Decompression Surgery for Frontal Migraine Headache

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Introduction: Migraine headache (MH) is one of the most common diseases worldwide and pharmaceutical treatment is considered the gold standard. Nevertheless, one-third of patients suffering from migraine headaches are unresponsive to medical management and meet the criteria for “refractory migraines” classification. Surgical treatment of MH might represent a supplementary alternative for this category of patients when pharmaceutical treatment does not allow for satisfactory results. The goal of this article is to provide a comprehensive review of the literature regarding surgical treatment for site I migraine management.

Methods: A literature search using PubMed, Medline, Cochrane and Google Scholar database according to Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines was conducted using the following MeSH terms: “frontal neuralgia,” “frontal trigger site treatment,” “frontal migraine surgery” and “frontal headache surgery” (period: 2000-2020; last search on 12 March 2020).

Results: Eighteen studies published between 2000 and 2019, with a total of 628 patients, were considered eligible. Between 68% and 93% of patients obtained satisfactory postoperative results. Complete migraine elimination rate ranged from 28.3% to 59%, and significant improvement (>50% reduction) rates varied from 26.5% to 60%.

Conclusions: Our systematic review of the literature suggests that frontal trigger site nerve decompression could possibly be an effective strategy to treat migraine refractory patients, providing significant improvement of symptoms in a considerable percentage of patients. (Plast Reconstr Surg Glob Open 2020;8:e3084; doi: 10.1097/GOX.0000000000003084; Published online 15 October 2020.)
Trigger site I migraine is most common and originates from the irritation of the supraorbital (SON) and supratrochlear nerves (STN), as well as the terminal branches of the frontal nerve. Different anatomical studies have been conducted to better understand supraorbital and supratrochlear nerve anatomy and to identify their possible irradiation points. The supratrochlear nerve exits the orbit medially, runs along its medial roof, and penetrates into the corrugator at about 1.8 cm from the midline, exiting the muscle approximately 2 cm from the midline. In most cases, the nerve splits into 2 branches in the retro-orbicularis oculi fat pad before penetrating the muscle. The supraorbital nerve exits the orbit via a supraorbital notch or via a foramen, splitting in a superficial and in a deep branch. Four different patterns of branching were identified based on their interaction with the corrugator muscle. However, different studies show that the mean distance of supraorbital nerve entrance into the brow and the midline is about 2.7 cm. Irritation mechanism depends on the compression of the nerve structures by either their arteries, the glabellar muscles group (procerus, depressor, and corrugator supercili), the supraorbital foramen, or by a fascial band present at the supraorbital notch. Clinically, patients affected by trigger site I MH usually report pain starting above the eyebrows and show deep frown lines and corrugator muscles hypertrophy or eyelid ptosis. Often, clinical history and clinical examination (tenderness of the trigger point at manual compression) are sufficient to clearly identify the MH trigger site. Complementary signs can be an audible vessel signal using a handheld Doppler on the trigger point, botulinum toxin-A injection (useful only in case of “non-vascular” etiology), or local anesthetic injection if the patient examination is contextual to a pain episode. Currently, frontal trigger site deactivation is performed through a transpalpebral or an endoscopic approach, under local anesthesia, sedo-analgesia, or general anesthesia, including different surgical procedures. The goal of this article is to provide a comprehensive review of the literature about surgical treatment for site I migraine management.

**METHODS**

A literature search using PubMed, Medline, Cochrane, and Google Scholar database according to Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines was conducted to perform a review of the different surgical techniques and to evaluate the outcomes of surgical deactivation of frontal trigger site migraines. The following MeSH terms were used: “frontal neuralgia,” “frontal trigger site treatment,” “frontal migraine surgery,” and “frontal headache surgery” (period: 2000–2020; last search conducted on March 12, 2020). Two independent reviewers performed two-stage screening and data extraction. Abstracts were screened to identify eligible papers. Reference lists of relevant articles were searched for additional studies. The search strategy is shown in the form of a flow chart (Fig. 1).

**RESULTS**

After duplicate exclusion, 1266 articles were identified. Two different reviewers analyzed all the records by titles and abstracts. Forty full-text articles were examined for eligibility. Eighteen studies published between 2000 and 2019 were considered eligible and included in this systematic review based on appropriateness, relevance, and actuality (Fig. 1).

