

In-Depth Review of Symptoms, Triggers, and Surgical Deactivation of Frontal Migraine Headaches (Site I)

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Background: This study reports details of the technique and assesses efficacy of surgical deactivation of frontal migraine headaches. In addition, this study examines the effect of surgical deactivation of frontal migraine headaches on migraine triggers and associated symptoms besides the pain.

Methods: Charts of 270 patients undergoing surgery performed by a single surgeon for frontal migraine headaches, who were followed for at least 1 year, were analyzed. Median regression adjusted for age, sex, and follow-up time was used to determine postoperative reduction in frontal-specific Migraine Headache Index, which is the product of duration, frequency, and severity. Reduction in migraine-days, which is the product of duration and frequency, was also measured. The association between individual symptom or trigger resolution and frontal-specific Migraine Headache Index reduction was studied by logistic regression. Details of the surgical treatment are discussed and complication rates are reported.

Results: Eighty-six percent of patients reported a successful operation (≥ 50 percent improvement of frontal-specific Migraine Headache Index) at least 12 months after surgery (mean follow-up, 3 years). Eighty-four percent of patients had a successful operation as measured by migraine-days. Fifty-seven percent of patients reported complete elimination of frontal migraine headaches. Symptoms resolving with successful site I surgery beyond the headaches include visual aura and blurred or double vision ($p < 0.05$). Triggers resolving with successful site I surgery include fatigue, weather change, and missed meals ($p < 0.05$).

Conclusions: Surgical deactivation of frontal migraine headaches provides long-lasting migraine relief. Successful site I surgery is associated with changes in specific symptoms and triggers. This information can assist in trigger avoidance and contribute to constellations used for frontal migraine headache trigger-site identification. (*Plast. Reconstr. Surg.* 138: 681, 2016.)

CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, IV.

Migraine headaches can be physically and socially disabling for patients and impose a sizable financial burden for patients and society.¹ Many patients respond to preventive or abortive medications or botulinum toxin type A injection. However, patients not responding to these treatments, who observe less effectiveness

over time, or who are unable to tolerate their side effects may be candidates for surgical intervention. Our team has developed surgical interventions to treat four primary migraine trigger sites: site I surgery for frontal-triggered migraine headaches, site II surgery for temporal-triggered migraine headaches, site III surgery for septonasal-triggered migraine headaches, and site IV surgery for occipital-triggered migraine headaches. In addition, we have discovered several less common trigger sites and developed surgical measure for deactivating these trigger sites. This article is

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a corollary to our previously published in-depth review of site II surgery.²

Frontal migraine headaches could be triggered by irritation of the supraorbital and supratrochlear nerves by muscular, bony, fascial, or vascular structures. On continual compression of these nerves or their branches or irritation of the nerve by the pulsatile pressure from the vessels, neurokinins and substance P are released, travel along the nerve, and produce localized meningitis that the patient perceives as a migraine.³

Cadaveric studies have described the course of the supraorbital and supratrochlear nerves and elucidated potential compression points. The supraorbital nerve, the lateralmost terminal branch of the frontal branch of the ophthalmic nerve, emerges from the cranium most commonly through a notch but occasionally through a bony foramen or combination of notch and foramen.⁴⁻¹⁰ Fallucco et al. have devised a classification system for fascial band morphology at the supraorbital notch.¹⁰ The supraorbital nerve continues cephalad, with superficial or deep branches interacting with the corrugator in 78 percent of heads. Janis et al. published a two-part anatomical study describing the corrugator supercillii muscle's extent and a classification system for deep and superficial supraorbital nerve branching patterns relative to the muscle.^{11,12}

The supratrochlear nerve is the medialmost branch of the frontal branch of the ophthalmic nerve. The nerve tends to split into two branches within the retro-orbicularis oculi fat. The supratrochlear nerve branches run between the trochlea and supraorbital foramen, exiting through the frontal notch. The supratrochlear nerve continues caudal, with branches interacting with the corrugator in 84 percent of cases. Janis et al. have devised a classification system for supratrochlear nerve branching patterns.¹³

Migraine headaches in our patients are always diagnosed by a board-certified neurologist. We determine the anatomical trigger site by numerous methods, including having the patient point to the migraine starting point, constellation of symptoms, serial botulinum toxin type A injection, nerve blocks, computed tomographic scan, and Doppler signals.¹⁴ Constellations of symptoms have been shown to be as effective as serial botulinum toxin type A injection for diagnosis of correct migraine trigger site. We now use ultrasound Doppler imaging to confirm the presence of an artery in the most painful or tender site for both supratrochlear and supraorbital nerves.

