substitute for GLONB treatment. PRFE was administered by the patient at home for 30 minutes twice daily through an applicator pad placed directly over the occiput and upper cervical spine.

Results. Three of four patients reported a decrease in frequency, severity, or both of prostrating migraines compared with their baseline symptoms; one reported no change from baseline. Comparing PRFE results with those obtained after nerve blocks, three of four patients reported decreases in nonprostrating migraines, while two reported a decrease in prostrating migraines. One patient reported an increase in prostrating migraine frequency. Variable degrees of increased productivity, decreased opioid and nonopioid analgesic use, and decreased visits to urgent care clinics were noted. In two patients who had combined PRFE and GLONB, marked improvement was noted in all symptoms.

Conclusions. Improvement in frequency of headaches was noted, especially when PRFE was combined with GLONB. Further study is warranted.

Key Words. Occipital Neuralgia; Migraine; Headache; Pulsed Radio Frequency Energy; Provant®

Introduction

Neuralgia of the greater occipital nerve (GON) and/or lesser occipital nerve (LON) is an often overlooked cause of chronic headache, especially when presenting in the context of occipital neuralgia with migraine headache, as opposed to isolated occipital neuralgia that is more commonly described in the literature.

Conservative treatment of occipital neuralgia, with or without migraine, has included chiropractic manipulation, massage, yoga, physical therapy, rest, heat, anti-inflammatory medication, antidepressant medication, anti-convulsant medication, opioid and nonopioid analgesia, and migraine prophylaxis medication [1–3]. More invasive treatment modalities have included acupuncture, botox injections, percutaneous pulsed radio frequency energy (PRFE), repetitive nerve blockade of the occipital nerve, implantable peripheral nerve stimulators, neurolysis, and surgical excision [4–8].

Distinguish Therapies and Delivery

PRFE is to be distinguished from pulsed radio frequency (RF) electrical current, a modality with similar nomenclature that is used in nerve ablation and electrosurgery. Radiofrequency ablation, which induces destructive thermal lesions, has been used for over 35 years to treat a variety of pain syndromes, including occipital neuralgia and cervicogenic headaches [5].
Noninvasive Pulsed Radiofrequency Energy in Migraine

The use of PRFE is a more recent development. There are two types of PRFE, contact and noncontact. The majority of reported uses for PRFE involve contact delivery; percutaneous, or other invasive methods of delivering the PRFE to target tissues for such uses as temporomandibular joint arthralgia, low back pain, neck pain, and wrist pain [2]. PRFE delivered percutaneously has been reported previously in the literature [2,3].

Contact applications of PRFE are different from the PRFE device described here, which involves delivery of RF electromagnetic fields by means of a noncontact radiating antenna. Noninvasive PRFE has shown to be of benefit in pain reduction in postoperative pain and edema in oral [9–11], breast [12], foot [13], and eye surgeries [14]. Additionally, reduction of chronic pain is noted in sprains [15,16], hand injuries [17], soft tissue injury [18–21], arthritis [22,23], neck [24,25], and heel pain [26]. To our knowledge, this is the first reported use of this noninvasive, nonpharmacological, and nonmechanical modality for occipital neuralgia.

Because PRFE has shown beneficial application in these and other chronic pain syndromes, we theorized that the application of noninvasive PRFE to the occipital region and upper cervical spine might decrease migraine frequency and severity, as well as influence associated symptoms perhaps through an anti-inflammatory mechanism or a direct neuromodulatory effect on nociceptive afferents.

This case series reports the effect of a novel treatment for occipital neuralgia utilizing PRFE (Provant, Regenesis Biomedical, Scottsdale, AZ, USA). Its novelty derives from the fact that it is noninvasive, nonpharmacological, and nonmechanical (as opposed to chiropractic, physical therapy, massage, etc.). A review of the medical literature suggests that this is the first reported use of PRFE administered noninvasively via topical applicator pad in the treatment of occipital neuralgia with or without migraine.

