Confirmation of Surgical Decompression to Relieve Migraine Headaches

Joseph T. Poggi, M.D.
Brett E. Grizzell, M.D.
Stephen D. Helmer, Ph.D.
Wichita, Kan.

Background: Surgical decompression of various trigger sites has been shown by two authors to relieve migraine headaches. The purpose of this study was to evaluate the effectiveness of surgical decompression of multiple migraine trigger sites in a clinical practice setting, and to compare the results to those previously published.
Methods: A retrospective, descriptive analysis was performed on 18 consecutive patients who had undergone various combinations of surgical decompression of the supraorbital, supratrochlear, and greater occipital nerves and zygomaticotemporal neurectomy performed by a single surgeon. All patients had been diagnosed with migraine headaches according to neurologic evaluation and had undergone identification of trigger sites by botulinum toxin type A injections.
Results: The number of migraines per month and the pain intensity of migraine headaches decreased significantly. Three patients (17 percent) had complete relief of their migraines, and 50 percent of patients (nine of 18) had at least a 75 percent reduction in the frequency, duration, or intensity of migraines. Thirty-nine percent of patients have discontinued all migraine medications. Mean follow-up was 16 months (range, 6 to 41 months) after surgery. One hundred percent of participants stated they would repeat the surgical procedure.
Conclusions: This study confirms prior published results and supports the theory that peripheral nerve compression triggers a migraine cascade. The authors have verified a reduction in duration, intensity, and frequency of migraine headaches by surgical decompression of the supraorbital, supratrochlear, zygomaticotemporal, and greater occipital nerves. A significant amount of patient screening is required for proper patient selection and trigger site identification for surgical success. (*Plast. Reconstr. Surg.* 122: 115, 2008.)

Migraine headache prevalence in the United States is estimated at 11.7 percent (5.6 percent for men and 17.1 percent for women). Most individuals (62.7 percent) suffer one to four migraine headache days per month, and 53 percent report severe impairment or the need for bed rest.[1] Previous studies estimate the indirect cost burden of migraine headache in the workplace to be $12 billion annually. Eighty-one percent of this value ($9.66 billion) is attributable to absenteeism.[2] Traditional therapy has been targeted at abortive prescription medication and prevention directed at the central theory of migraine propagation. Recently, studies concerning the peripheral theory (certain trigger points outside the brain start reactions that migrate centrally) have shown promising results. This theory postulates that peripheral trigger points can be eliminated by surgery. This leads to elimination of sites of nerve compression, stopping a migraine cascade. Dr. Guyuron and other researchers have shown that up to 92 percent of patients, when properly selected, can benefit from migraine surgery.[3–5] Of this group, 35

From the Department of Surgery, The University of Kansas School of Medicine–Wichita.
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percent of patients undergoing surgery eliminated their migraines at 1-year follow-up. An additional 57 percent experienced significant improvement at 1 year.[3] The purpose of this retrospective study was to evaluate and critically analyze a consecutive group of our patients who have undergone surgical procedures for migraine headaches. Our goal was to establish whether those same results could be duplicated.

PATIENTS AND METHODS

Patient Selection

This study was approved by the Human Subjects Committee 2 of the University of Kansas School of Medicine–Wichita. Medical records and office records were reviewed to identify all patients who had undergone surgical treatment of migraine headaches 6 months before initiation of the study. Consent was obtained for all patients. All 18 patients included in this study had been diagnosed with migraines by board-certified neurologists according to criteria of the *International Classification of Headache Disorders*[6] and had a positive response to botulinum toxin type A (Botox; Allergan, Inc., Irvine, Calif.) screening injections. Response to Botox was considered positive if patients had at least a 50 percent reduction in frequency, intensity, and/or duration of migraines from baseline, lasting 6 weeks or greater. To document response to Botox injection therapy and to determine eligibility of patients for surgical therapy, Botox was injected into the suspected trigger point as defined by the patient's perception of the initial site of onset of their migraine pain. Patients had 12.5 units injected into each corrugator muscle for pain in the central forehead or above either eyebrow. Patients had 12.5 units injected into the portion of the temporalis muscle surrounding the exit of the zygomaticotemporal nerve for temporal pain and/or 12.5 units into each semispinalis muscle for pain in the back of the neck at the exit site of the greater occipital nerve. Patients with at least a 50 percent reduction in frequency, intensity, or duration were then offered selected surgery according to their trigger points. Patients were notified that the operation was still experimental during their initial office consultation and during the informed consent before surgery.