However, the specific symptoms and triggers have not been individually evaluated for site-specific associations.¹⁵ Frontal migraine headaches are thought to be characterized by episodes of imploding pain and tenderness close to the supraorbital notch, corrugator hypertrophy signified by the presence of deep frown lines, eyelid ptosis, and improvement of pain with warm or cold compress applied to the lower forehead. Some patients can abort the pain temporarily by manually compressing the neurovascular bundles in very early stages of the migraine cascade. The single most important piece of information in detecting the trigger sites is the location of pain onset. The headache that starts from another site and travels to the frontal area is often the result of secondary inflammation of the supraorbital and supratrochlear nerves.

Our research team has performed retrospective,³ prospective,^{16,17} and placebo-controlled¹⁸ studies that support the role of surgery in treatment of migraine headaches. Other research groups have replicated these results.¹⁹⁻²³ We have also shown that the endoscopic (versus transpalpebral) approach to site I surgery may achieve slightly better outcomes.²⁴ This retrospective study examines the impact of site I surgery on frontal migraine headache frequency, duration, and severity and reviews the technical surgical details. This is the first study to associate specific triggers and symptoms with frontal migraine headaches and is the largest study to analyze specifically site I surgery outcomes.

PATIENTS AND METHODS

Institutional review board approval was obtained for this retrospective review of prospectively recorded data. A detailed history and a board-certified neurologist consultation were obtained to diagnose migraine headaches. The frontal trigger site was identified by either constellation of symptoms or systematic injection of botulinum toxin type A. Patients who proceeded with surgery for frontal migraine headaches performed by a single surgeon (B.G.), and had completed a preoperative Migraine Headache Questionnaire and a postoperative Migraine Headache Questionnaire greater than or equal to 12 months after surgery, were included.

Preoperative Procedure

Patients completed a Migraine Headache Questionnaire before surgery to assess migraine headache frequency (number of migraine headaches per month), duration (in days), severity

(scale of 1 to 10, with 10 being most severe), and anatomical location of pain (yes/no report of migraine headaches originating from right or left frontal, temporal, septonasal, and occipital regions). A preoperative Migraine Headache Index was calculated by multiplying the duration, frequency, and severity. Migraine-days, accounting for frequency and duration of each episode, was also recorded. Preoperative frontal-specific Migraine Headache Index was assumed to equal the overall Migraine Headache Index in the presence of diagnosed frontal migraine headaches. In addition, the questionnaire asked patients to select from 16 symptoms and 13 triggers they may have observed in the month before the final preoperative visit.

Surgical Technique

Corrugator resection was performed by means of either transpalpebral or endoscopic approach, depending on whether it was being performed with or without the surgery on site II. For those who underwent site I surgery without site II surgery, the operation on site I was performed through the transpalpebral approach. The details of the senior author's (B.G.) surgical technique have been described previously.²⁴

Transpalpebral Nerve Decompression

The incision was marked in the supratarsal crease involving up to two-thirds of the medial limit of the caudal portion of the conventional upper

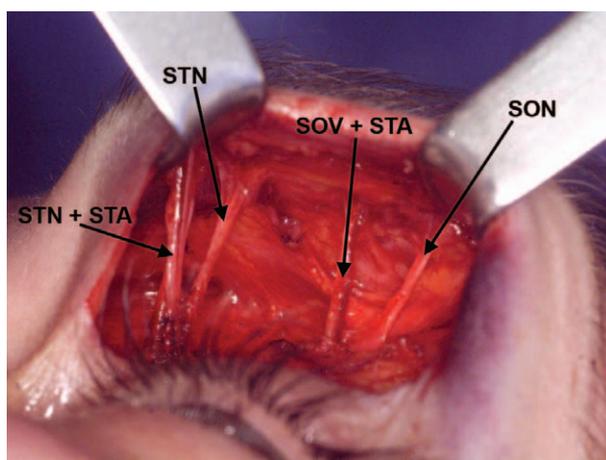


Fig. 1. Transpalpebral approach to site I surgery. *STV*, supra-trochlear vein; *STA*, supra-trochlear artery; *STN*, supra-trochlear nerve; *SOV*, supraorbital vein; *SOA*, supraorbital artery; and *SON*, supraorbital nerve. (Adapted from with permission from Liu MT, Chim H, Guyuron B. Outcome comparison of endoscopic and transpalpebral decompression for treatment of frontal migraine headaches. *Plast Reconstr Surg*. 2012;129:1113–1119.)