From the 16 selected studies, 6 were retrospective studies, of which 1 was a blinded randomized cohort study. One was a double-blind, sham surgery, controlled clinical trial, and 1 was a cross sectional study. A total of 628 patients were included in the review, and the sample size of each study ranged from 10 to 132 patients. Ten of 16 studies reported patient gender showing female prevalence ranged from 68.14% to 100%. Twelve of 16 studies reported the age of patients (as mean or as range). Moreover, two additional studies investigating supraorbital region anatomy were included; one study described the supraorbital

| Trigger Site | Trigger Site | Corresponding Nerve |
|--------------|--------------|---------------------|
| Site I       | Frontal      | Supratrochlear and supraorbital nerves |
| Site II      | Temporal     | Zygomatico-temporal branch of the trigeminal nerve |
| Site III     | Septo-nasal  | Great occipital nerve |
| Site IV      | Occipital    | Auriculo-temporalis |
| Site V       | Auriculo-temporalis | Lesser occipital nerve |
| Site VI      | Lesser occipital | Lesser occipital nerve |

**Table 1. Six Different Migraine Trigger Sites Corresponding to Branches of the Trigeminal and the Greater Occipital Nerves in 3 Different Craniofacial Regions**
anatomy in 30 cadavers and the other \(^44\) reported the intraoperative findings in 61 patients who had undergone multiple site deactivation surgery.

Concerning surgical techniques, 2 different approaches were mentioned. Seven studies reported a transpalpebral approach \(^28\)–\(^30\),\(^40\),\(^44\); 6 studies reported an endoscopic approach \(^31\),\(^35\)–\(^38\),\(^42\) and 5 studies reported both.\(^27\),\(^31\)–\(^34\),\(^41\)

Studies further mentioned that among endoscopic techniques from 1 single incision (1.5 cm) to 5 incisions, all were positioned behind the hairline. Moreover, the tip to place three surgical sutures bilaterally in the superciliary region to lift the frontal skin allowing for better visualization of the SON, STN, and the surrounding muscles \(^36\)–\(^38\) was given. Among transpalpebral approaches, 5 studies referenced the transposition of fat from the medial compartment of the upper eyelid to fill any defect left by the excised muscles.\(^31\)–\(^34\),\(^40\)

One paper \(^34\) consisted of a comparative study between the two approaches and reported significantly higher success and elimination rates in the endoscopic decompression group than in the transpalpebral decompression group (89% versus 79%, \(P < 0.05\) and 67% versus 52%, \(P < 0.03\), respectively). In any case, the surgical approach corrugator and depressor supercilii resections or myotomies and careful preservation of SON and STN were described in all the procedures. Procerus muscle weakening was reported in 10 articles.\(^29\),\(^30\),\(^32\)–\(^38\),\(^40\)

Three articles expressly mentioned vessels coagulation or arterectomy.\(^28\),\(^34\),\(^41\)

Three articles \(^32\),\(^34\),\(^41\) expressly mentioned foraminotomy using a percutaneous 2 mm osteotome to perform a supraorbital foramen release,\(^32\) and 2 articles expressly mentioned fasciotomy.\(^34\),\(^41\)

The anatomical cadaveric study included in the review\(^43\) reported the presence of a supraorbital foramen or a supraorbital notch in 26.6% and 83.3% of the sample, respectively. Moreover, this study\(^43\) documented the existence of a fascial band encasing the supraorbital neurovascular bundle in 86% of the supraorbital region that contained a notch. A recent study\(^44\) describing the intraoperative anatomy of the supraorbital region on 118 sites reported a supraorbital nerve foramen and a supraorbital nerve notch prevalence pair to 41% and 49%, respectively.

In addition, SON or STN compression appeared macroscopically evident in 95% of cases. Another interesting finding was the presence of nerve edema, nerve flattening, or nerve discoloration in 74% of patients.

Table 2 shows the study characteristics and data collection regarding surgical strategies (surgical approach, incision type, glabellar muscle resection, foraminotomy, fasciotomy, or arterectomy).

With respect to outcome measurements, the most frequently used methods were migraine headache index (MHI) \(^32\),\(^35\)–\(^38\),\(^41\) and the headache questionnaire.\(^36\)–\(^39\),\(^42\)

Follow-up period varied from 6 months to 126 months. The majority of the studies defined a successful migraine treatment as migraine attack elimination or at least a 50% reduction of its symptoms.

