Efficacy of Surgical Treatment of Migraine Headaches Involving the Auriculotemporal Nerve (Site V)

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Background: This study reports the surgical technique and efficacy of treatment for the less commonly studied auriculotemporal nerve (site V). The aim was to evaluate symptom relief and differences in migraine headache parameters (i.e., intensity, duration, and migraine-free days) after site V surgery.
Methods: Patients undergoing site V surgery for auriculotemporal nerve–triggered migraine headaches were analyzed. Charts were reviewed retrospectively for age, sex, dates of surgery and follow-up, preoperative migraine data, types of surgery, and laterality. Postoperatively, patients completed a migraine headache questionnaire by means of office visit, phone, e-mail, or video conference.
Results: Forty-three patients were included in the study (36 women; median age, 50 years; interquartile range, 40 to 57 years). The majority of patients underwent bilateral surgery (n = 36) and reported site-specific relief (n = 34). The average follow-up was 17.2 months. The number of migraine-free days (per month) increased from 12.6 days before surgery to 25.1 days after surgery (median increase, 12.6 days; $p < 0.005$). Median migraine intensity scores decreased from 8.3 to 3.2 after surgery (median decrease, 5.1; $p < 0.005$) on 10-point severity scale. Migraine duration decreased from 1.2 hours/day to 0.5 hour/day after surgery (median decrease, 0.7 hour/day, $p < 0.005$). The median difference in migraine duration was the only value found not to be statistically significant, defined as $p < 0.005$. On both univariate and multivariate analyses, patient-reported site relief was significantly associated with decreased migraine intensity.
Conclusions: Surgery for auriculotemporal nerve–triggered migraine headaches improves migraine headache parameters. This study is the first to examine surgical efficacy of this less commonly studied trigger site. (*Plast. Reconstr. Surg.* 143: 557, 2019.)
CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, IV.

Surgical treatment of migraine headaches has recently emerged as a viable option for patients that cannot tolerate or do not respond to medical therapy. The senior author (B.G.) introduced contemporary surgery as a potential treatment in a retrospective report that found 80 percent of 39 patients experienced elimination or improvement in migraine headaches after undergoing corrugator supercilii muscle resection for forehead rejuvenation surgery.[1] This prompted additional studies, including a prospective pilot, prospective randomized, prospective randomized with 5-year follow-up, and prospective randomized with sham surgery studies, to investigate the efficacy and safety of deactivation of the peripheral trigger sites in treating migraine headaches.[2] These studies have pinpointed four key nerve trigger sites

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that can be surgically treated to provide headache relief.[3,4] Investigation of alternate, lesser known migraine trigger sites has brought to our attention the auriculotemporal nerve.

A subset of patients who do not respond to surgical decompression of the four main trigger sites and, less commonly, patients with isolated temporal migraine headache may suffer from headaches triggered through irritation of the auriculotemporal nerve. The auriculotemporal nerve is a branch of the mandibular division of the trigeminal nerve (V3) that runs with the superficial temporal artery and vein. Patients suffering from auriculotemporal neuralgia often experience pain along the distribution of this nerve. Cadaveric studies have explored the anatomical course and variation of the auriculotemporal nerve to better elucidate potential compression points that act as migraine triggers. Janis et al. outlined three potential compression points: two points that corresponded to preauricular fascial bands superior to the most anterosuperior point of the external auditory meatus, and a third point between the auriculotemporal nerve and the superficial temporal artery.[5] The latter compression point underscores the clinically significant relationship between the auriculotemporal nerve and the superficial temporal artery. Janis et al. noted the variations of this relationship in their anatomical study: the artery crossing over the nerve, a helical intertwining relationship, and the nerve crossing over the artery.[5] Our studies demonstrated a direct relationship between the superficial artery and auriculotemporal nerve in 34.0 percent of cranial halves that were dissected, and suggested that exploration of branching patterns of the auriculotemporal nerve can elucidate trigger sites.[6] The trigger site could be addressed surgically by ligation of the artery through a small incision within the temporal hairline or with an endoscopic technique.[7] Prior literature describing techniques learned from the senior author have been published; however, a paucity of literature exists regarding the surgical outcomes in this anatomical location.[8–12]

Surgical treatment of migraine headaches is cost-effective, has shown positive patient outcomes, has few adverse events, and, most importantly, provides relief for a cohort of patients who cannot tolerate or do not respond to medical management.[13–15] Outcomes for lesser known trigger sites are not well established. The purpose of this study was to evaluate symptom relief after surgical treatment of migraine headaches involving the auriculotemporal nerve (site V).