blepharoplasty incision (Fig. 1). The upper eyelid, glabellar area, and lower forehead were infiltrated with 1% lidocaine containing 1:100,000 epinephrine and 0.5% ropivacaine hydrochloride. After making the incision, a skin–orbicularis oculi muscle flap was raised above the level of the septum in a cephalic direction. The dissection was continued to the supraorbital rim. The depressor supercillii muscle was exposed and resected as completely as possible, protecting the supraorbital nerve. This allowed exposure of the corrugator supercillii muscle, which is darker and more friable compared with the depressor supercillii muscle. Excision of the corrugator supercillii muscle was then achieved as thoroughly as possible with electrocautery, and lateral fibers of the procerus muscle encasing the supratrochlear nerve were also removed. Fat was then harvested either from the medial fat pad of the upper lid or from an area deep to the deep temporal fascia above the zygomatic arch, if endoscopic decompression or avulsion of the zygomaticotemporal branch of the trigeminal nerve was performed concomitantly, and placed to fill the depression resultant from resection of the corrugator supercillii muscle and to cushion the nerves.^{25–27} For patients who did not have an excessive medial fat pad in the upper eyelid and were undergoing isolated transpalpebral approach, fat was aspirated from the abdomen and spun for 3 minutes, and 1 cc was injected in multiple planes in each side to replace the removed muscle volume. Additional procedures included removal of the vessels accompanying the nerves, foraminotomy when a foramen was present and, more recently, release of the fibrous bands across the supraorbital notch when a notch was present and nerves appeared compressed by the tight bands.

Endoscopic Nerve Decompression

A midline incision or two paramedian incisions were marked 1.5 cm long approximately 3.5 cm apart in the frontal area in addition to one or two similar incisions in the temple if decompression of the temple trigger site was also indicated (Fig. 2). The hair-bearing forehead scalp was infiltrated with 0.5% lidocaine mixed with 1:200,000 epinephrine, and the rest of the forehead was infiltrated with a mix of 0.5% ropivacaine hydrochloride and 1% lidocaine with 1:100,000 epinephrine. If this was performed together with site II surgery for temporal migraine headaches, five or six 1.5-cm incisions were made for access to the glabellar muscle group and the zygomaticotemporal branch of the trigeminal nerve. Site II surgery was performed first, and fat was harvested from beneath the deep temporal

fascia above the zygomatic arch medially.²⁸ To remove the muscles, the incisions were made and the endoscopic access devices were placed in position. The dissection was carried caudally and medially in a subperiosteal plane to expose the glabellar muscle group. The corrugator supercilii muscle and depressor supercilii muscles were resected as completely as possible, with removal of the lateral fibers of the procerus muscle under direct endoscopic visualization and with care taken to preserve the supraorbital and supratrochlear nerves.²⁵ Additional surgical maneuvers at the frontal trigger site included percutaneous foraminotomy using a 2-mm osteotome with clear and precise endoscopic visualization of the foramen endoscopically whenever there was a foramen rather than a notch,