Methods

Patients

After approval by the G.V. (Sonny) Montgomery VA Medical Center Research and Development Committee, as per institutional policy, four patients with occipital neuralgia and comorbid, chronic, prostrating migraine headache, as defined by the International Headache Society’s diagnostic criteria [27], were identified. All four patients had been receiving treatment at our pain clinic for periods ranging from 1.5 to 4 years. They had received repeated blocks containing anesthetic and steroid of the bilateral GON and LONs (GLONBs). All four patients reported complete relief of their prostrating migraineous headaches, and decreased frequency and intensity of their nonprostrating, nonmigrainous headache episodes for 2–4 weeks after GLONB. The clinical response to GLONB was highly reproducible over a period of years. At baseline, when patients were not receiving GLONB, headache frequency, duration of headaches, medication use, associated symptoms (nausea, vomiting, photophobia, phonophobia, sensitization of taste, light touch, and smell), and lost productivity were documented over a period of years (Table 1).

Informed consent was obtained from each patient, and each agreed to try PRFE as a substitute for GLONB for a period of 30 days. PRFE was initiated during a routine follow-up visit when the patients would have normally received repeat GLONB. By withholding GLONB, the response to PRFE could be compared with the patient’s typical baseline and post-treatment response to GLONB.

Procedure

The Provant PRFE system emits regulated, non-ionizing, nonthermal RF energy at 27.12 MHz through an applicator pad, which is placed directly over the treatment area, in this case the occiput and upper cervical region. The pulsed RF (pulse width 42 microseconds, pulse frequency 1,000 pulses per second) generates an electromagnetic field (electrical field strength 591 V/m and magnetic field strength 7 A/m at 5 cm) that permeates the treatment area in a manner that is imperceptible to the patient and creates an induced electrical field in target tissues [28]. The device is portable and lightweight. Patients can be trained in the use of the Provant PRFE device, and treatments can be self administered at home without skilled supervision. The therapy session duration is preset at 30 minutes.

Treatments are administered twice daily, ideally once every 12 hours. Regular follow-up may be necessary to ensure patient compliance. The patients were instructed in the proper application of the applicator pad over the occiput and upper cervical region for a 30-minute, twice daily treatment rendered in accordance with the manufacturer’s instructions for use.

Patients

Case 1

A 62-year-old male developed acute onset of left occipital neuralgia following acute onset of left-sided Bell’s palsy, 5 years prior to initiation of PRFE and 16 months prior to enrollment in the pain clinic. The comprehensive stroke workup performed at the onset of initial symptoms was negative. Upon presentation to the pain clinic, the Bell’s palsy had resolved without permanent neurological sequelae, but the patient’s left occipital neuralgia had become persistent and chronic. The pain clinic regimen consisted of monthly left-sided GLONB with reported good pain relief. Unfortunately, 12 months into treatment, his occipital neuralgia progressed to involve both occipital regions and GLONB was provided bilaterally.

At baseline, patient experienced daily headaches, of variable intensity, which rendered him unable to function or
## Table 1  Patient symptoms and results