PATIENTS AND METHODS

This study received institutional review board approval by University Hospitals Cleveland Medical Center (institutional review board 07-15-10). A detailed history and board-certified neurologist consultation were obtained to diagnose migraine headache. The study included patients who had undergone surgery for auriculotemporal nerve deactivation of migraine trigger site V performed by a single surgeon (B.G.) between 2007 and 2016 and had completed a preoperative and postoperative migraine headache questionnaire. The charts were reviewed retrospectively for age, sex, dates of surgery and follow-up, preoperative and postoperative migraine data, types of surgery, and laterality. Excluded from the study were patients who could not be contacted to obtain site-specific data or postoperative migraine data, patients who did not return for follow-up, and patients who did not wish to participate. During the initial examination, the patients were asked to point to the area of migraine headache and find the most tender spot. Even in the absence of an active migraine headache, all patients could point to a spot where an ultrasound Doppler signal was identified, marked, and confirmed preoperatively.

Data Collection

Patients completed a global migraine headache questionnaire before surgery to assess migraine frequency (number of migraine-free days per month), duration (recorded in hours per day), severity (scale of 1 to 10, with 10 being most severe), and anatomical location of pain. Postoperatively, patients were then contacted using phone, e-mail, and/or video conference to obtain updated postoperative migraine data and site-specific data. The site-specific data included whether or not the specific surgical site continued to trigger migraines. A video conference with the patient was conducted if there was any confusion regarding the anatomical locations of the migraine trigger sites to ensure specificity of the headache location.

Statistical Analysis

Descriptive statistics were used to summarize demographic and clinically relevant variables. Tests of difference, confidence intervals, and p values were calculated for preoperative and postoperative variables (i.e., migraine duration, intensity, and migraine-free days) using Wilcoxon rank sum tests for continuous variables and Fisher's exact test for categorical variables. Statistical

significance was defined retroactively as a value of $p < 0.001$, given the small sample size of the cohort. The associations between site relief or laterality (i.e., unilateral versus bilateral surgery) and migraine duration, intensity, and migraine-free days were studied by both univariate and multivariate logistic regression. All analyses were performed using R Statistical Computing Language version 3.3.0.

Migraine Site V Surgical Technique

All patients who underwent decompression of the auriculotemporal nerve underwent a direct approach. Before surgery, the patients were asked to identify the point of intense pain in the temporal region. A Doppler probe was then used to identify a Doppler signal, and the site was marked.[16] Local anesthetic was administered using lidocaine containing 1:200,000 epinephrine, and a 1-cm incision was made. Blunt dissection was used until the main auriculotemporal nerve or the involved branch was identified. When the involved nerve branch was a minor branch, it was avulsed. When the main nerve was involved, it was isolated to a sufficient length, transected, and buried in the temporalis muscle through rent in the deep temporal fascia. To do so, a 5-0 Prolene suture (Ethicon, Inc., Somerville, N.J.) was passed through the fascia approximately 5 mm away from the rent in the fascia, and the nerve was neurotized into the muscle. As the suture was tied, it pulled the nerve end underneath the fascia through the rent. A permanent suture was used to facilitate finding the nerve in case exploration became necessary. Fortunately, this has not become necessary. A small amount of triamcinolone (0.1 cc) was injected next to the end of the buried nerve only. The main superficial temporal artery or its branch interfacing with the auriculotemporal nerve or its branch was also identified with ultrasound Doppler, and an arterectomy was performed. Suture ligature was placed around the main vessel, and the minor branch was simply cauterized. The wound was dressed with bacitracin ointment. The patient was allowed full activities immediately.

RESULTS

Patients

Table 1 presents demographic information of the patient cohort. A total of 43 patients underwent migraine surgery of site V and met inclusion criteria for the study. At the time of surgery, the median age was 50 years (interquartile range, 40 to 57 years). The cohort was largely female, with 36 women and seven men. The average follow-up time was 17.2 months. Of the 43 patients with site V surgery, 34 (79 percent) reported site-specific relief.

Table 1. Demographics of Patients Undergoing Migraine Site V Surgery

Variable	Value (%)
Total no. of patients	43
Age, yr	
Median	50
IQR	40–57
Sex	
Male	7 (16)
Female	36 (84)
Follow-up, mo	17.19
Site relief	34 (79)
Bilateral surgery	36 (84)

IQR, interquartile range.