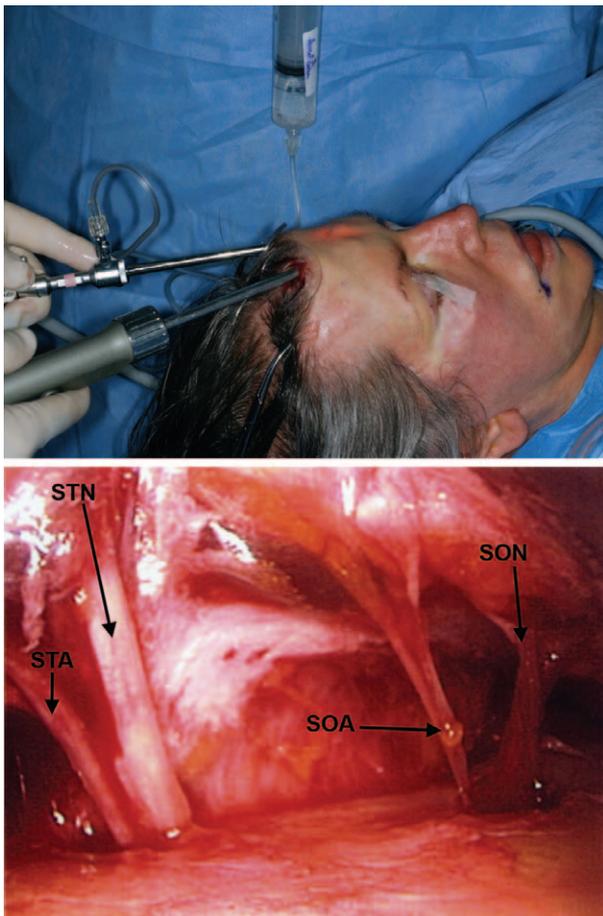


Fig. 2. Endoscopic approach to site I surgery. (Above) Endoscopic ports are placed in the hair-bearing region of the forehead. (Below) Supraorbital and supratrochlear nerves are freed from compression. STA, supratrochlear artery; STN, supratrochlear nerve; SOA, supraorbital artery; and SON, supraorbital nerve. (Adapted with permission from Liu MT, Chim H, Guyuron B. Outcome comparison of endoscopic and transpalpebral decompression for treatment of frontal migraine headaches. *Plast Reconstr Surg.* 2012;129:1113–1119.)

and cauterization of the vessels accompanying the nerves. Finally, an accessory supraorbital nerve was transected whenever it was identified to exit from a separate foramen in which the unroofing of the related tunnel was deemed unsafe.

Postoperative Procedure

Patients completed a Migraine Headache Questionnaire every 3 months, and at greater than or equal to 12 months after surgery, postoperative Migraine Headache Index and migraine-days were calculated. Frontal-specific Migraine Headache Index was assumed to equal overall Migraine Headache Index if frontal migraine headaches persisted postoperatively. Elimination of frontal migraine headaches was defined as zero reported frontal migraine headaches in the frontal region. A successful site I operation was defined as frontal-specific Migraine Headache Index reduction of at least 50 percent during the 12-month follow-up. Patients also reported symptoms and triggers they experienced in the month before each follow-up visit. Complications of surgery were recorded from review of postoperative visit notes dictated by the senior author and postoperative questionnaires. Complications were stratified by endoscopic versus transpalpebral approach.

Statistical Analysis

Exploratory and descriptive statistics were used in summarizing demographic and clinically relevant (e.g., frontal-specific Migraine Headache Index reduction) variables. Reduction in frontal migraine headache duration, frequency, and severity were tested using basic tests (e.g., chi-square test), with the level of significance at 0.05. For skewed response variables, median regressions adjusted for age, sex, and follow-up time were used to determine postoperative reduction in frontal-specific Migraine Headache Index. The association between individual symptoms or trigger resolutions and frontal-specific Migraine Headache Index reduction were studied by logistic regressions. Odds ratio estimates and their 95 percent confidence intervals were reported. All analyses were performed using Stata 11.0 software (StataCorp, College Station, Texas).²⁹

RESULTS

Overall Surgery Outcome

Two hundred seventy patients (242 female and 28 male patients) with a median age of 45 years (range, 20 to 70 years) were included for analysis in this study after exclusion of 136 patients who were not followed for at least 1 year. Follow-up ranged from 12 to 120 months, with a mean

follow-up of 3.33 ± 1.85 years. Seventy-six percent of patients received botulinum toxin injection as part of the diagnostic workup, with the rest diagnosed by constellation of symptoms alone or a nerve block.

