Outcome Comparison of Endoscopic and Transpalpebral Decompression for Treatment of Frontal Migraine Headaches

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Background: This study was designed to compare the efficacy of the transpalpebral versus endoscopic approach to decompression of the supraorbital and supratrochlear nerves in patients with frontal migraine headaches.

Methods: The medical charts of 253 patients who underwent surgery for frontal migraine headaches were reviewed. These patients underwent either transpalpebral nerve decompression ($n = 62$) or endoscopic nerve decompression ($n = 191$). Preoperative and 12-month or greater postoperative migraine frequency, duration, and intensity were analyzed to determine the success of the surgeries.

Results: Forty-nine of 62 patients (79 percent) in the transpalpebral nerve decompression group and 170 of 191 patients (89 percent) who underwent endoscopic nerve decompression experienced a successful outcome (at least a 50 percent decrease in migraine frequency, duration, or intensity) after 1 year from surgery. Endoscopic nerve decompression had a significantly higher success rate than transpalpebral nerve decompression ($p < 0.05$). Thirty-two patients (52 percent) in the transpalpebral nerve decompression group and 128 patients (67 percent) who underwent endoscopic nerve decompression observed elimination of migraine headaches. The elimination rate was significantly higher in the endoscopic nerve decompression group than in the transpalpebral nerve decompression group ($p < 0.03$).

Conclusion: Endoscopic nerve decompression was found to be more successful at reducing or eliminating frontal migraine headaches than transpalpebral nerve decompression and should be selected as the first choice whenever it is anatomically feasible. (*Plast. Reconstr. Surg.* 129: 1113, 2012.)

CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, III.

Migraine headaches affect 35 million Americans, or approximately 17 percent of women and 6 percent of men in the United States.[1] On average, one of every four households has someone who suffers from migraine headaches.[1] The symptoms can last from 4 hours to several days and can include recurrent unilateral or bilateral throbbing pain, nausea, vomiting, photophobia, and phonophobia.[2] Most migraine sufferers manage migraine headaches with pharmacologic interventions. The annual cost of these migraine medications is estimated to be $1.5 billion.[3,4] There is no widely accepted permanent cure at this time, and many patients continue to experience symptoms even under pharmacologic treatment.

Although the pathophysiology of migraine headaches remains controversial, studies have shown that irritation of the trigeminal nerve causes the release of calcitonin gene-related peptide and neurokinin A into the cell bodies of the trigeminal nerve.[2,5] These substances induce inflammation and pain in the areas around the trigeminal nerve. The senior author's (B.G.) theory is that the musculature, vessels, bony foramen, and possibly fascia bands around the trigeminal nerve branches in the head and neck irritate the nerves, leading to inflammation. Anatomical

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studies have supported the potential for such irritation.[6–13] Based on this theory, surgical treatment of migraine headaches has evolved to include removal of various surrounding superficial muscles, fascia, or vessels to reduce irritation to the nerve, resulting in reduction of migraine headaches.

Surgical intervention for migraine headaches has been shown to provide long-term (>5 years) relief (≥50 percent reduction in frequency, duration, or intensity) in over 80 percent of patients.[14–16] Migraine surgery can be performed at four common trigger sites, the most prevalent of which is the frontal site (migraine site I), where the glabellar muscle group (depressor supercilii, corrugator supercilii, procerus muscle) and accompanying vessels, overlying fascia bands, and the foramina cause compression of the supratrochlear nerve and supraorbital nerve to trigger frontal migraine headaches.[9] Sixty-eight percent of all migraine surgeries performed by the senior author included intervention at this site. Other common trigger sites include temporal, septonasal, and occipital sites.[14–17] Intervention at the frontal trigger site involves the resection of the glabellar muscle group, cauterization of the vessels accompanying the nerves, unroofing of the supraorbital foramen when present, and more re-cently, release of the fibrous band across the supraobital notch when present. These surgical maneuvers reduce irritation of the supratrochlear nerve and supraorbital nerve.

Since 2000, the senior author has used *endoscopic nerve decompressions* on patients undergoing concomitant endoscopic manipulation of the zygomaticotemporal branch of the trigeminal nerve for temporal migraine headaches trigger site (migraine site II). Endoscopic nerve decompression, however, was not performed on patients with long foreheads (≥8 cm measured from the anterior hairline to the supraorbital ridge) or on patients with significant curvature to the forehead, as endoscopic access would have been difficult to impossible (Fig. 1). *Transpalpebral nerve decompression* was performed when there was no concomitant endoscopic site II surgery, as transpalpebral nerve decompression provided closer access to the glabellar muscle group and did not require endoscopic equipment. The purpose of this study was to evaluate and compare the effectiveness of transpalpebral nerve decompression and endoscopic nerve decompression in the reduction of frontal migraine headaches and discuss additional techniques that can further improve the outcome of frontal migraine surgery.