Study Design

A pretreatment questionnaire (Fig. 1), office notes, and operative reports were reviewed for each of the 18 participants. The pretreatment questionnaire included marital status, education, migraine history, migraines per month, migraine severity, migraine location, age at onset, symptoms, health status, degree of disability, family history, history of neck trauma, neurologist evaluation, previous test, medication history, previous migraine treatments, and quality-of-life analysis. A follow-up postoperative questionnaire was sent to all eligible patients along with an informed consent document and the study protocol. These were explained during phone conversation or office visit. Follow-up data revisited the pretreatment questionnaire and included additional information, including degree of reduction of migraines with regard to intensity, duration, and frequency; migraine location; medication usage; surgical site problems; comparison with Botox; and whether they would undergo the operation again. Phone interviews were made to clarify discrepancies. Inclusion criteria and treatment methodology were modeled after Guyuron's method.[3]

Surgical Procedures

All procedures were performed by a single surgeon according to surgical techniques developed by Guyuron.[3,7,8] Surgical decompression of septal and intranasal trigeminal nerve branches was not performed during this study. Surgical decompression of the supraorbital and supratrochlear neurovascular bundles was performed routinely with zygomaticotemporal neurectomy because of exposure obtained during the procedure. Greater occipital nerve decompression was generally performed as a staged procedure to minimize initial operative time during the learning curve and to aid in patient postoperative comfort. Palpebral incision for corrugator resection was performed in the one patient that had revision surgery to remove residual corrugator muscle fibers.

Statistical Analysis

Data were summarized by generating means or frequencies as appropriate. Statistical analyses were conducted by using Stata statistical software (Stata Corp., College Station, Texas). Data regarding headache frequency and migraine headache frequency were not normally distributed, so comparisons of these variables before and after surgery were performed using the Wilcoxon matched-pairs signed rank test. Comparison of migraine severity, which was measured using a scale of 1 to 10, where 1 represented mild migraine pain and

1. How many migraine headaches did you have in the 30 days after surgery?
2. How many migraines have you had per month on average?
3. How many regular headaches have you had in the last month?
4. What percentage of relief do you feel you have received?
    a. 100%- I have had no migraine headaches
    b. 75-99% -significant reduction in migraine headaches
    c. 50%- some improvement
    d. <50% - little improvement, continue to have regular migraines
    e. 0% - Migraines are same as before surgery
    f. Worse than before surgery
5. My migraines have decreased in (circle all that apply)
    a. Frequency (# of times per week)
    b. Duration (length of each migraine)
    c. Intensity (severity of each migraine)
    d. My migraines have not decreased in any of the above.
6. Are your migraines located in the same area as before surgery? (Multiple boxes provided for location check off).
7. Are you still taking medication for migraine relief?
8. If yes to number 7, please circle one of the following:
    a. My medication requirements are significantly less than before surgery.
    b. My medication requirements are about half.
    c. My medication requirements are about the same or more.
9. How painful were/are your migraines headaches after surgery, on average? (1-10)
10. If you are female, was your migraine during the time of your menstrual cycle?
11. Have you had any problems with any of your surgical sites? Explain.
12. How severe were the problems you incurred? (1-10) Explain.
13. Is your surgical migraine relief more or less than the relief you experienced with Botox injections?
    a. More relief with surgery
    b. More relief with Botox
    c. Same relief
14. Would you have this surgery again? Explain.