Eleven studies\(^27\)–\(^29\),\(^31\)–\(^34\),\(^39\) reported the success rate as a percent value. Overall, 68.3%–93.3% of patients presented

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Table 2

| Study Characteristics and Data Collection | Surgical Strategies |
|------------------------------------------|---------------------|
| Surgical Approach                        | Incision Type       |
| Glabellar Muscle Resection               | Foraminotomy        |
| Fasciotomy                               | Arterectomy         |

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Fig. 1. PRISMA guidelines.
satisfactory results. Specifically, the complete elimination of migraine attacks varied from 28.5% to 59.1%, and the rate of significant improvement (at least a 50% reduction of symptoms) varied from 26.5% to 60.5%.

A double-blind controlled clinical trial\(^{39}\) compared two groups of patients who had undergone actual surgery and sham surgery (placebo), expressing the result as an absolute score using the Migraine Disability Assessment, the Migraine-Specific Quality of Life, and the Medical Outcomes Study 36-Item Short Form Health Survey, where significantly better results were observed in the actual surgery group. Another comparative study\(^{40}\) investigated the difference between performing only glabellar myectomy and performing glabellar myectomy combined with supraorbital foraminotomy. This study used MH severity, frequency, and duration, as well as the MHI and the forehead pain score and reported significantly better results in the group of patients who had undergone a glabellar myectomy combined with supraorbital foraminotomy compared with the group who had only undergone a myectomy (postoperative migraine frequency: 7.8 per month versus 4.1 per month; postoperative migraine severity: 5.6 versus 4.4; MHI: 26.5 versus 11.12; persistent forehead pain: 48.8% versus 25.6%). Punjabi et al\(^{41}\) analyzed the appearance of secondary trigger sites after decompression primary surgery showing that the most frequent unmasked secondary trigger after site I surgery is in site III (20.83%). Another article\(^{42}\) suggested that frequent unmasked secondary trigger after site I surgery decompression primary surgery showing that patients who undergo arterectomy obtained better outcomes in terms of MHI (51.71 versus 5.55), MFD (18 versus 24), and frequency (12 versus 6.11) compared with patients who had not undergone arterectomy. Moreover, 31% of patients who had not undergone arterectomy needed a second surgery consisting of a revision arterectomy and after the procedure showed a statistically equivalent improvement in MFD (20.75 versus 24, \(P = 0.178\)) compared with the patients who had undergone arterectomy as primary surgery. Finally, the most recent study included in the review\(^{43}\) showed a decrease in VAS headache intensity from 8.10 before surgery to 1.09 after surgery (\(P<0.001\)).

Seven of 16 studies mentioned postoperative complications.\(^{27,31,39,42}\) The most common complication reported in 6 studies\(^{27-29,31,39,42}\) was transient paresthesia, followed by pruritus reported in 2 studies,\(^{30,39}\) and eyebrow asymmetry or uneven movement,\(^{27,30}\) frontal muscle paralysis,\(^{27}\) eyelid ptosis,\(^{30}\) and hematoma formation reported in one patient.\(^{31}\) Many authors suggest wearing a compressive bandage for 24–48 hours after surgery.

Table 3 reports in detail the outcomes after the surgical treatment of each study (outcome measures method, MH elimination or improvement, patient satisfaction, and postoperative complications).

**DISCUSSION**

Since the unexpected finding of frontal headache amelioration consequent to glabellar muscle resection and periosteal release performed during brow-lift procedures,\(^{27}\) the field of migraine surgery has rapidly progressed. Our study evidences the positive effects of frontal nerve decompression surgery and underlines how the migraine surgical field is still evolving. In our review, seven studies reported a transpalpebral approach, 6 studies reported an endoscopic approach, and 5 studies reported both. This proportion denotes that there is still no consensus as to what the best approach to treat frontal migraine is. The transpalpebral approach consents the direct visualization and the excision of the glabellar muscles, leaving the periosteal and the fascial structures undamaged. This can be considered as an extension of an upper eyelid blepharoplasty. The anatomical findings that emerged from the two studies included in the review\(^{43,44}\) reported a relatively high prevalence of supraorbital foramen, supraorbital notch, and fascial band encasing the supraorbital neurovascular bundle, which may suggest that a transpalpebral approach allows for better visualization and treatment of nerve compression. Conversely, some authors argue that the endoscopic technique, at the same time allowing a complete periosteal release on the orbital ridge and a wide glabellar muscles dissection, should be considered as the best choice whenever anatomically possible. The endoscopic approach is not recommended for patients with a forehead length greater than 8 cm or patients presenting with a protruding forehead.\(^{45}\) A retrospective study\(^{45}\) included in our review reported significantly higher success rates in cases of endoscopic approach than in the transpalpebral option. As aforementioned, among the described endoscopic techniques, surgical access varies from 1 single incision of 1.5 cm to 5 incisions, all of which are positioned behind the hairline. The minimally invasive technique described by Raposio,\(^{36-38,46-48}\) in addition to the single midline incision, requires the use of a modified endoscope and the placement of 3 surgical sutures bilaterally in the suprperiosteal region to have a better visualization of the anatomical structures lifting the frontal skin.