<table>
<thead>
<tr>
<th>Pt</th>
<th>Baseline</th>
<th>GLONB</th>
<th>PRFE</th>
<th>GLONB + PRFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>62-year-old male</td>
<td>Headaches: Prostrating daily Nonprostrating daily Associated symptoms: Photophobia Phonophobia Lost productivity: 8 hours/day at best 24 hours/day at worst Medication: None</td>
<td>Headaches: Prostrating complete relief Nonprostrating complete relief Associated symptoms: Photophobia (no effect) Phonophobia (no effect) Lost productivity: ↓83% from baseline Medication: None Return to baseline: 3.5 weeks with no rebound headaches</td>
<td>No benefit from baseline No exacerbation from baseline</td>
</tr>
<tr>
<td>2</td>
<td>39-year-old male</td>
<td>Headaches: prostrating 1/week nonprostrating 3/week Associated symptoms: Photophobia Phonophobia Smell sensitization Taste sensitization Nausea Vomiting Lost productivity: 1 day/week Medication: Butorphanol – 28 dose/week Cyclobenzaprine – 2.43 dose/day</td>
<td>Headaches: Prostrating ↓50% Nonprostrating ↓33% Associated symptoms: Photophobia (no effect) Phonophobia (no effect) Smell sensitization (no effect) Taste sensitization (no effect) Nausea (no effect) Vomiting (no effect) Lost productivity: ↓50% Medication: Butorphanol ↓50% Cyclobenzaprine ↓50% Return to baseline: 15 days with no rebound headaches</td>
<td>Headaches: Prostrating ↓9.7% from baseline, ↑44% vs GLONB, could completely abort a prostrating headache with immediate use of PRFE and sleep Nonprostrating ↓70% from baseline, ↓54% vs GLONB Associated symptoms: Photophobia (no effect) Phonophobia (no effect) Smell sensitization ↓25% Taste sensitization (eliminated) Nausea (eliminated) Vomiting (eliminated) Lost productivity: No effect Medication: Butorphanol ↓50% Cyclobenzaprine ↓50%</td>
</tr>
<tr>
<td>3</td>
<td>58-year-old female</td>
<td>Headaches: Prostrating 3/week Nonprostrating 6/week Associated symptoms: Photophobia Phonophobia Smell sensitization Nausea Vomiting Lost productivity: 1/1.5 day Medication: Topiramate 200 mg bid Hydrocodone 10 mg tid Codeine 30 mg/acetaminophen 300 mg 2 tab/week Sulindac 150 mg qd bid</td>
<td>Headaches: Prostrating ↓75% Nonprostrating ↓75% Associated symptoms: Photophobia (no effect) Phonophobia (no effect) Smell sensitization (no effect) Nausea (no effect) Vomiting (no effect) Lost productivity: ↓75% Medication: No change from baseline Unscheduled visits to urgent care center: ↓ (compared with baseline) Return to baseline: 21 days with no rebound headache</td>
<td>Headaches: Prostrating frequency ↓53% from baseline Nonprostrating ↓39% from baseline Associated symptoms: Photophobia (no effect) Phonophobia (no effect) Smell sensitization (no effect) Nausea (no effect) Vomiting (no effect) Lost productivity: ↓69% from baseline Medication: No change from baseline Unscheduled visits to urgent care center: ↓ (compared with baseline)</td>
</tr>
</tbody>
</table>
49-year-old male

**Headaches:**
- Prostrating 2/week, duration 2-3 days, intensity 8/10 NRS
- Nonprostrating daily

**Associated symptoms:**
- Photophobia
- Phonophobia
- Smell sensitization
- Taste sensitization
- Nausea
- Vomiting
- Total body hyperesthesia

**Lost productivity:**
- 5/7 days

**Medication:**
- 100 Topiramate mg daily
- Gabapentin 400 mg qid

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**Headaches:**
- Prostrating ↓87%
  - Nonprostrating daily (no effect)

**Associated symptoms:**
- Photophobia (no effect)
- Phonophobia (no effect)
- Smell sensitization (no effect)
- Taste sensitization (no effect)
- Nausea (no effect)
- Vomiting (no effect)
- Total body hyperesthesia (no effect)

**Lost productivity:**
- ↓75%

**Medication:**
- No change from baseline

**Return to baseline:**
- 42 days (28 days relief followed by 14 days rebound period with increased migraines)

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**Headaches:**
- Prostrating
  - Frequency ↓90% from baseline. Duration ↓80% from baseline. Frequency ↓23% vs GLONB. Duration ↑36% vs GLONB.
  - Nonprostrating: frequency ↓14% from baseline and GLONB (from daily to 1/1.16 days with 5/36 days pain-free)

**Associated symptoms:**
- Photophobia (no effect)
- Phonophobia (no effect)
- Smell sensitization (no effect)
- Taste sensitization (no effect)
- Nausea (no effect)
- Vomiting (no effect)
- Total body hyperesthesia (no effect)