Fig. 1. Postoperative questionnaire.

10 represented severe migraine pain, before and after surgery was also performed using the Wilcoxon matched-pairs signed rank test. The McNemar test for symmetry was used to determine whether patients felt that surgery or Botox therapy provided more relief from their symptoms. Results of analyses were considered significant for values of $p < 0.05$.

RESULTS

Data gathered included information from pretreatment and posttreatment questionnaires and medical record reviews. Mean follow-up was 16 months (range, 6 to 41 months). Demographic data are listed in Table 1. The majority of participants were women (89 percent), with a mean age of 41 years. Mean age of onset of migraine was 24 years, and 100 percent of patients studied had migraines diagnosed by a board-certified neurologist and met criteria set forth by the *International Classification of Headache Disorders*.[6] Six of the patients had an additional diagnosis of cluster and/or tension headache. All patients received an extensive workup and treatment for their migraines (computed tomography, magnetic resonance imaging, ergot, and triptans) before referral. There was no prominent education level among the study population.

Data in Table 2 describe the patient's perception of health status and migraine history. Twenty-two and 44 percent ranked their overall

Table 1. Demographic Data

Variable	No.	Result*
No. of subjects	18	100%
Mean age, years	18	41 ± 8.6 (range, 22–53)
Sex (female)	16/18	88.9%
Mean age of onset, years	18	24.6 ± 10.3 (range, 5–41)
Neurologist diagnosis of migraine	18/18	100%
Education level		
High school graduate	7	41.2%
2-Year degree	4	23.5%
4-Year degree	4	23.5%
Advanced degree	2	11.8%
Race (Caucasian)	16/18	88.9%
Marital status (married)	16/18	88.9%
Follow-up from surgery, months		16 (range, 6–41)

*Mean ± SD (range) or percent.

Table 2. Baseline Health Status and Migraine Data

Variable	No. (%)
Length of migraine	
≤2 hours	0 (0)
3–4 hours	1 (5.6)
5–24 hours	8 (44)
Several days	8 (44)
1 week or longer	1 (5.6)
Migraines change with menstrual periods (yes)	6/16 (38)
History of neck trauma (yes)	2/18 (11)
Patient evaluation of overall health	
Excellent	4 (22)
Good	8 (44)
Fair	5 (28)
Poor	1 (6)
Extent migraines affect quality of life	
Extremely	17 (94)
Moderately	1 (6)
Very little	0 (0)
Not at all	0 (0)
Family history of migraine	
First- or second-degree relative	14 (78)

health as excellent and good, respectively; 27 percent ranked their health as fair. Seventeen of the 18 patients (94.4 percent) stated that migraine headache affected their quality of life to an "extreme" extent.

All patients ($n = 18$) stated they would have the surgery again. Although difficult to quantify, surgical satisfaction and improvement in quality of life were repeatedly discussed in the comments section. Two patients had "slight" improvement (defined as <50 percent improvement). One reported that the duration and intensity of migraines had not improved, although the "character" of her migraines had "improved." Interestingly, she demonstrated chronic frontalis muscle contracture, which was not caused by compensation for low brow position or upper lid ptosis. She received further improvement with Botox injection to the frontalis musculature.

Interestingly, patients all had nearly complete relief of their migraines during the first 2 months postoperatively, with some increase in headaches as sensation returned to the central forehead region at 6 months. All patients continue to experience a quality of life better than before surgery and all would have the surgery again. Three patients have had no migraines since surgery. Preoperative and postoperative comparison of migraines and headaches are shown in Table 3. The number of migraines dropped from a mean of 12 per month to 1.3 per month in the month immediately after surgery ($p = 0.0001$). This increased to 3.7 in the months after the initial 30 days postoperatively but was still significantly reduced compared with baseline ($p = 0.0005$).