Regardless of the approach, another noticeable difference among the studies is related to surgical procedures. All the authors agree that glabellar muscles group excision and SON and STN preservation are mandatory. The necessity to perform an arterectomy, a fasciotomy, and a foraminotomy is still a matter of debate. Gatherwright,\(^{41}\) in a prospective blinded randomized cohort study, demonstrated the role of arterectomy in frontal migraine surgery showing that patients who undergo arterectomy obtain better outcomes. Moreover, the study reported that in about 30% of cases, patients who had not undergone arterectomy needed a revision consisting of an arterectomy; after which, a statistically equivalent improvement was achieved when compared with patients who had undergone arterectomy as the primary surgery. Another retrospective comparative study\(^{42}\) investigated the role of supraorbital foraminotomy proving a reduction of migraine frequency, migraine severity, MHI, and forehead pain in patients who had undergone foraminotomy. This clinical finding is supported by recent radiological and anatomical evidence\(^{49}\) showing that SON and especially supraorbital foramen contribute significantly to MH symptoms. This radiological study suggests that an analysis
| Study                          | Type                  | Sample (patients) | Surgical Incision | Surgical Strategy                                                                 |
|-------------------------------|-----------------------|-------------------|-------------------|-----------------------------------------------------------------------------------|
| Guyuron et al10               | Retrospective analysis| 39                | TP or E or open   | Resection of the corrugator and depressor muscles                                |
| Dirnberger and Becker11       | Prospective           | 60, Female: 78.3% | TP                | Resection of the corrugator and depressor muscles, vessels coagulation by bipolar diathermy |
| Bearden and Anderson12        | Prospective           | 12                | TP (combined with blepharoplasty) | Resection of the corrugator and depressor muscles, procerus muscle weakening     |
| Guyuron et al10               | Double-blind, sham surgery, controlled clinical trial | 29, Actual surgery: 19, Sham surgery: 10 | TP                | Resection of corrugator, depressor and procerus muscle + fat from medial compartment of the upper eyelid to fill any defect left by the excised muscles |
| de Ru et al14                 | Prospective           | 10, Mean age: 30.7 y, Female: 100% | E 3 small incisions above the hairline | Cleavage of the corrugator muscle                                               |
| Chepla et al12                | Retrospective analysis| Mean age: 42.5 y versus 46.4 y, Female: 97.67% | TP or E            | Group 1: glabellar myectomy                                                       |
| Lee et al15                   | Retrospective analysis| 132, Mean age: 44.6 y versus 44.7 y, Female: 89.3% | TP or E            | Group 2: glabellar myectomy + supraorbital foraminotomy                           |
| Liu et al14                   | Retrospective analysis| 35, Mean age: 45.3 y versus 44.7 y, Female: 89.3% | TP or E            | Resection of corrugator, depressor, and lateral portion of the procerus + fat from medial compartment of the upper eyelid to fill any defect left by the excised muscles |
| Caruana et al15               | Prospective           | 54, Age range: 18–75 y |
| Caruana et al16               | Prospective           | 16, Age range: 27–72 y, Female: 80% | E 2 incisions (1.5 cm) above the hairline, positioned 1 cm from the midline | Placement of 3 surgical sutures in the supciliary region to lift the frontal skin |
| Polotto et al17               | Retrospective analysis| 43, Age range: 18–72 y, Female: 88.3% | E One midline scalp incision (length: 1.5 cm) | Selective myotomies of corrugator, depressor, and procerus muscles               |
| Raposio and Caruana18         | Prospective           | 43, Age range: 18–72 y, Female: 88.3% | E 3–5 incisions (length: 1.5 cm) behind the hairline using a specifically modified endoscope | Corrugator, depressor, and procerus muscles section performing one myotomy (full-thickness to reach the subcutaneous tissue) per side parallel and approximately 2 mm medially and laterally to each nerve |
| Kurlander et al19             | Retrospective analysis| 34, Age range: 20–70 y, Female: 89.6% | TP                | Corrugator resection                                                             |
| Punjabi et al20               | Cross-sectional study | 185               | TP                | Corrugator, depressor, and procerus resection + fat from medial compartment of the upper eyelid to fill any defect left by the excised muscles |
| Gatherwright et al45          | Prospective, blinded randomized cohort study | 13, Mean age: 41.8 y, Female: 100% | TP                | 4 groups: 1. Myectomy 2. Myectomy + foraminotomy/fasciotomy 3. Myectomy + arterectomy 4. Forminotomy/fasciotomy |
| Filipovic et al22             | Prospective           | 22, Mean age: 42 y, Female: 68.1% | E                  | Complete release of STN and SON by cutting the periosteum at the level of the supraorbital ridge Glabellar muscles were not removed |
| Fallucco et al43              | Cadaveric study       | 30                | TP                | Transpalpebral bilateral approach                                                 |
| Ortiz et al44                 | Prospective           | 61                | TP                | Transpalpebral bilateral approach                                                 |