**Lost productivity:**
- ↓88% from baseline

**Medication:**
- No change from baseline

**Return to baseline:**
- 42 days relief followed by 14 days rebound period with increased migraines

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**Headaches:**
- Prostrating
  - During first 30 days of treatment: frequency ↓100% from baseline and GLONB alone (no prostrating HA >30 days)
  - During days 31-73: Frequency ↓66% from baseline. Intensity ↓ from 8/10 at baseline to 6/10. Duration ↓25% from baseline.
  - Nonprostrating: Frequency ↓36% from baseline. Frequency ↓36% vs GLONB. Frequency ↓25% vs PRFE alone

**Associated symptoms:**
- Photophobia ↓75%
- Phonophobia (eliminated)
- Smell sensitization ↓75%
- Taste sensitization (eliminated)
- Nausea ↓75%
- Vomiting ↓75%
- Cutaneous hyperesthesias (eliminated)

**Lost productivity:**
- ↓92% from baseline
- ↓67% vs GLONB
- ↓35% vs PRFE alone

**Medication:**
- Gabapentin ↓98% vs baseline and all other treatments

**Return to baseline:**
- At follow-up, 109 days after initiating PRFE and 73 days after last GLONB, patient denied rebound headache after most recent GLONB. He remained improved from baseline. Patient continued PRFE but declined repeat GLONB

GLONB = greater and lesser occipital nerve block; HA = headache; NRS = numeric rating scale; PRFE = pulsed radio frequency energy.
perform normal activities of daily living (ADLs) and caused him to seek refuge in a dark, isolated room with bed rest (Table 1).

Following GLONB, he received complete relief of headache pain for 3.5 weeks during which time he had no functional limitations or lost productivity due to headache pain. After 3.5 weeks, his pain returned to baseline without rebound increase in frequency or intensity of headache pain (Table 1).

Seven days after initiating PRFE, the patient was contacted by telephone. At that time, the patient reported receiving no benefit or exacerbation of his symptoms compared with baseline. At his subsequent follow-up visit, 14 days after initiating PRFE therapy, the patient continued to report no improvement or exacerbation compared with his baseline, and at his request, PRFE therapy was discontinued and bilateral GLONB was resumed.

Case 2

A 39-year-old male experienced the acute onset of headache 20 years prior to evaluation when he developed a severe allergic reaction to an anthrax vaccine required during the Gulf War deployment. The patient required emergency medical evacuation for his allergic reaction and developed the simultaneous onset of severe headaches. At baseline, he experienced three occipital neuralgia-type, nonprostrating headaches per week (Table 1, Figure 4) starting in the bilateral occipital region with aching and lancinating pain referred into the parietal, frontal, and retro-orbital regions. During these headaches, he was functional with the daily use of cyclobenzaprine and, as needed, butorphanol.

He also experienced one prostrating migrainous headache per week, with associated symptoms and lost productivity, preceded by occipital neuralgia as a prodrome, which then generalizes into migraine.

Following GLONB, he received complete relief of prostrating headache pain and lost productivity, with a reduction in nonprostrating headache frequency for 2 weeks. During this time, the use of all opioid medication was eliminated. During the third week post-GLONB, he returned to baseline without rebound. Headache frequency, associated symptoms, medication utilization, and lost productivity at baseline and in response to treatments are summarized in Table 1 and Figures 1–6.
During the first 10 days of treatment with PRFE, patient decreased the number of days when butorphanol was utilized by 60% from baseline and decreased the total number of self administered doses by 75%. During the last 21 days of treatment with PRFE, patient reduced his opioid utilization by 100% when he discovered that at the start of an acute episode, he could use a 30-minute PRFE treatment to terminate his headache episodes. If patient attempted to resume normal activity after completing PRFE treatment, his headache would return within 2 and 1/2 hours, but if he slept after treatment, his headache treatment to terminate his headache episodes.

Figure 3 Prostrating migraine frequency comparing baseline to greater and lesser occipital nerve (GLONB), pulsed radio frequency energy (PRFE), and combination therapy with PRFE and GLONB. Patients 1 and 3 dropped out after treatment with PRFE and did not have data for combination therapy. Patient 4 had no migraine headaches during combination therapy.