Eighty-six percent of patients experienced greater than or equal to 50 percent frontal-specific Migraine Headache Index reduction, including 57 percent experiencing frontal migraine headache elimination. Eighty-four percent of the patients observed at least 50 percent reduction in migraine-days. Frontal migraine headache duration (mean, 62 percent reduction), frequency (mean, 69 percent reduction), and severity (mean, 65 percent reduction) were each significantly decreased postoperatively ($p < 0.0001$). Age, sex, use of botulinum toxin for diagnosis, and follow-up time had no impact on surgical efficacy ($p > 0.05$).

Thirty-four patients (12.6 percent) underwent site I surgery only, 215 (79.6 percent) underwent concomitant site II surgery, 168 (62.2 percent) underwent site III surgery, 125 (46.3 percent) underwent site IV surgery, and two (0.7 percent) underwent site V (auriculotemporal nerve decompression) surgery. Among the 34 patients who had site I surgery without concomitant surgery, 30 (88 percent) had successful surgery, including 20 (59 percent) with complete elimination. Botulinum toxin type A was used in 28 of these patients (82 percent) for diagnosis.

Symptoms and Triggers

Symptoms with resolution significantly associated with decrease in frontal-specific Migraine Headache Index include visual aura and blurred/double vision ($p < 0.05$). Odds ratios and 95 percent confidence intervals for symptoms are listed in Table 1. Odds ratio describes the likelihood of symptom resolution in patients who benefited compared to those who did not benefit from surgery.

Triggers with resolution significantly associated with decrease in frontal-specific Migraine Headache Index include fatigue, weather change, and missed meals ($p < 0.05$). Odds ratios and 95 percent confidence intervals for triggers are listed in Table 2.

Complications

Complications data were available for 223 of 270 patients and are listed in Table 3. The most common complications were numbness (34.5 percent) and itching (14.8 percent). Eyelid

ptosis was seen in 5.8 percent of cases. No major complications were recorded. No analysis could be performed to compare endoscopic versus transpalpebral approaches because of inadequate sample sizes.

DISCUSSION

These results provide strong support for the efficacy of surgery to reduce frontal migraine headaches frequency, duration, and severity. Eighty-six percent of patients experienced significant benefit from surgery. Furthermore, a mean 3-year follow-up supports surgery's lasting effect.

Despite high rates of success, inability to eliminate frontal migraine headaches in all patients suggests room for improving patient selection and surgical technique. Our team has separately shown that positive response to botulinum toxin A is predictive of a successful operation, and preoperative narcotics were associated with poor outcomes.^{30,31} However, neither the demographic data (age, sex) nor the diagnostic data (botulinum toxin A use) here suggest who may benefit most from site I surgery.

Controversy has existed in the literature regarding the extent of corrugator that is resectable by transpalpebral compared to endoscopic approaches.^{24,32-34} Previous publication by our research team supports the endoscopic over the transpalpebral approach for site I surgery when possible.²⁴ We use an endoscopic approach when performing concomitant site I and site II surgery and rely on the transpalpebral approach in patients with forehead lengths greater than 8 cm or if the patient has a significantly protruded forehead, which makes reaching the muscles very difficult if not impossible. Over years of performing site I surgery and improving the extent of corrugator resection, we have been able to more consistently decompress accessory supraorbital nerve branches laterally and the supratrochlear nerve medially.

Some nonresponders may suffer from a "double-crush" phenomenon, with compression by glabellar muscles and bony or fascial structures. All patients with the supraorbital nerve passing through a supraorbital foramen that is detected undergo supraorbital foraminotomy. We have recently discovered that computed tomographic scan of the paranasal sinuses can reveal the presence or absence of a supraorbital foramen and guide dissection. Visualization of a foramen through the transpalpebral approach requires extra dissection, and visualization of a foramen

through the endoscopic approach on a patient who has a prominent frontal bar or frontal bossing can be difficult. Only patients with tight fascial bands traveling within a supraorbital notch are subject to fasciotomy. Releasing the facial

bands or performing foraminotomy may improve outcomes.³⁵

Previous publication by our research team suggests no difference in surgical outcomes between patients diagnosed with a constellation of symptoms alone compared to serial botulinum toxin type A injection. This is the first study to identify symptoms and triggers associated with frontal migraine headaches. Understanding that frontal migraine headaches may be associated with symptoms of visual aura and blurred and double vision and triggers of fatigue, weather change, and missed meals may facilitate anatomical trigger site localization. However, weather change as a trigger is not specific to this site and is a common trigger in most sites. In addition, patients with frontal migraine headaches who cannot explicitly identify triggers or who are not surgical candidates may be counseled in a more targeted manner. We are currently collecting symptom and trigger data for each of the other anatomical trigger sites to assess sensitivity and specificity of these symptoms and triggers. Although this study cannot provide a pathophysiologic explanation, we find it interesting that frontal migraine headaches are associated with visual symptoms. In addition, we decide to have patients report symptoms and triggers for the month preceding the visit, given that other migraine measures, including migraine frequency, are reported over a 1-month duration.