Migraine Site V Outcomes

Table 2 presents a summary of preoperative and postoperative migraine duration, intensity, and migraine-free days. Migraine-free days (per month) increased from 12.6 days before surgery to 25.1 days after surgery, with a median increase of 12.6 days ($p < 0.005$). The migraine intensity decreased from a median of 8.3 to 3.2 after surgery, with a median decrease of 5.1 on 10-point severity scale ($p < 0.005$). Migraine duration (in hours per day) decreased from 1.2 to 0.5 after surgery, with a median decrease of 0.7 ($p < 0.005$). The median difference in migraine duration was the only value not found to be statistically significant, defined as $p < 0.005$.

Site Relief

Overall, patients who had site-specific relief had an increase in migraine-free days (Fig. 1). Among patients who had relief, there was an increase from 11.6 migraine-free days per month to 27.2 migraine-free days per month. For those who did not have site relief, there was a small increase from 16.2 migraine-free days per month to 17.3 migraine-free days per month. Migraine intensity decreased in all patients, with a significant change in those who had site relief (Fig. 2). The intensity decreased from a median of 8.4 to 2.1 on a 10-point scale; scores for patients who did not have site relief decreased from a median of 7.9 to 7.4 on the 10-point scale. Migraine duration improved in all patients, with the site-relief patients decreasing from a median of 1.1 hours/day to 0.3 hour/day (Fig. 3). Patients who did not have site relief decreased from 1.6 hours/day to 1.1 hours/day. On both univariate and multivariate analysis, patient-reported site relief was significantly associated with decreased migraine

Table 2. Preoperative and Postoperative Migraine Parameters

Migraine Parameter	Median (IQR)		Median Change	95% CI	*p*
	Preoperatively	Postoperatively			
Migraine-free days (per month)	12.57 (10.22)	25.12 (8.22)	12.55	8.7–17.5	<0.005*
Migraine intensity (10-point scale)	8.31 (1.58)	3.22 (3.55)	5.09	4.5–7.0	<0.005*
Migraine duration (hr/ day)	1.22 (1.59)	0.50 (0.81)	0.71	0.17–0.87	<0.005*

IQR, interquartile range.
*Statistically significant.

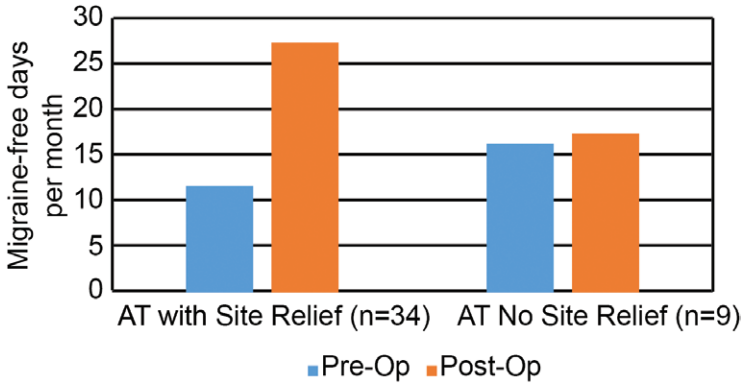

Fig. 1. Migraine-free days before and after surgery in patients with and without site V relief. *AT*, auriculotemporal nerve surgery.

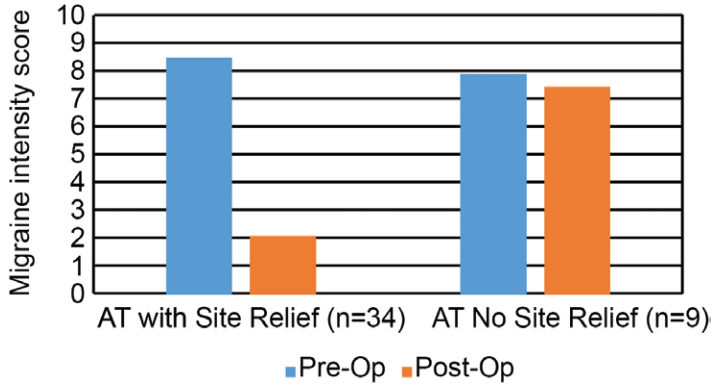

Fig. 2. Migraine intensity before and after surgery in patients with and without site V relief. *AT*, auriculotemporal nerve surgery.