Figure 4 Nonprostrating headache frequency comparing baseline with greater and lesser occipital nerve (GLONB), pulsed radio frequency energy (PRFE), and combination therapy with PRFE and GLONB. Patients 1 and 3 dropped out after treatment with PRFE and did not have data for combination therapy.

Figure 5 Narcotic pain medication utilization comparing baseline with greater and lesser occipital nerve (GLONB), pulsed radio frequency energy (PRFE), and combination therapy with PRFE and GLONB. Patients 1 and 4 do not use narcotics for headache pain. Patient 3 dropped out after treatment with PRFE and did not have data for combination therapy.

Figure 6 Non-narcotic pain medication utilization comparing baseline with greater and lesser occipital nerve (GLONB), pulsed radio frequency energy (PRFE), and combination therapy with PRFE and GLONB. Patients 2 and 4 both demonstrated significant declines in non-narcotic medication utilization with combination therapy.
episode would be terminated permanently and he would remain pain-free on waking, until the next episode, days later. When butorphanol utilization is averaged over the 31-day treatment period, there was a 92.8% reduction in opioids utilization compared with baseline and an 85.5% reduction when compared with GLONB (Table 1, Figure 5).

After 31 days of treatment with PRFE, patient received bilateral GLONB for the first time in 60 days and continued to use PRFE at home. Thirty-four days later, he was seen for follow-up to evaluate efficacy of using GLONB in combination with PRFE. During combination treatment, patient went 32 consecutive days without a prostrating headache and reported only one prostrating headache in 34 days. Combination therapy with PRFE and GLONB demonstrated 2 and 1/2 times the efficacy of GLONB alone in terms of consecutive days during which patient was prostrating headache-free.

Case 3

A 58-year-old female developed classic migraine with aura, without precipitating event, when she was 24 years old. At baseline, she experienced almost daily occipital neuralgia-type, nonprostrating headaches (Table 1, Figure 4), starting in the bilateral occipital region with aching and lancinating pain referred into the parietal, frontal, and retro-orbital regions. She also experienced one to four prostrating migraine headaches per week preceded by classic aura and often also preceded by occipital neuralgia pain as a prodrome. Headache frequency, associated symptoms, medication utilization, and lost productivity at baseline and in response to treatments are summarized in Table 1 and Figures 2–6.

At baseline, she also utilized urgent care or neurology headache clinic, as a walk in patient, for acute headache pain exacerbation an average of once every 4.5 days. Following GLONB, unscheduled utilization of health care services decreased from baseline. During treatment with PRFE, unscheduled utilization of health care services decreased 64% from once every 4.5 days to once every 12.5 days (Table 1).

After treatment period with PRFE, patient elected to resume treatment with GLONB alone despite demonstrating clinical improvement with PRFE as compared with baseline. She expressed concern about using a device that generates an RF electromagnetic field.

Case 4

A 49-year-old male. At baseline, he experienced constant, daily aching pain starting in the bilateral occipital region and referred into the parietal, frontal, and retro-orbital regions. During these headaches, he was functional with normal ADLs. He also averaged two prostrating migraine headaches per week, each lasting 2–3 days, with pain intensity on the numeric rating scale reported as 8/10 or greater. Headache frequency, rebound headaches following GLONB, associated symptoms, medication utilization, and lost productivity at baseline and in response to treatments are summarized in Table 1 and Figures 2–7.

During 36-day treatment period with PRFE, patient was headache pain-free 5/36 days. These were the first headache pain-free days he had experienced in years. After 36 days of treatment with PRFE, patient received bilateral GLONB for the first time in 93 days and continued to use PRFE at home. He returned for follow-up 73 days later to

Figure 7 Pulsed radio frequency energy (PRFE) subjectively decreased the intensity of phonophobia. Frequency of symptoms associated with prostrating headache were unaffected by PRFE. Combination therapy with PRFE and greater and lesser occipital nerve (GLONB) eliminated phonophobia, cutaneous hyperesthesia, and sensitization of taste. Frequency of nausea, emesis, photophobia, and sensitization of smell associated with prostrating headaches were decreased by 75%.
evaluate efficacy of using GLONB in combination with PRFE. During combination treatment, patient went more than 30 days without any prostrating headaches at all. This is a 100% decrease in prostrating headache activity from both baseline and a comparable 30-day period after GLONB. During combination therapy with PRFE and GLONB, patient experienced 2–3 completely pain-free days per week. This represents a significant change from both baseline and response to GLONB, when patient has no pain-free days, and an additional 25% reduction in nonprostrating headache compared with PRFE alone. Rebound headache pain following his most recent GLONB was completely eliminated by combination therapy with GLONB and PRFE.