Loss to follow-up was a limitation. Many patients traveled from out of state and out of country for treatment, which makes long-term contact difficult. We do send questionnaires to out-of-town patients; however, our response rate is inconsistent. In addition, the number of patients with multiple anatomical decompression sites may be a limitation, and deducing preoperative and postoperative frontal-specific Migraine Headache Index from overall Migraine Headache Index was a limitation. We made the assumption that a patient reporting migraines in two or more sites either preoperatively or postoperatively had

Table 1. Symptom Association with Frontal-Specific Migraine Headache Index Reduction

Symptom	No. of Patients	OR	<i>p</i>	95% CI
Visual aura	77	7.24	0.024*	1.29–40.59
Blurred/double vision	93	2.54	0.031*	1.09–5.94
Eyelid ptosis	47	3.91	0.069	0.90–17.00
Bothered by light and noise	206	1.56	0.116	0.90–2.72
Speech difficulty	48	2.35	0.210	0.62–8.98
Running nose	75	0.83	0.372	0.55–1.25
Nausea	190	1.12	0.469	0.82–1.53
Numbness/tingling	48	1.15	0.469	0.78–1.70
Difficulty concentrating	187	1.08	0.608	0.80–1.46
Loss of consciousness	13	1.63	0.703	0.13–20.21
Eyelid puffy	70	0.91	0.730	0.52–1.58
Feeling lightheaded	90	0.95	0.750	0.68–1.32
Vomiting	122	1.03	0.867	0.75–1.40
Vision loss	21	1.17	0.869	0.17–7.93
Diarrhea	48	0.96	0.889	0.59–1.57
Limb weakness	26	1.16	0.889	0.14–9.30

*Statistically significant (*p* < 0.05).

Table 2. Trigger Association with Site Frontal-Specific Migraine Headache Index Reduction

Trigger	No. of Patients	OR	<i>p</i>	95% CI
Fatigue	108	21.79	0.002*	2.97–159.75
Weather change	135	8.27	0.013*	1.56–43.81
Missed meals	104	4.98	0.036*	1.11–22.3
Letdown after stress	75	6.99	0.053	0.97–50.31
Air travel	56	14.26	0.099	6.06–335.59
Coughing, straining, bending over	66	1.93	0.118	0.85–4.39
Bright sunshine	139	1.63	0.140	0.85–3.12
Certain foods	110	1.89	0.205	0.71–5.07
Heavy lifting	33	2.08	0.208	0.66–6.51
Stress (worry, anger)	146	0.81	0.280	0.55–1.19
Loud noise	117	1.29	0.365	0.75–2.21
Sexual activity	12	1.06	0.916	0.35–3.19
Certain smells or perfume	126	0.995	0.976	0.72–1.37

*Statistically significant (*p* < 0.05).

Table 3. Adverse Events following Site I Surgery*

	No.	Numbness (%)	Itching (%)	Hypersensitivity (%)	Hyposensitivity (%)	Eyelid Ptosis (%)	Hair Thinning (%)	Dry/Irritated Eye (%)	Scar Deformity (%)	Strabismus (%)
Endoscopic	167	59 (35.3)	28 (16.8)	16 (9.6)	12 (7.2)	11 (6.6)	6 (3.6)	2 (1.2)	2 (1.2)	1 (0.6)
TPCR	56	18 (32.1)	5 (8.9)	5 (8.9)	2 (3.6)	2 (3.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Total	223*	77 (34.5)	33 (14.8)	21 (9.4)	14 (6.3)	13 (5.8)	6 (2.7)	2 (0.9)	2 (0.9)	1 (0.4)

TPCR, transpalpebral corrugator resection.