Fig. 1. Contraindication for endoscopic nerve decompression is forehead length of 8 cm or more, most commonly seen in patients with receded hairlines or significant forehead curvature. (*Left*) Patient with 8-cm forehead length received transpalpebral nerve decompression despite receiving concomitant endoscopic release of the temporal trigger site (site II). (*Right*) Patient with 6-cm forehead length received endoscopic nerve decompression concomitantly with endoscopic site II surgery.

PATIENTS AND METHODS

Patient Selection

Institutional review board approval was obtained before the commencement of this retrospective chart review. The subjects were patients who underwent frontal migraine surgery by the senior author during a span of 10 years (August 31, 2000, to August 31, 2010) and completed a migraine headache questionnaire before surgery and 12 months or more after surgery. These questionnaires recorded the frequency (number of migraine headaches per month), duration (in days), intensity (scale of 0 to 10, 10 being the most severe), and location of migraine headache pain. A migraine index was calculated by multiplying frequency, duration, and intensity of migraine headaches. A successful surgery was defined as a decrease of 50 percent or more in migraine index after 12 months. Elimination was defined as a migraine index of 0 after 12 months. Only frontal migraine headache pain was considered in this study, as it pertained directly to the results of supratrochlear nerve and supraorbital nerve decompression. There were 253 patients who met these inclusion criteria, each receiving either transpalpebral nerve decompression or endoscopic nerve decompression.

Surgical Technique

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 blepharoplasty incision. The upper eyelid, glabellar area, and the lower forehead were infiltrated with 1% lidocaine containing 1:100,000 epinephrine and 0.5% ropivacaine HCl. After incision, a skin–orbicularis oculi muscle flap was raised above the level of the septum and the orbicularis muscle in a cephalic direction. The dissection was continued to the supraoribtal rim. The depressor supercilii muscle was exposed and resected as completely as possible, protecting the supraorbital nerve and supratrochlear nerve. This allowed exposure of the corrugator supercilii muscle, which is darker in color and more friable compared with the depressor supercilii muscle. Excision of the corrugator supercilii muscle was then achieved with electrocautery, and lateral fibers of the procerus muscle encasing the supratrochlear nerve were also removed (Fig. 2). 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 ablation
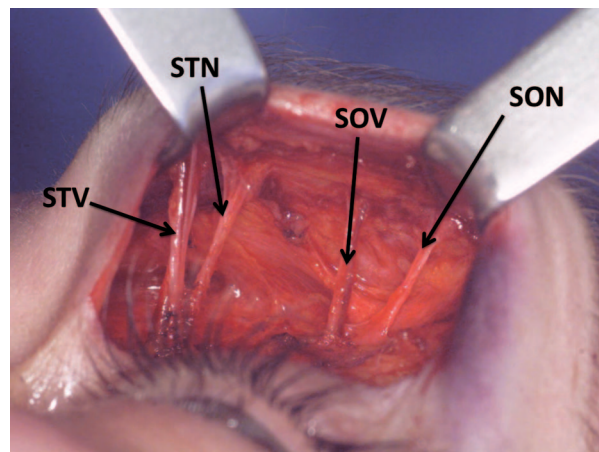

Fig. 2. Supraorbital nerve (*SON*) and vessels (*SOV*), and supratrochlear nerves (*STN*) and vessels (*STV*) preserved after removal of the corrugator supercilii muscle through transpalpebral dissection.

of the zygomaticotemporal branch of the trigeminal nerve was performed concomitantly, and placed to fill the depression left following resection of the corrugator supercilii muscle and to cushion the nerves.[17–19] 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.