In one set of questions, patients were asked to state whether their migraines had decreased in any of three categories: (1) frequency, (2) duration, or (3) intensity (Table 4). Of the 18 patients, 16.7 percent had complete relief from migraine symptoms, and 61.1 percent stated their migraine headaches had decreased in frequency, duration, and intensity. An additional 16.7 percent stated their headaches had decreased in a combination of the above, but not all three. One patient (5.6 percent) reported no improvement.

Patients were then asked what percentage of relief they felt they had received (Table 4). As far as overall percentage of relief received from surgery, 16.7 percent of patients stated they had no migraine headaches, 50 percent stated they had a significant reduction (>75 percent) in migraine headaches, 22.2 percent had some improvement (50 percent reduction), and 11.1 percent felt they had little improvement (<50 percent reduction) and continue to have regular migraines. None of the patients indicated that their migraines were the same as before surgery or worse.

Medications have been completely discontinued in seven of 18 of participants (38.9 percent) (Table 4). Of the 11 patients who continue to require medications, 54.5 percent have requirements that are significantly reduced (defined by usage of <50 percent of baseline requirements). Two patients (18.2 percent) have requirements

Table 3. Preoperative and Postoperative Comparison of Headaches and Migraines

Variable	Preoperative	Postoperative	*p**
Migraine headaches per month (first 30 postoperative days)			
Mean ± SD	11.9 ± 9.3	1.3 ± 2.9	0.0002
Range	3–28	0–12	
Migraine headaches per month (after the initial 30 postoperative days)			
Mean ± SD	11.9 ± 9.3	3.7 ± 4.4	0.0003
Range	3–28	0–14	
Migraine severity†			
Mean	8 (7, 9)	6 (4, 8)	0.0029
Range	6–10	3–10	
Regular headaches per month			
Mean ± SD	7.4 ± 11.1	7.7 ± 9.9	0.5664
Range	0–31	0–31	

*Wilcoxon matched-pairs signed-rank test.
†Severity was measured on a scale from 1 to 10, where 1 corresponds to mild migraine pain and 10 corresponds to the severe migraine pain, median (25th and 75th percentiles).

that are approximately half, and three (27.3 percent) have requirements that are approximately the same as baseline requirements. Only two patients reported any surgical site problems, which consisted of itching, numbness, and scar alopecia.

When comparing patient perception of the relative efficacy of Botox injection therapy versus surgery, 12 of 18 patients (66.7 percent) felt that surgery offered more relief than Botox (Table 4). Two of the patients felt that Botox therapy was more effective than surgery, and four (22.2 percent) felt the treatments were equivalent. More patients felt that surgery provided greater relief of their migraine symptoms as compared with Botox therapy ($p = 0.013$).

Individual procedures performed varied with each patient according to their trigger points (Table 5). Thirty-three percent of patients (six of 18) had frontal migraines only. Four patients (22 percent) had both frontal and temporal migraines. Two patients (11 percent) had headaches localized to the greater occipital nerve headaches. The final six patients (33 percent) had migraines that started in all three regions. Procedures performed are listed in Table 5. Of the procedures performed, four of 18 (22 percent) had resection of the glabellar muscle group (frontal), and six of 18 (33 percent) underwent both endoscopic removal of the glabellar muscle group and removal of the zygomaticotemporal branch (3 cm) of the trigeminal nerve. Thirty-three percent of the patients (six of 18) underwent surgery of all groups offered, to include the frontal, occipital, and trigeminal groups. Two individuals (11 percent) underwent occipital nerve decompression alone.