E, endoscopic approach; TP, transpalpebral approach.
| Study                     | Sample (patients) | Outcomes Measurements                                                                 | Follow-up (mo) | Results                                      | Complications                                                                 |
|--------------------------|-------------------|----------------------------------------------------------------------------------------|----------------|----------------------------------------------|-----------------------------------------------------------------------------|
| Guyuron et al\(^7\)     | 39                | –                                                                                       | 46.5           | 79.5% positive response 38.4% → elimination 41% → significant improvement | –Paresthesia –Eyebrow asymmetry –Frontalis muscle paralysis Paraesthesia, disappeared in all patients within 3–9 months. |
| Dirnberger\(^28\)       | 60                | % reduction of MH days, drugs, side effects, and severity of MH Patient satisfaction using a scale from 1 to 5 (1 = elimination; 5 = any change) | 6 and 18       | 68.3% positive response 28.3% → elimination 40% → significant improvement 31.7% → minimal or no change | –Paraesthesia, disappeared in all patients within 3–9 months. |
| Bearden and Anderson\(^9\) | 12               | Onset, frequency, severity, and duration of MH episodes; headache medications; and botulinum toxin | 6–19           | 92% → improvement | Any |
| Guyuron et al\(^30\)    | 29                | Migraine Disability Assessment –MSQEM –Medical Outcomes Study 36-Item Short Form Health Survey | 12             | Baseline actual surgery versus sham surgery: Frequency: 9.8 versus 7.6–Intensity: 5.9 versus 6.1–Duration: 0.56 versus 1.3–MHI: 24.3 versus 27.5–MSQEM: 48.8 versus 37.2–Study 36-Item Short Form Health Survey: 45.4 versus 46.7 1 year postoperative actual surgery versus sham surgery: Frequency: 6.37 (P < 0.001) versus 1.5 (P < 0.18)–Intensity: 2.5 (P = 0.005) versus 2.1 (P = 0.51)–Duration: 0.24 (P = 0.01) versus 0.18 (P = 0.57)–MHI: 15.4 (P = 0.003) versus 12.2 (P = 0.03)–MSQEM: 24 (P = 0.02) versus 0.46 (P = 0.97)–36-Item Short Form Health Survey: 5.9 (P = 0.002) versus 1.5 (P = 0.51) | –Temporary intense pruritus → 11% –Uneven brow movement → 5% –Residual corrugator muscle function → 5% |
| de Ru et al\(^31\)      | 10                | Pain severity scoring verbal numerical rating scale (NRS): from 0 (no pain) to 10 (severe pain) | 3–30           | 90% → lowered pain score from 8.1 to 0.8 10% → any change | Numbness in 3 patients Paresthesia and hematoma formation in 1 patient Not reported |
| Chepla et al\(^32\)     | 86                | MH severity, frequency, and duration MH Forehead pain | 12             | Glabellar myectomy versus Glabellar myectomy + suprorbital foraminotomy Postoperative migraine frequency: 7.8 versus 4.1 per month Severity: 5.6 versus 4.4 MHI: 26.5 versus 11.1 Persistent forehead pain: 48.8% versus 25.6% | Not reported |
| Lee et al\(^33\)        | 132               | MHI (success defined as >50% of reduction) 2 groups: a) preoperative BTA responsive (109 patients) b) preoperative BTA NON responsive (23 patients) | >12            | 83.3% → positive response 56.8% → elimination 26.5 → >50% reduction BTA responsive versus BTA NON responsive group: Migraine elimination: 33.7% versus 7.6% >50% reduction: 92.5% versus 69.2% | Not reported |
| Liu et al\(^34\)        | 35                | MH frequency, duration and intensity | 12–126 (mean: 34) | 77% → positive response | Not reported |
| Caruana et al\(^35\)    | 54                | Age range: 18–75 y 36-item short questionnaire (before surgery) 29-item short questionnaire (6 months and 2 years after surgery) | 24             | 6 months (51 patients): 84.3% → positive response 41.2% → elimination 43.1% → significant improvement 2 years (29 patients): 89.6% → positive response 31% → complete elimination 58.6% → significant improvement | Not reported |
| Caruana et al\(^36\)    | 16                | Headache questionnaire | –             | 81.5% → positive response 31.5% → elimination | Not reported |
| Polotto et al\(^37\)    | 43                | Headache questionnaire | 24             | 93.3% → positive response to the surgery: 33.3% → complete elimination 60% → significant improvement | Not reported |