At follow-up, 73 days after restarting GLONB, patient requested not to repeat GLONB because he was still doing, so well he did not feel that he needed it. He requested not to be scheduled for follow-up and allowed to follow-up as needed.

Results

Headache frequency, associated symptoms, medication utilization, and lost productivity at baseline and in response to treatments are summarized in Table 1 and Figures 1–7. Three of four patients reported a decrease in frequency of both nonprostrating headache and prostrating migrainous headache during treatment with PRFE. One patient reported no benefit or exacerbation with use of PRFE and discontinued its use. Two patients (patients 2 and 4) were able to use PRFE at the start of an acute migraine episode to terminate or decrease the duration of a migraine episode. One patient (patient 2) reported a significant reduction in utilization of opioids during PRFE treatment period and during combination therapy with both PRFE and GLONB. One patient (patient 3) significantly reduced unscheduled visits to urgent care clinics during the PRFE treatment period. Two patients (patients 2 and 4) reported reduction or elimination of one or more associated symptoms with protrasting headaches during PRFE treatment or combination therapy with both PRFE and GLONB. It is unusual that patient 2 did not report any change in the intensity or frequency with which photophobia and phonophobia were associated with his migraine headaches after GLONB, PRFE, or combination therapy with both PRFE and GLONB. However, he did report significant benefit in the other four associated symptoms measured (Table 1, Figure 1). Patient 4 also did not report improvement in photophobia or phonophobia during single treatment periods with either GLONB or PRFE. However, he reported a 75% reduction in frequency or complete elimination of six of six symptoms associated with migraine, including photophobia and phonophobia, during combination therapy with both PRFE and GLONB. Patient 4, who did not report reduction of any medication use with any other therapy, reported a 98% reduction in nonopioid medication use with combination therapy. Combination therapy demonstrated 2.5 times the efficacy of GLONB alone in terms of consecutive days during which patient 2 was free of prostrating headaches.

Discussion

Neuralgia of the GON or LON is a benign, extracranial cause of headache pain that has been described in the literature for over 60 years. In its classic ‘neuralgia’ presentation, it typically presents as sudden, recurring hemi-cranial pain, often associated with tearing of the eye, flushing of the face, alteration of sweating pattern, and occlusion of the ipsilateral nasal passage [29,30]. The key to diagnosis is the presence of neuralgia-type pain, which is a brief, sharp, lancinating pain in the distribution of the involved nerve [29]. Blurred vision, rhinorrhea, and vertigo may be present but are less common [30]. In chronic pain patients there is usually a continuous aching pain in the distribution of the occipital nerve and sometimes the ophthalmic division of the trigeminal nerve [29,31,32], which may be present episodically for recurring periods of hours to days or constantly for months or years at a time. The cardinal feature and diagnostic criteria is complete relief of pain following local anesthetic blockade of either the C2 nerve root or the GONs and/or LONs [8,29,30,33].

Occipital neuralgia is associated with migraine either as a potential trigger or a late complication [31,33]. One study found that of 383 patients diagnosed with migraine headaches, 184 (48%) had headaches caused by irritation of the GON that could be arrested by injecting the ipsilateral GON with local anesthetic [31]. The relationship between occipital neuralgia and migraine is often poorly appreciated. However, there is a growing understanding that irritation or inflammation of the occipital nerves can produce referred pain in diverse cranial structures not only within the distribution of the C2 nerve roots from which the GON and LON arise but also within other nerves as well, particularly the ophthalmic division of the trigeminal nerve [30,32].

