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Radiofrequency Ablation of Pericranial Nerves for Treating Headache Conditions: A Promising Option for Patients

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Background: Chronic daily headache, including chronic migraine, can be challenging to treat. Medications often only provide limited improvement, and surgical interventions can be associated with significant adverse effects. We present our experience with using radiofrequency ablation (RFA) for pericranial nerves to treat chronic headache conditions.

Methods: This retrospective analysis included patients who received RFA for pericranial nerves to treat chronic daily headache conditions from January 1, 2015 to June 1, 2016. Outcomes were pain scores as measured on the visual analog scale (with 0 representing no pain and 10 representing the worst pain imaginable) and the patient-reported percent improvement in headache conditions, including pain scores, severity, duration, frequency, and associated symptoms.

Results: Of the 57 patients who received 72 RFAs for pericranial nerves to treat headache or pericranial neuralgia, 90.3% of patients had improvement in their headache condition after receiving RFA. In addition, pain scores decreased from 6.6 $\pm$ 1.7 preprocedure to 1.9 $\pm$ 1.9 postprocedure ($P<0.001$).

Conclusion: Our study demonstrates the efficacy and safety of RFA in treating pericranial neuralgias associated with chronic daily headache.

Keywords: *Catheter ablation, headache, migraine disorders*

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INTRODUCTION

Pericranial neuralgias are characterized by pain in the region corresponding to the pathway of a particular nerve or nerve root.[1] Of the several types of pericranial neuralgias, each can be identified diagnostically by the success of local anesthetic nerve blocks in alleviating headache symptoms.[2] Abundant evidence in clinical studies and practice demonstrates that these neuralgias represent sensitization of pericranial nerves, often associated with chronic daily headache, including chronic migraine.[3] Many patients with chronic migraine have pericranial tenderness on palpation, and in 30% of these patients, palpation of the scalp will induce an attack.[4] Pericranial nerve blocks have successfully been used for treating headache, demonstrating the role of peripheral sensitization associated with chronic headache.[5]

First-line treatment of chronic headache involves pharmacotherapy, including tricyclic antidepressants, beta blockers, and antiepileptic medications. For some patients, this treatment has limited efficacy and can result in significant adverse effects or drug interactions.[6] One study tested the efficacy of occipital nerve blocks with steroids in treating occipital neuralgia and reported short-term relief.[7] Invasive treatments for pericranial neuralgia include gamma knife surgery (GKS), neurectomy, and microvascular decompression (MVD). While the success of these procedures can be upwards of 80% in some cases,[8] the potential adverse effects, including anesthesia dolorosa, as well as the financial burden of these treatments, vastly outweigh patient benefit.

This article focuses on radiofrequency ablation (RFA) as a minimally invasive treatment option for patients suffering from chronic headache, including chronic migraine, associated with pericranial neuralgias.

METHODS

This retrospective analysis included patients who received RFA for pericranial nerves to treat chronic headache conditions from January 1, 2015 to June 1, 2016. Patients were identified using the Current Procedural Terminology codes from our billing system. Outcomes included pain scores as measured on the visual analog scale (with 0 representing no pain and 10 representing the worst pain imaginable) reported after the procedure during their follow-up visit that was within a few weeks or a few months after

surgery, depending on when the patient returned to the clinic, and patient-reported percent improvement (expressed as 0%-100%). Percent improvement was defined as improvement in pain scores, headache severity, duration, frequency, and associated symptoms. We also report the duration of improvement in days as reported by patients during their follow-up visits to our clinic or other clinics.

This work received an institutional review board exemption from the University of Wisconsin-Madison.

Radiofrequency Ablation Performance Technique

Most patients were referred by the headache clinic at the University of Wisconsin-Madison. All patients had identifiable neuralgias (either intermittent pain in the area of the nerve distribution or constant pain with exacerbations) with tenderness on palpation over the nerve on physical examination. The diagnosis of the headache condition was established by the headache specialists, and the diagnosis of associated neuralgias was diagnosed by the headache specialist and a pain physician. Diagnostic blocks to the target nerve(s) were performed using 0.25% bupivacaine. Most patients received 2 diagnostic blocks, and RFA candidates reported >50% improvement in their pain after the diagnostic nerve block(s). Two patients received only one diagnostic block because of patient request.

After giving informed consent, patients received RFA for the nerve(s) targeted by the diagnostic blocks. RFA was performed using a 21-gauge needle with a 4-mm active tip placed on top of the target nerve in the anatomic locations discussed below. Sensory testing was performed at 50 Hz, with most patients reporting paresthesias in the distribution of the targeted nerve(s) at <0.8 amplitude. Needle adjustments were performed if stimulation was not attained or attained at a higher amplitude. After testing, 2% lidocaine was administered through each needle to provide local anesthesia before performing the RFA. RFA was then carried out in the lesion mode at 80°C for 180 seconds. RFA was performed with intravenous sedation/analgesia using small doses of fentanyl and midazolam.