Endoscopic Nerve Decompression

A midline incision or two paramedian incisions were marked 1.5 cm long about 3.5 cm apart in the frontal area and one or two similar incisions in the temple if decompression of the temple trigger site was also indicated. 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 HCl and 1% lidocaine with 1:100,000 epinephrine. If this was performed together with migraine trigger site II surgery, five or six 1-cm incisions were made for access to the glabellar muscle group and the zygomaticotemporal branch of the trigeminal nerve. Migraine site II surgery was performed first, and fat was harvested from beneath the deep temporal fascia above the zygomatic arch medially.[20] 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 in their entirety along with the lateral fibers of the procerus muscle un-

Fig. 3. Supraorbital nerve (*SON*) and vessels (*SOV*), and supratrochlear nerve (*STN*) and vessels (*STV*) seen after endoscopic removal of corrugator supercilii muscle. The supraorbital foramen (*SOF*) is clearly exposed for foraminotomy.

der direct endoscopic visualization, with care taken to preserve the supraorbital and supratrochlear nerves (Fig. 3).[17]

Additional surgical maneuvers at the frontal trigger site included percutaneous foraminotomy using a 2-mm osteotome, whenever there was a foramen rather than a notch, 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.

Data Analysis

The success and elimination rates in the transpalpebral nerve decompression and endoscopic nerve decompression groups were compared using chi-square tests. In addition, *t* tests were performed to compare mean reductions in frequency, duration, intensity, and migraine index between the transpalpebral nerve decompression and endoscopic nerve decompression groups. A *p* value less than 0.05 was considered significant. Furthermore, the operative note from each patient was analyzed for any additional surgical maneuvers performed at the supraorbital site. Lastly, the subjects were grouped by number of concomitant migraine surgery sites, and chi-square tests were performed to determine whether concomitant trigger site release affected the outcome of frontal migraine headache relief. Statistical analyses were performed using QuickCalcs (GraphPad Software, La Jolla, Calif.) and the Microsoft Excel 2007 Data Analysis Tool (Microsoft Corporation., Redmond, Wash.).

RESULTS

Overall Surgery Outcome

There were a total of 253 patients (226 female and 27 male) included in this study. The follow-up ranged from 12 months to 126 months, with a mean follow-up of 34 months. Of these 253 patients who underwent surgery for frontal migraine headaches, 62 received transpalpebral nerve decompression, and 191 underwent endoscopic nerve decompression. There was no significant difference in gender (transpalpebral nerve decompression, 84 percent female; endoscopic nerve decompression, 91 percent female; $p > 0.09$) or average age (transpalpebral nerve decompression, 45.3 ± 8.8; endoscopic nerve decompression, 44.7 ± 11.2; $p > 0.70$) between the two groups. Of the 62 transpalpebral nerve decompression patients, 49 (79 percent) experienced a reduction of 50 percent or greater in frontal migraine index, with 32 (52 percent) having elimination of migraine headaches. Of the 191 endoscopic corrugator resection patients, 170 (89 percent) experienced a frontal migraine index reduction of 50 percent or greater, with 128 (67 percent) experiencing elimination. The success rate (percentage of patients who experienced ≥50 percent reduction in migraine headaches) of endoscopic nerve decompression (89 percent) was significantly higher than that of transpalpebral nerve decompression (79 percent; $p < 0.05$). The elimination rate of endoscopic nerve decompression (67 percent) was also significantly higher than that of transpalpebral nerve decompression (52 percent; $p < 0.03$). These results are summarized in Table 1.

Outcome by Reductions In Migraine Pain Variables

Endoscopic nerve decompression produced a significantly greater ($p < 0.01$) mean reduction in migraine frequency (89.1 ± 45.4 percent) than transpalpebral nerve decompression ($51.8 \pm$
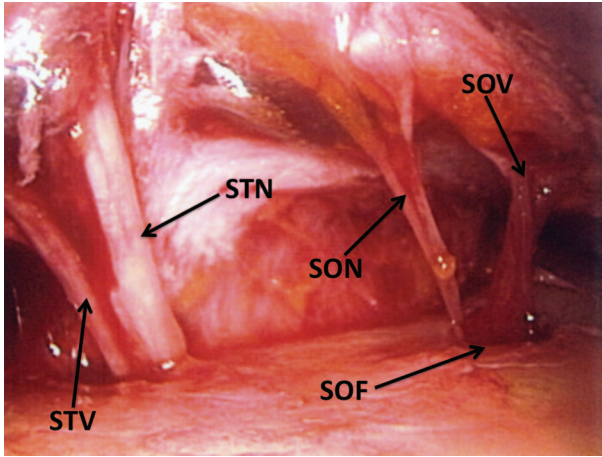
Table 1. Success and Elimination Rates

	TPND	END	*p**
Success rate†	79%	89%	<0.05
Elimination rate‡	52%	67%	<0.03

TPND, transpalpebral nerve decompression; END, endoscopic nerve decompression.
*p calculated from chi-square tests.
†Success rate indicates the percentage of patients who experienced reduction of 50 percent or greater in migraine headaches at 12 months.
‡Elimination rate indicates the percentage of patients who experienced no migraine headaches at 12 months.