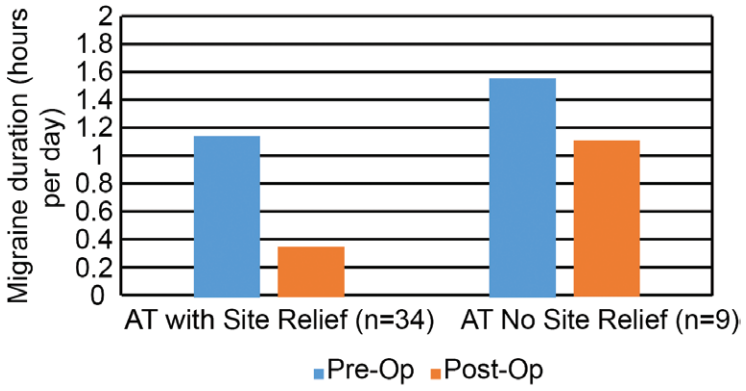

Fig. 3. Migraine duration before and after surgery in patient with and without site V relief. *AT*, auriculotemporal nerve surgery.

intensity. There was no significant association between patient-reported site relief and migraine duration and migraine-free days on both univariate and multivariate analysis.

Laterality

Bilateral procedures demonstrated a larger increase in migraine-free days per month when compared to unilateral procedures (Fig. 4). Patients who underwent bilateral surgery (n = 36) improved from 12 migraine-free days to 25 migraine-free days per month after surgery. Unilateral surgery patients (n = 6) improved from 15 migraine-free days to 23 migraine-free days per month after surgery. Migraine intensity decreased in all patients (Fig. 5). Among the patients who underwent bilateral procedures, the intensity decreased from a median of 8.3 to 2.9 on a 10-point scale. Patients who underwent unilateral procedures decreased from a median migraine intensity of 8.0 to 5.3 on the 10-point scale. Migraine duration improved in all patients, with those undergoing bilateral procedures decreasing from a median of 1.2 hours/day to 0.5 hour/day (Fig. 6). Patients who had unilateral procedures decreased from a median of 1.3 hours/day to 0.7 hour/day. On both univariate and multivariate analyses, there was no significant association between laterality and migraine duration, migraine-free days, and intensity.

DISCUSSION

Our study reaffirms that migraine site V surgery demonstrates significant improvement in site-specific relief and overall improvement of migraine headache parameters. The procedure has a 79 percent success rate (>50 percent reduction in frequency, intensity, and duration) in the migraine site V, with minimal risk. The use of

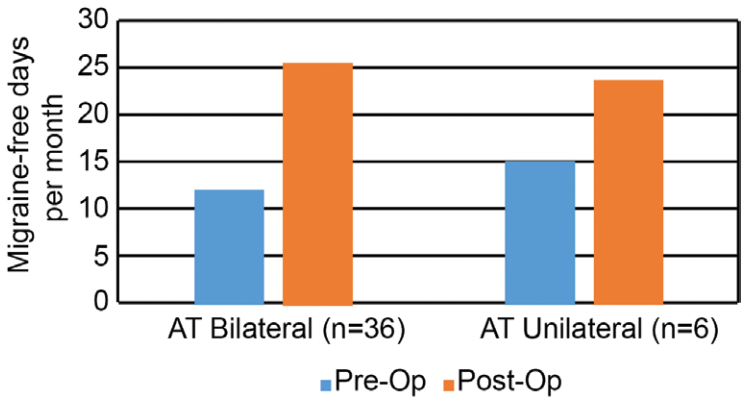

Fig. 4. Migraine-free days before and after site V surgery in patients undergoing unilateral versus bilateral procedures. *AT*, auriculotemporal nerve surgery.

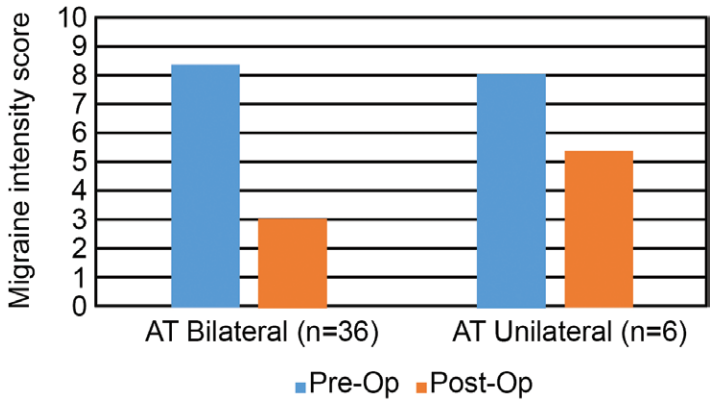

Fig. 5. Migraine intensity before and after site V surgery in patients undergoing unilateral versus bilateral procedures. *AT*, auriculotemporal nerve surgery.