*Complications data were available for only 223 of 270 patients.

equal Migraine Headache Index at each site. Ideally, each patient would have reported frequency, duration, and severity for each migraine trigger site, including the frontal site, and we are currently more focused on obtaining this type of detailed information.

Although the research team has demonstrated independence of each anatomical site,¹⁵ it is possible that symptom and trigger changes in patients with concomitant surgery were influenced by surgery at distant sites in an unknown way. However, this effect does not appear in our data, as overall Migraine Headache Index decreased significantly among the patients who experienced complete elimination of site I headaches.

Adverse consequences of site I surgery have been documented previously by our group in a small sample.¹⁸ In this larger study, we did not observe any major complications related to site I surgery. Patients most frequently complain of numbness, hypersensitivity, and hyposensitivity, which are related to unavoidable traction on the nerves and nearly always spontaneously resolve over several weeks to months. Hair thinning can rarely follow the endoscopic approach to site I surgery, and this must be discussed with the patient preoperatively. We observed eyelid ptosis in 6.6 percent of endoscopic and 3.6 percent of transpalpebral approaches for site I surgery. This was likely related to postoperative swelling and resolved without need for surgical intervention.

CONCLUSIONS

This study is the largest to examine site I surgery, and demonstrates the efficacy of this procedure to improve frontal migraine headaches frequency, duration, and severity, and numerous symptoms and triggers. It also outlines the technical details and the anatomical nuances. Future research will describe outcomes and associated symptoms and triggers for each of the other surgical sites.

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REFERENCES

1. Lipton RB, Bigal ME. Toward an epidemiology of refractory migraine: Current knowledge and issues for future research. *Headache* 2008;48:791–798.
2. Kurlander DE, Punjabi A, Liu MT, Sattar A, Guyuron B. In-depth review of symptoms, triggers, and treatment of

- temporal migraine headaches (site II). *Plast Reconstr Surg*. 2014;133:897–903.
3. Guyuron B, Varghai A, Michelow BJ, Thomas T, Davis J. Corrugator supercillii muscle resection and migraine headaches. *Plast Reconstr Surg*. 2000;106:429–434; discussion 435.
4. Beer GM, Putz R, Mager K, Schumacher M, Keil W. Variations of the frontal exit of the supraorbital nerve: An anatomic study. *Plast Reconstr Surg*. 1998;102:334–341.
5. Saylam C, Ozer MA, Ozek C, Gurler T. Anatomical variations of the frontal and supraorbital transcranial passages. *J Craniofac Surg*. 2003;14:10–12.
6. Webster RC, Gaunt JM, Hamdan US, Fuleihan NS, Giandello PR, Smith RC. Supraorbital and supratrochlear notches and foramina: Anatomical variations and surgical relevance. *Laryngoscope* 1986;96:311–315.
7. Knize DM. A study of the supraorbital nerve. *Plast Reconstr Surg*. 1995;96:564–569.
8. Erdogmus S, Govsa F. Anatomy of the supraorbital region and the evaluation of it for the reconstruction of facial defects. *J Craniofac Surg*. 2007;18:104–112.
9. Shimizu S, Osawa S, Utsuki S, Oka H, Fujii K. Course of the bony canal associated with high-positioned supraorbital foramina: An anatomic study to facilitate safe mobilization of the supraorbital nerve. *Minim Invasive Neurosurg*. 2008;51:119–123.
10. Fallucco M, Janis JE, Hagan RR. The anatomical morphology of the supraorbital notch: Clinical relevance to the surgical treatment of migraine headaches. *Plast Reconstr Surg*. 2012;130:1227–1233.
11. Janis JE, Ghavami A, Lemmon JA, Leedy JE, Guyuron B. The anatomy of the corrugator supercillii muscle: Part II. Supraorbital nerve branching patterns. *Plast Reconstr Surg*. 2008;121:233–240.
12. Janis JE, Ghavami A, Lemmon JA, Leedy JE, Guyuron B. Anatomy of the corrugator supercillii muscle: Part I. Corrugator topography. *Plast Reconstr Surg*. 2007;120:1647–1653.
13. Janis JE, Hatf DA, Hagan R, et al. Anatomy of the supra-trochlear nerve: Implications for the surgical treatment of migraine headaches. *Plast Reconstr Surg*. 2013;131:743–750.
14. 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.
15. Liu MT, Armijo BS, Guyuron B. A comparison of outcome of surgical treatment of migraine headaches using a constellation of symptoms versus botulinum toxin type A to identify the trigger sites. *Plast Reconstr Surg*. 2012;129:413–419.
16. Guyuron B, Tucker T, Davis J. Surgical treatment of migraine headaches. *Plast Reconstr Surg*. 2002;109:2183–2189.
17. Guyuron B, Kriegler JS, Davis J, Amini SB. Five-year outcome of surgical treatment of migraine headaches. *Plast Reconstr Surg*. 2011;127:603–608.
18. Guyuron B, Reed D, Kriegler JS, Davis J, Pashmini N, Amini S. A placebo-controlled surgical trial of the treatment of migraine headaches. *Plast Reconstr Surg*. 2009;124:461–468.
19. Dirnberger F, Becker K. Surgical treatment of migraine headaches by corrugator muscle resection. *Plast Reconstr Surg*. 2004;114:652–657; discussion 658.
20. Behin F, Behin B, Behin D, Baredes S. Surgical management of contact point headaches. *Headache* 2005;45:204–210.
21. Poggi JT, Grizzell BE, Helmer SD. Confirmation of surgical decompression to relieve migraine headaches. *Plast Reconstr Surg*. 2008;122:115–122; discussion 123.
22. Gfrerer L, Maman DY, Tessler O, Austen WG Jr. Nonendoscopic deactivation of nerve triggers in migraine headache patients: Surgical technique and outcomes. *Plast Reconstr Surg*. 2014;134:771–778.