Five patients had variable factors associated with their treatment. The first of these underwent staged decompression of the greater occipital nerve fol-

Table 4. Additional Composite Data

Variable	No. (%)
No. of patients who would undergo surgery again	18 (100)
Relief overall	
100% reduction	3 (16.7)
75–99% reduction	9 (50.0)
50–75% reduction	4 (22.2)
<50% reduction	2 (11.1)
Medication usage	
Discontinued	7 (38.9)
Significantly less	6 (33.3)
Half of baseline	2 (11.1)
Approximately the same	3 (16.7)
Surgery vs. Botox	
More relief with surgery	12 (66.7)
More relief with Botox	2 (11.1)
Same relief	4 (22.2)

Table 5. Summary of Trigger Sites and Procedures Performed

Variable	No. (%)
Trigger site	
Frontal alone	6 (33.3)
Frontal and temporal	4 (22.2)
Frontal/occipital/temporal	6 (33.3)
Occipital	2 (11.1)
Procedure performed	
Removal of glabellar muscle group (frontal headache)	4 (22.2)
Endoscopic frontal and temporal group resection	6 (33.3)
Occipital nerve decompression	2 (11.1)
Occipital, frontal, temporal groups	6 (33.3)

lowed by supraorbital decompression and zygomaticotemporal neurectomy. This patient was found to have complete relief of her posterior headaches but recurrent focal trigger pain over her right eyebrow. Evident on postoperative photographs is asymmetric brow elevation. This was initially thought to be iatrogenic to the brow suspension, but was found to be chronic unilateral frontalis muscle contracture to compensate for unilateral levator dehiscence and asymmetric lid position. She responds to supplemental Botox injections to the frontalis muscle. An additional patient (our first in the series) had revision surgery to resect additional corrugator muscle fibers after recurrent postoperative migraines. After initial recurrence of her migraines, residual corrugator muscle contraction was evident laterally. Botox was injected into the partially resected corrugator muscle bed, with further relief of her migraines. She therefore underwent resection of the residual corrugator muscle through a blepharoplasty approach with fat grafting to the muscle bed. This improved her migraines further, but she continues to have several migraines per month located in her central forehead. She also demonstrates chronic frontalis muscle contracture and obtains further relief with Botox to the frontalis muscle group. She has good brow position, with mild right upper lid ptosis. A third patient had a staged procedure. Originally, she complained of isolated migraines in the posterior neck. After surgery, she developed migraines in the frontal region and underwent decompression of the supraorbital nerve and zygomaticotemporal neurectomy. The fourth patient had isolated posterior migraines with complete relief following surgery for 10 months with new-onset migraines at a poorly defined site. She had moved out of state and underwent several attempts at greater occipital nerve ablation, Botox decompression, and physical therapy, with no change in her migraines (sensation to her posterior scalp was not affected by the "greater occipital nerve ablation"). She returned to our office after being mailed our postoperative questionnaire and received Botox to the corrugator muscles and temporalis muscle, which resulted in complete relief of her recurrent migraines. She will be undergoing surgical decompression. The fifth patient had our poorest long-term result. She initially experienced complete relief of her 10 migraines per month during the first 2 months after surgical decompression of the supraorbital and supratrochlear nerves and zygomaticotemporal neurectomy. As touch sensation returned to her forehead, the migraines recurred. Noted on her examination was chronic frontalis muscle contracture. She has no clinical evidence of upper lid ptosis or malposition. Botox to the frontalis muscle improves her migraines somewhat, but she has requested supraorbital and supratrochlear nerve ablation.