1116

Table 2. Reductions in Migraine Pain Variables

Variable	Mean Reduction*		p†
	TPND	END	
Frequency, migraine headaches/month	$51.8 \pm 110.1\%$	$89.1 \pm 45.4\%$	<0.01
Duration, days	$61.7 \pm 92.1\%$	$71.3 \pm 45.4\%$	>0.30
Intensity, analog scale 0–10	$58.6 \pm 52.6\%$	$74.0 \pm 41.5\%$	<0.02
Migraine index, frequency x duration x intensity	$78.0 \pm 36.6\%$	$89.0 \pm 31.4\%$	<0.05

TPND, transpalpebral nerve decompression; END, endoscopic nerve decompression.
*Reduction was determined by the formula (*variable at 12 months − variable at baseline)/(variable at baseline*).
†The p values were calculated from t tests comparing mean reduction between transpalpebral nerve decompression and endoscopic nerve decompression.

110.1 percent). The mean reduction in migraine duration was not significantly different ($p > 0.30$) between the transpalpebral nerve decompression (61.7 ± 92.1 percent) and endoscopic nerve decompression (71.3 ± 45.4 percent) groups. The mean pain severity was significantly more reduced following endoscopic nerve decompression (74.0 ± 41.5 percent) compared with transpalpebral nerve decompression (58.6 ± 52.6 percent; $p < 0.02$). Finally, the mean reduction in migraine index was significantly greater ($p < 0.05$) following endoscopic nerve decompression (89.0 ± 31.4 percent) compared with transpalpebral nerve decompression (78.0 ± 36.6 percent). These results are summarized in Table 2.

Additional Surgical Maneuvers at Supraorbital Site

Two of 62 patients (3 percent) in the transpalpebral nerve decompression group and 40 of 191 patients (21 percent) in the endoscopic nerve decompression group received supraorbital foraminotomies. The surgical success rate for frontal migraine headache surgery that included a foraminotomy was 93 percent, with 71 percent having elimination of migraine headaches compared with 85 percent success with 61 percent elimination of migraine headaches in the group without foraminotomy. One patient in the group that underwent endoscopic nerve decompression and three patients in the group subjected to transpalpebral nerve decompression had supraorbital arterectomy, and all four of these patients had successful surgeries, with two experiencing elimination of frontal migraine headache pain. Four patients in the transpalpebral nerve decompression group and 16 patients in the endoscopic nerve decompression group had avulsion of at least one accessory supraorbital nerve, and all 20 of these patients had successful surgeries, with 16 (80 percent) experiencing elimination of migraine headaches. One patient in the transpalpe-

bral nerve decompression group had notch fasciotomy and had a 60 percent reduction in migraine index. One endoscopic nerve decompression group patient also had notch fasciotomy and experienced elimination of migraine headaches.

Concomitant Surgery Sites

The majority ($n = 35$) of the 62 patients who underwent transpalpebral nerve decompression received surgery at site I only, without any concomitant sites. The number of patients in the transpalpebral nerve decompression group decreased as the number of concomitant surgery sites increased (Table 3). The number of concomitant sites did not contribute to a significant difference in the success rate of transpalpebral nerve decompression ($p > 0.5$). In contrast, all 191 patients in the endoscopic nerve decompression group underwent at least one concomitant trigger site release, with the majority of endoscopic nerve decompression patients being subjected to at least two concomitant surgery sites (Table 3). The number of concomitant sites did not contribute to a significant difference in the success rate of endoscopic nerve decompression ($p > 0.15$).

DISCUSSION

There are several possible reasons why endoscopic nerve decompression was significantly

Table 3. Surgery Outcomes of Site I with Concomitant Sites

Surgery Site	TPND		END	
	n	Success Rate*	n	Success Rate*
I only	35	77%	0	—
I + 1 more site	17	82%	35	83%
I + 2 more sites	9	78%	85	89%
All 4 sites	1	100%	71	92%

TPND, transpalpebral nerve decompression; END, endoscopic nerve decompression.
*The success rates reflect improvements in frontal migraine headache pain only, not the overall migraine headache pain.