Anatomic Locations for Nerve Blocks

Descriptions of the nerve block locations are as follows:

- Supraorbital nerve: At the edge of the supraorbital foramen that was identified by palpation, making sure the needle was not inside the foramen
- Supratrochlear nerve: At the junction of the nasal bone and the orbital margin approximately 1.5 cm medial to the vertical reference line
- Infratrochlear nerve: At the medial angle of the orbit just above the caruncula lacrimalis
- Infraorbital nerve: At the edge of the infraorbital foramen that was identified by palpation, making sure the needle was not inside the foramen
- Greater occipital nerve: Slightly inferior to the superior nuchal line and medial to the occipital artery, identified by palpating the arterial pulsation
- Lesser occipital nerve: Lateral to the occipital artery and medial to the mastoid process
- External branches of anterior ethmoidal: Between the nasal bone and upper lateral nasal cartilage

Statistical Analysis

The SPSS v.22 software (IBM) was used for analysis. Number and percentage are presented for categorical data and average ± standard deviation for continuous data. Before and after procedure numeric variables were analyzed using paired *t* test. Significance was defined as $P \leq 0.05$.

RESULTS

We reviewed records for 62 patients who received 77 RFAs but excluded 5 patients from our analysis for the following reasons: 1 patient reported 75% improvement but was involved in a motor vehicle accident (MVA) accident 1 week later and headache was aggravated, 1 patient reported 90% improvement but was involved in an MVA 31 days after RFA and headache was aggravated, 1 patient had missing outcomes data on follow-up, and 2 patients underwent bilateral RFA and reported improvement on one side but not the other.

Therefore, we analyzed the data from 57 patients who received 72 RFAs for pericranial nerves to treat chronic headache with pericranial neuralgia. Some patients received more than one RFA (for different nerves). One patient had a missing pain score at baseline but reported percent improvement after the procedure, so we report average pain scores for 71 RFAs. The average age of patients was 46.1 ± 14.6 years, and the majority were female (Table 1). Seventy-two percent of patients (n=41) presented with chronic migraine, and the remaining patients presented with other headache conditions, including cluster headache, tension headache, and chronic facial pain. Other symptoms that patients reported in association with their headaches are shown in Table 2. Table 3 lists surgeries (and for 1 patient, a condition) that patients had had and that could be a reason for the development of their headaches. Patients received RFA for different pericranial nerves as outlined in Table 4.

Seven RFAs led to no improvement (9.7%), while the majority of the RFAs (n=65, 90.3%) led to improvement. Forty-six patients reported ongoing improvement after their procedure; the durations of improvement are reported in Table 5.

All patients who reported improvement (number of RFAs=65) reported an average percent improvement of 81.2% ± 18.7% (range, 40%-100%). RFAs with an endpoint at follow-up (improvement is not ongoing and pain is back) were associated with a mean percent improvement of 75.2% ± 14.1% (range, 50%-100%) and a mean duration of 127 days ± 79.2 days (range, 8-270 days). Based on data from all RFAs (all patients with and without improvement; number of RFAs=72), the average percent improvement was 71.7% ± 28.8% (range, 0%-100%).

Pain scores decreased from 6.6 ± 1.7 preprocedure to 1.9 ±1.9 postprocedure ($P<0.001$, n=71).

Two patients reported swelling of their eyelids after they received bilateral supraorbital and supratrochlear RFAs. In both cases, the swelling was self-limited and resolved within 1 week. Otherwise, patients reported no side effects.

DISCUSSION

Chronic headache, including chronic migraine, can lead to peripheral sensitization and aggravation of pericranial neuralgias. Pharmacologic treatment often has limited efficacy in treating chronic headache and chronic migraine.[6,9] Treatment with onabotulinum toxin A, while

Table 1. Demographic Data for Patients Receiving Radiofrequency Ablation (n=57)

Variable	n (%)
Race	
White	55 (96.5)
Other	2 (3.5)
Sex	
Male	12 (21.1)
Female	45 (78.9)
Mean age, years ± SD (range)	46.1 ± 14.6 (19-81)

successful at alleviating chronic migraine, must be repeated every 3 months for long-lasting pain relief and can place a significant financial burden on patients who are already missing work because of chronic migraine.[10] Nerve blocks using steroids can provide relief but for a short period of time. More invasive treatments such as GKS and MVD are approximately 80% successful at alleviating pericranial neuralgia symptoms[8] but are associated with more complications than RFA. Namely, patients are at greater risk for facial dysesthesias, new facial pain, numbness, and anesthesia dolorosa, which can be extremely difficult to treat.