DISCUSSION

Overall, we were very pleased with our results. Previous reports by Guyuron et al. and Dirnberger and Becker[3,4] have shown promising results. We feel that it is possible to take migraine surgery to the clinical setting. Although our results are promising, our study has inherent weaknesses associated with a retrospective design. First, the small number of patients enrolled in this case series leads this study to a more descriptive nature of results rather than a comparison. Early patients had more limited surgery. Zygomaticotemporal neurectomy is now routinely performed in patients undergoing supraorbital and supratrochlear nerve decompression. This is performed because the nerve is readily apparent in the operative field and to prevent "unmasking" of new trigger sites after treatment of the primary trigger site. Fat grafts are now applied routinely to the decompressed nerves, a procedure that was not performed in several of our early patients. In addition, the subjective nature of the questionnaire allows for possible bias and inaccuracy in data. The postoperative questionnaire was sent to prospective subjects from 6 to 41 months after surgery. The variability of patient memory bias is most significant for recall regarding migraine frequency in the 30 days immediately after surgery. However, the remaining questions in the follow-up questionnaire are valid without "recall bias." Headaches in general are hard to summarize either quantitatively or qualitatively in a retrospective fashion; a more specific questioning system is needed for accurate comparison between groups. Continued research will assess data, including a migraine diary, medication diary, and work history. Although it would be beneficial to report the proportion of patients responding to Botox injection therapy during screening, this was not a focus of this retrospective study and was not tracked. The proportion of patients who did not "respond" to Botox injections is difficult to assess, as originally Botox was only injected into the corrugator, as it was the only site we addressed initially. Additional sites were offered as they were discussed

in the literature and as our experience grew. A problem with single-site injections early on was that if an uninjected site became the new "pacemaker" for the patient's headaches, the overall headache frequency was unchanged and we did not offer them surgery. Currently, with decompression of four distinct zones (zone 1, supraorbital and supratrochlear nerves; zone 2, zygomaticotemporal nerve; zone 3, greater occipital nerve; and zone 4, septal trigeminal nerve innervation), approximately 95 percent of patients referred to our office are surgical candidates.

Another problem inherent to this retrospective review includes the learning curve. These patients represent the first 18 patients we treated surgically for migraines. Originally, surgery was only offered to patients with frontal migraines. As we found their treatment to be successful, we included patients with temporal and posterior neck migraines. This led to an artificially higher incidence of patients with frontal migraines in our early patients.

Selection bias is inherent to our study. Because of the "experimental" nature of migraine surgery, referral patterns have not been set and the mass public is not yet aware of surgical treatment. It is likely that our patients represent a subgroup of more "difficult" patients who did not respond as well to conventional treatments and were therefore referred for surgical treatment as an option of last resort.

Interestingly, similar to the report by Dirnberger and Becker,[4] we did have a number of patients who experienced excellent relief during the first 30 to 60 days postoperatively and then experienced gradual (though improved) return of their headaches to the treated region. This was most common with headaches in the frontal region. The recurrent headaches are often described as less intense and more "treatable" with medications or rest. Most of these patients continued to have improvement well beyond baseline, but one patient reports near baseline frequency. The exact mechanism of this phenomenon is not understood but appears to coincide directly with returning nerve function. It has been observed that many of these patients demonstrate some degree of chronic frontalis muscle contracture. Patients with greater occipital nerve decompression have experienced a greater degree of relief with surgery. This may be attributable to a more complete and thorough decompression. In the senior author's experience, the greater occipital nerve decompression is technically easier to perform.

CONCLUSIONS

This study confirms prior published results and supports the theory that peripheral nerve compression triggers a migraine cascade. We have verified a reduction in duration, intensity, and frequency of migraine headaches by surgical decompression of the supraorbital, supratrochlear, zygomaticotemporal, and greater occipital nerves. We feel strongly that patient screening is key to surgical success. They should have an independent examination and meet criteria for migraines as set forth by the *International Classification of Headache Disorders*[6] and have demonstrated significant improvement of migraine headaches by Botox injection therapy before surgical intervention. We believe that the concept of peripheral nerve compression as a cause of migraines will gain wider acceptance and spur new insights into the cause and treatment of migraine headache. Although many migraine sufferers achieve adequate control of their headaches through pharmacologic means, it appears that surgical decompression of trigger points is a viable treatment option for migraine sufferers, particularly for patients whose headaches are poorly controlled by pharmacologic means and whose lives are significantly affected by their migraine headaches.

Joseph T. Poggi, M.D.
Department of Surgery
University of Kansas School of Medicine–Wichita
929 North Saint Francis Street, Room 3082
Wichita, Kan. 67214
poggiplasticsurgery@yahoo.com

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