1117

more effective at reducing frontal migraine headaches than transpalpebral nerve decompression was. One reason is the potential incomplete resection of the corrugator supercilii muscle in transpalpebral nerve decompression. Walden et al. performed transpalpebral corrugator and endoscopic corrugator resections on 12 cadaveric heads and subsequently evaluated the extent of corrugator supercilii muscle resection through coronal exposure.[21] Their results showed that transpalpebral corrugator resection left up to one-third of the lateral aspect of the transverse head of corrugator supercilii muscle intact, whereas endoscopic corrugator resection successfully removed the entire corrugator supercilii muscle.[21] We believe the amount of residual corrugator supercilii muscle after transpalpebral corrugator resection is largely dependent on technique but concur that a transpalpebral approach is less effective at completely removing the corrugator supercilii muscle than an endoscopic approach.

Better visibility and magnification through the endoscope allows for more thorough removal of the glabellar muscle group, whereas transpalpebral nerve decompression requires more extensive lateral and medial dissection using a smaller operative window. We consider complete resection of the glabellar muscle group crucial for the successful treatment of frontal migraine, as any residual muscle may continue to irritate the supraorbital nerve and supratrochlear nerve.

Another advantage of endoscopic nerve decompression is that the supraorbital foramen is more frequently identified endoscopically than in transpalpebral nerve decompression (Fig. 3). The supraorbital nerve exits through a supraorbital foramen in approximately 25 percent of the population, whereas in the remaining 75 percent, it exits through a supraorbital notch.[8,22–25] We now routinely release any fibrous bands enclosing the supraorbital notch. We have, however, been doing foraminotomy using a 2-mm osteotome percutaneously since we started performing migraine surgery in 2000. Both maneuvers will release potential supraorbital nerve compression. In addition, we diligently and routinely isolated and cauterized the supraorbital and supratrochlear arteries and veins, hoping to achieve additional improvement in the results. The potential role of the vessels in irritation of the nerves has been discussed for decades.[26–28] Our results show that patients who received foraminotomies experienced higher success rates, thus supporting the theory that constriction of the supraorbital nerve within the foramen contributes to frontal migraine headaches.[24]

Another surgical technique more easily performed in endoscopic nerve decompression is the identification of accessory supraorbital nerves. The 20 patients who had transection of an accessory supraorbital nerve had 100 percent success rate and 80 percent elimination rate. The accessory supraorbital nerves are often very lateral and cephalic, making the visualization through the transpalpebral approach difficult. In contrast, the accessory supraorbital nerves can be detected readily through the endoscopic approach.

On the other hand, release of the bands across the supraorbital notch is easier through the transpalpebral approach, whereas the identification of the supraorbital artery is easier through the endoscopic approach. Although our studies clearly demonstrate the superiority of the results with a foraminotomy,[24] our current sample size for the patients who have undergone supraorbital arterectomy and fasciotomy is not enough to provide statistical support. We are, however, conducting studies to further elucidate the role of fasciotomy and arterectomy in treatment of frontal migraine headaches.

Concomitant trigger-site deactivation did not significantly alter the success of transpalpebral nerve or endoscopic nerve decompression in reducing frontal migraine headaches, offering further evidence that these trigger sites are independent, with an overlap of the symptoms occurring when the entire trigeminal nerve becomes inflamed. Moreover, our previous study documented that an increase in concomitant migraine operative sites significantly improved the outcome of migraine headache surgery, confirming the importance of the identification of all of the existing trigger sites without demonstrating interaction among the trigger sites.[29] Our results suggest that pain at other trigger sites (e.g., temporal site II) does not usually radiate to the supraorbital area.

Both transpalpebral nerve decompression and endoscopic nerve decompression carry risks for rare complications including paresthesia of the frontoparietal or temporal scalp if the nerves were injured, and forehead asymmetry if the corrugator supercilii muscle was not equally removed on both sides.[17] Additional risks associated only with endoscopic nerve decompression include frontalis paralysis from injury to the temporal branch of the facial nerve, unilateral or bilateral eyebrow elevation, and dimpling on animation.[17]

Based on the results of this study, endoscopic nerve decompression should be the first choice in all frontal migraine surgeries unless contraindicated by a forehead length of 8 cm or more (Fig.

1118

1), usually resulting from hairline recession or an excessive prominence to the forehead. When endoscopic nerve decompression is not feasible, transpalpebral nerve decompression should be performed. Under this scenario, it is important to ensure that the entire corrugator supercilii muscle is removed and that the supratrochlear nerve and supraorbital nerve are maximally released. Maneuvers to achieve this include either notch fasciotomy or foraminotomy, resection of the supraorbital and supratrochlear vessels, and removal of any accessory supraorbital nerve. These additional procedures may require more extensive dissection than what was previously described for transpalpebral nerve decompression.[17–19]

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PATIENT CONSENT

Patients provided written consent for the use of their images.

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