The mechanism by which irritation of the occipital nerves can be associated with migraine derives from the trigeminocervical complex. Neurons that provide nociceptive,afferent input from the meninges and cervical structures synapse with relay neurons in the trigeminocervical complex. These relay neurons serve as the neural substrates of head pain [34]. Stimulation of trigeminally innervated intracranial structures, such as supratentorial dura mater and large cranial vessels, evokes painful sensations and implies that afferent input from dural structures is the likely neural substrate in head pain and migraine [34]. Nociceptive input from the dura mater is transmitted by small-diameter A and C fiber afferents in the ophthalmic division of the trigeminal nerve to nociceptive second-order neurons in the superficial and deep layers of the medullary dorsal horn of the trigeminocervical complex [34]. Occipital and suboccipital structures, such as vessels and the dura mater of the posterior fossa, deep paraspinal neck muscles, upper cervical zygopophyseal (facet) joints, and ligaments have nociceptive inflow that is also mediated by small-diameter afferent fibers that synapse with nociceptive second-order neurons in the trigeminocervical complex [32,34]. Thus, there is a direct coupling between meningeal afferents and cervical afferents in the spinal
dorsal horn [35]. Electrical stimulation of primary sensory afferents has an antinociceptive effect.

Animal studies and functional imaging studies in humans suggest that central supraspinal structures play a role in this response [6]. Matharu et al. reported the results of positron emission tomography (PET) scans on eight patients with chronic migraine and implanted, bilateral, suboccipital stimulators [6]. Each of these patients had complete relief of headache pain within 30 minutes of stimulation. After switching off the stimulation, headache returned immediately and peaked within 20 minutes.

PET scans were performed during stimulation and demonstrated significant changes in regional cerebral blood flow in the dorsal rostralpons, anterior cingulate cortex, cuneus, and left pulvinar. The study concluded by naming the dorsal rostral pons as a potential locus of neuromodulation resulting from suboccipital stimulation by electrical current [6].

Mechanisms of action by which PRFE may exert a neuromodulatory effect and decrease pain include alteration of inflammatory responses [36], increase in early c-Fos immunoreactivity in laminae I and II of the dorsal horn [37]—a selective effect on the axons of small-diameter C and A-delta nociceptive fibers [38]—and alteration of excitatory post-synaptic transmission [39]. Hence, the application of PRFE to the occipital region and upper cervical spine may play a role in decreasing migraine frequency and severity as well as influencing migraine’s associated symptoms, both through a direct neuromodulatory effect on nociceptive afferents in peripheral nerves and the trigeminocervical complex of the upper cervical spinal cord and brainstem, and by decreasing potential pain and inflammation in structures in the occipital, suboccipital, and upper cervical regions that may be producing nociceptive input.

In this study, the use of noninvasive PRFE markedly decreased migraine frequency (prostrating and nonprostrating) compared with baseline symptoms in three of four patients. In addition, two of four patients noted a decrease in at least one symptom associated with migraine. Of significant note is a reduction in nausea and emesis. A recent study found that patients with migraines who reported associated nausea often had significantly higher scores on the Migraine Disability Assessment Score and the Headache Impact Test (HIT-6) when compared with those who never or rarely had nausea [40]. Frequent nausea worsened all items examined by the HIT-6, including more severe pain and more limited activities [40], and was closely associated with a lower treatment satisfaction. Also, patients with nausea were more likely to report medication side effects and increased interference with their ability to function at work or school, perform household chores, and participate in family or social activities [40]. PRFE, alone or in combination with GLONB, either eliminated or reduced the frequency of nausea associated with migraine by 75% in two of the four patients. These findings suggest a potentially valuable role for PRFE as adjunctive treatment in chronic migraine.

Conclusions

The Provant system for delivering PRFE at home as a noninvasive, nonpharmacological modality was effective in decreasing the frequency and, in some cases, the severity of pain and associated symptoms in three of four patients with chronic migraines associated with occipital neuralgia. The results of using PRFE with GLONB produced better results than GLONB alone or PRFE alone. Further investigation into this modality as a useful, adjunctive treatment for an often lifestyle altering and sometimes disabling condition is warranted.

References


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