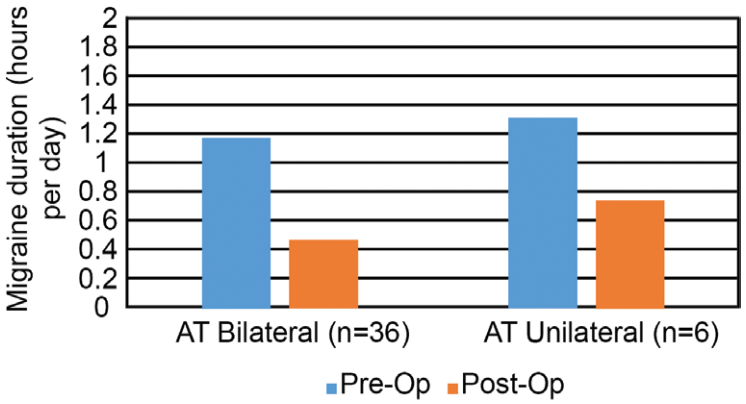

Fig. 6. Migraine duration before and after site V surgery in patients undergoing unilateral versus bilateral procedures. *AT*, auriculotemporal nerve surgery.

Doppler imaging to confirm the precise trigger site has been a colossal development in the care of most migraine patients, especially those with site V trigger sites. Of the patients included in this study, there were no reported surgical-site infections, hematoma, wound healing complications, or need for additional same-site operations.

In our predominantly female (n = 36 [84 percent]) cohort, the median age was 50 years. This is consistent with national data demonstrating a three-times higher incidence of migraine headaches in female subjects compared with male subjects.[17,18] The median follow-up time in our cohort was 1.4 years.

When analyzing specific migraine site V parameters, the average patient undergoing surgery had a statistically significant increase of 12.6 migraine-free days per month after surgery. In addition, they also reported a statistically significant decrease in migraine intensity of 5.1 on a 10-point scale after surgery. Migraine duration decreased from 1.2 hours/day to 0.5 hour/day after surgery, and although this was found to be statistically significant, it can also be considered clinically significant, as it is greater than a 50 percent decrease in average migraine duration. Our results show that the average patient experienced a 79 percent chance of specific site relief, 12.6 more migraine-free days per month, and 50 percent decrease or more in the average migraine intensity and duration when the patient does experience a migraine headache.

Migraine-free days had the largest increase in those who experienced site relief in migraine site V. This is expected, as patients with site relief are more likely to have a positive outcome with regard to migraine-free days. Migraine intensity and duration showed a strong clinical correlation in that those who experienced site relief had a greater decrease in both parameters, and those who did not experience site relief had a lesser change. We expected those who did not have site relief to have relatively consistent migraine parameters as they did before surgery, as some of the data show. Interestingly, the group without site relief had a decrease in migraine duration that was greater than expected. The data suggest that decompression of the auriculotemporal nerve provided some improvement, but these patients continue to demonstrate symptoms of nerve compression in the temple area, invariably involving another branch of the auriculotemporal nerve. No patient identified the migraine headache corresponding to the incisional scar.

All patients who underwent surgery demonstrated improvement in all migraine parameters after surgery regardless of laterality of the procedure. Bilateral surgery demonstrated the greatest improvement, with an increase of 13 migraine-free days per month after surgery. The unilateral group had an increase of 8 migraine-free days per month. To optimize outcomes, communication between the surgeon and patient is critical in the preoperative evaluation for identifying trigger sites and the laterality specifics of the trigger site.[19] Not all patients experience bilateral symptoms, and therefore they would not benefit from bilateral procedures. Failing to identify those who may benefit from strictly unilateral procedures has the potential to negatively influence surgical outcomes.

Our study is not without limitations. Given the small cohort (n = 43), it is possible that we did not achieve statistical power. However, we attempted to address this shortcoming by designating a low p value cutoff for statistical

significance. Further details regarding changes in site-specific migraine characteristics (e.g., severity, frequency, and duration) that may indicate a need for secondary-site surgery for those who did not have successful site relief after the primary operation were not included. Future studies specifically looking at indications for secondary surgery across the migraine sites are currently underway. In addition, the analysis did not account for those who may have undergone migraine surgery in another site before or after site V surgery; it is possible their migraine parameters may have changed surrounding additional migraine surgery. Many patients undergoing migraine site V surgical release have also undergone prior surgical release of the more common trigger sites (I, II, III, and IV). Our prior studies have shown that deactivation of migraine headache trigger sites may unmask secondary headaches and therefore leads to these patients seeking further surgical interventions, such as the auriculotemporal nerve trigger site release.[20]

CONCLUSIONS

Our findings confirm that surgical release of migraine trigger site V improves both site-specific migraine trigger outcomes and global migraine parameters. Patients seeking surgical release of this site should be made aware of the positive outcomes and the limitations of these procedures.