Our study shows that RFA is a promising treatment option for patients suffering from pericranial neuralgias associated with headache. Advantages of RFA include partial or complete relief of pain with minimal surgical risk compared to invasive options such as GKS and MVD. Our study displayed similar results to MVD without the invasive surgical risks. In addition, 46 patients reported long-term pain relief. A disadvantage associated with RFA treatment is that pain may recur, although treatment may be repeated multiple times.[11] In addition, potential side effects include worsening of headache and minor residual numbness. The only side effects observed in this study were swelling of the eyelid in 2 patients that resolved within a week after the procedure.

RFA should be performed only by those who have received appropriate training because the procedure is performed close to sensitive structures and can lead to adverse effects if not done appropriately.

Patients included in our study were diagnosed with headache—migraine and nonmigraine—and showed positive pericranial neuralgias by history and physical examination. Recognizing the relationship between pericranial neuralgias and headache is important. Headache, including

Table 2. Patient Symptoms on Presentation (n=57)

Symptom	n (%)
Dizziness	7 (12.3)
Insomnia	30 (52.6)
Nausea and vomiting	16 (28.1)
Sensitivity to light and sound	20 (35.1)
Sensitivity to cold	3 (5.3)
Tingling	7 (12.3)

Table 3. Patients With Prior Head Surgeries and Conditions (n=46)

Surgery/Condition	n (%)
Zoster ophthalmicus	1 (1.8)
Cranial surgery	4 (7.0)
Ear, nose, and throat surgery	19 (33.3)
Trauma	22 (38.6)

migraine, may lead to central sensitization that, in turn, can cause peripheral sensitization and may aggravate pericranial neuralgias.[5] Our study demonstrates that treating the pericranial neuralgia can lead to improvement in the headache condition. This observation supports our hypothesis of a 2-way relationship between pericranial neuralgias and headache, including chronic migraine. This unique phenomenon can be attributed to upstream desensitization in which treatment of peripheral sensitization promotes desensitization of central receptors and reversal of the central sensitization. Central pathways will then function and conduct normally, and the headache condition will resolve. A 2015 study published by Cohen et al proved the efficacy of pulsed radiofrequency in treating occipital neuralgia and occipital neuralgia associated with migraine,[7] findings that support the efficacy of this technique in treating peripheral neuralgias and associated headaches.

A limitation of this study is that it is a retrospective analysis with data collected from electronic medical records. Such an analysis does not adjust for all confounders. Another limitation is that our percent improvement outcome included improvement in pain scores, headache severity, duration,

Table 4. Nerves Targeted by Radiofrequency Ablation (n=72)

Site of Radiofrequency Ablation	n (%)
Bilateral greater and lesser occipital	25 (34.7)
Bilateral supraorbital and supratrochlear	10 (13.9)
Right greater and lesser occipital	7 (9.7)
Left greater and lesser occipital	5 (6.9)
Right supraorbital and supratrochlear	5 (6.9)
Left supraorbital and supratrochlear	4 (5.6)
Right supraorbital and infraorbital	3 (4.2)
Right supraorbital	2 (2.8)
Right infraorbital	1 (1.4)
Left supraorbital and infraorbital	1 (1.4)
Left supraorbital and infraorbital	1 (1.4)
Left supraorbital	1 (1.4)
Bilateral supraorbital	1 (1.4)
Bilateral external branches of anterior ethmoidal	1 (1.4)
Bilateral infraorbital	1 (1.4)
Bilateral supraorbital and infraorbital	1 (1.4)
Left greater occipital	1 (1.4)
Right greater occipital	1 (1.4)
Bilateral infratrochlear	1 (1.4)

Table 5. Duration of Improvement for Patients Who Reported Ongoing Improvement at Time of Follow-Up (n=46)

Duration of Improvement in Days	n (%)
<50	4 (8.7)
50-99	8 (17.4)
100-149	6 (13.0)
150-199	9 (19.6)
200-249	8 (17.4)
250-299	7 (15.2)
300-349	2 (4.3)
350-399	0
400-449	1 (2.2)
≥450	1 (2.2)

frequency, and associated symptoms. We did not quantify those outcomes separately. A strength of this study is that it includes a large number of RFAs. In addition, our primary outcomes—pain scores and percent improvement—were accurately reported in our records.

CONCLUSION

Our study supports the efficacy of RFA in treating pericranial neuralgias associated with headache conditions. Our findings also demonstrate the safety of this technique as our patients did not develop any serious side effects.

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