23. 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.
24. Liu MT, Chim H, Guyuron B. Outcome comparison of endoscopic and transpalpebral decompression for treatment of frontal migraine headaches. *Plast Reconstr Surg.* 2012;129:1113–1119.
25. Achauer BM, Eriksson E, Guyuron B, Coleman JJ III, Russell RC, Vander Kolk CA, eds. *Plastic Surgery: Indications, Operations, and Outcomes.* St. Louis: Mosby; 2000.
26. Guyuron B, Michelow BJ, Thomas T. Corrugator supercilii muscle resection through blepharoplasty incision. *Plast Reconstr Surg.* 1995;95:691–696.
27. Guyuron B, Rose K. Harvesting fat from the infratemporal fossa. *Plast Reconstr Surg.* 2004;114:245–249.
28. Guyuron B, Knize DM. Corrugator supercilii resection through blepharoplasty incision. *Plast Reconstr Surg.* 2001;107:606–607.
29. StataCorp. *Stata Statistical Software: Release 12.* College Station, Texas: StataCorp LP; 2011.
30. Lee M, Monson MA, Liu MT, Reed D, Guyuron B. Positive botulinum toxin type a response is a prognosticator for migraine surgery success. *Plast Reconstr Surg.* 2013;131:751–757.
31. Adenuga P, Brown M, Reed D, Guyuron B. Impact of preoperative narcotic use on outcomes in migraine surgery. *Plast Reconstr Surg.* 2014;134:113–119.
32. Walden JL, Brown CC, Klapper AJ, Chia CT, Aston SJ. An anatomical comparison of transpalpebral, endoscopic, and coronal approaches to demonstrate exposure and extent of brow depressor muscle resection. *Plast Reconstr Surg.* 2005;116:1479–1487; discussion 1488.
33. Amirlak B. Discussion: Outcome comparison of endoscopic and transpalpebral decompression for treatment of frontal migraine headaches. *Plast Reconstr Surg.* 2012;129:1120–1122.
34. Afifi AM, Alghoul M, Zor F, Kusuma S, Zins JE. Comparison of the transpalpebral and endoscopic approaches in resection of the corrugator supercilii muscle. *Aesthet Surg J.* 2012;32:151–156.
35. Chepla KJ, Oh E, Guyuron B. Clinical outcomes following supraorbital foraminotomy for treatment of frontal migraine headache. *Plast Reconstr Surg.* 2012;129:656e–662e.

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The mission of the Plastic Surgery Foundation® is to develop and support the domestic and international education, research, and public service activities of plastic surgeons.