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REFERENCES

1. Guyuron B, Varghai A, Michelow BJ, Thomas T, Davis J. Corrugator supercilii muscle resection and migraine headaches. *Plast Reconstr Surg.* 2000;106:429–434; discussion 435–437.
2. Guyuron B, Kriegler JS, Davis J, Amini SB. Five-year outcome of surgical treatment of migraine headaches. *Plast Reconstr Surg.* 2011;127:603–608.
3. Kung TA, Guyuron B, Cederna PS. Migraine surgery: A plastic surgery solution for refractory migraine headache. *Plast Reconstr Surg.* 2011;127:181–189.
4. Seyed Forootan NS, Lee M, Guyuron B. Migraine headache trigger site prevalence analysis of 2590 sites in 1010 patients. *J Plast Reconstr Aesthet Surg.* 2017;70:152–158.
5. Janis JE, Hatef DA, Ducic I, et al. Anatomy of the auriculotemporal nerve: Variations in its relationship to the superficial temporal artery and implications for the treatment of migraine headaches. *Plast Reconstr Surg.* 2010;125:1422–1428.
6. Chim H, Okada HC, Brown MS, et al. The auriculotemporal nerve in etiology of migraine headaches: Compression points and anatomical variations. *Plast Reconstr Surg.* 2012;130:336–341.
7. Sanniec K, Borsting E, Amirlak B. Decompression-avulsion of the auriculotemporal nerve for treatment of migraines and chronic headaches. *Plast Reconstr Surg Glob Open* 2016;4:e678.
8. Peled ZM. A novel surgical approach to chronic temporal headaches. *Plast Reconstr Surg.* 2016;137:1597–1600.
9. Dirnberger F, Becker K. Surgical treatment of migraine headaches by corrugator muscle resection. *Plast Reconstr Surg.* 2004;114:652–657; discussion 658–659.
10. Poggi JT, Grizzell BE, Helmer SD. Confirmation of surgical decompression to relieve migraine headaches. *Plast Reconstr Surg.* 2008;122:115–122; discussion 123–124.
11. Janis JE, Dhanik A, Howard JH. Validation of the peripheral trigger point theory of migraine headaches: Single-surgeon experience using botulinum toxin and surgical decompression. *Plast Reconstr Surg.* 2011;128:123–131.
12. Gfrerer L, Maman DY, Tessler O, Austen WG. Nonendoscopic deactivation of nerve triggers in migraine headache patients: Surgical technique and outcomes. *Plast Reconstr Surg.* 2014;134:771–778.
13. Janis JE, Barker JC, Javadi C, Ducic I, Hagan R, Guyuron B. A review of current evidence in the surgical treatment of migraine headaches. *Plast Reconstr Surg.* 2014;134(Suppl 2):131S–141S.
14. Gfrerer L, Guyuron B. Surgical treatment of migraine headaches. *Acta Neurol Belg.* 2017;117:27–32.
15. Faber C, Garcia RM, Davis J, Guyuron B. A socioeconomic analysis of surgical treatment of migraine headaches. *Plast Reconstr Surg.* 2012;129:871–877.
16. Guyuron B, Riazi H, Long T, Wirtz E. Use of a Doppler signal to confirm migraine headache trigger sites. *Plast Reconstr Surg.* 2015;135:1109–1112.
17. Buse DC, Loder EW, Gorman JA, et al. Sex differences in the prevalence, symptoms, and associated features of migraine, probable migraine and other severe headache: Results of the American Migraine Prevalence and Prevention (AMPP) Study. *Headache* 2013;53:1278–1299.
18. Clayton JA. Sex influences in neurological disorders: Case studies and perspectives. *Dialogues Clin Neurosci.* 2016;18:357–360.
19. Guyuron B, Nahabet E, Khansa I, Reed D, Janis JE. The current means for detection of migraine headache trigger sites. *Plast Reconstr Surg.* 2015;136:860–867.
20. Punjabi A, Brown M, Guyuron B. Emergence of secondary trigger sites after primary migraine surgery. *Plast Reconstr Surg.* 2016;137:712e–716e.