(Continued)
of all available face or perinasal sinus CT images could be helpful in preoperative planning, possibly including foraminotomy and fasciotomy.

An important criticism in frontal migraine management is the lack of consensus among clinicians regarding the methods to measure surgical outcomes. In our review the most frequently used methods were MHI and the headache questionnaire. Quality of life documentation before and after a migraine surgery is exiguous, mirroring the literature regarding trigger site decompression surgery. In our opinion, to improve the migraine surgery effect reporting, future investigations should spotlight what is the most complete evaluation method to universalize outcome measurements.

Patient follow-up period varied from 6 to 126 months; results were considered as stable three months after surgery by most of the authors. Overall, 68.3%–93.3% of patients presented satisfactory results. Complete migraine elimination rate ranged from 28.3% to 59% and significant improvement (>50% of reduction) rate varied from

| Study                          | Sample (patients) | Outcomes Measurements                                      | Follow-up (mo) | Results                                                                 | Complications       |
|--------------------------------|-------------------|-----------------------------------------------------------|----------------|------------------------------------------------------------------------|---------------------|
| Raposo and Caruana⁶⁰            | 43                | Headache questionnaire                                      | 6 and 24       | 6-month-long follow-up (43 patients): 81.4% → positive response        | Not reported        |
|                                |                   |                                                           |                | 39.5% → elimination                                                    |                     |
|                                |                   |                                                           |                | 41.9% → significant improvement                                         |                     |
|                                |                   |                                                           |                | 2-year-long follow-up (15 patients): 93.3% → positive response         |                     |
|                                |                   |                                                           |                | 33.3% → elimination                                                    |                     |
|                                |                   |                                                           |                | 60% → significant improvement                                           |                     |
| Kurlander et al⁶⁰              | 34                | Frontal-specific MHI Reduction in migraine days (duration × frequency) | 12            | 88% → positive response                                                 | Numbness → 32.1%    |
|                                |                   |                                                           |                | 59% → elimination                                                       | Pruritus → 8.9%     |
|                                |                   |                                                           |                |                                                                        | Hypersensitivity → 8.9% |
|                                |                   |                                                           |                |                                                                        | Eyelid Ptosis → 3.6% |
| Punjabi et al⁵⁰                | 185               | Migraine headache questionnaire                            | 13            | 17.8% of the cohort reported new postoperative migraines                | Not reported        |
|                                |                   |                                                           |                | Site I: 20.85% → Site III (septo-nasal) unmasked after surgery           |                     |
| Gatherwright et al⁴¹           | 13                | Migraine headache severity and duration                   | 21.6          | MHI: from 32.6 (3.8–85) to 4.7 (0–21.3), P = 0.0001                   | Not reported        |
|                                |                   | MHI                                                        | (7.6–34.1)     | Frequency: 12 versus 6.11                                               |                     |
|                                |                   | MFDs                                                       |                | Improvement MFDs: from 18 to 24                                         |                     |
|                                |                   |                                                           |                | No arterectomy (4 patients):                                            |                     |
|                                |                   |                                                           |                | Improvement MFDs: 13.25                                                 |                     |
|                                |                   |                                                           |                | Less than arterectomy group (13.25 versus 24 MFDs):                    |                     |
|                                |                   |                                                           |                | 31% required a site I revision that included an arterectomy. Following revision, both groups had statistically equivalent improvement in MFDs (20.75 versus 24 MFDs) |                     |
| Filipovic et al⁴²               | 22                | Daily headache diary (4 points only)                      | 12–107        | VAS headache intensity from 8.10 to 1.3 at 3 months after surgery and to 1.09 at 12 months after surgery | Transient paresthesia → 2 patients (3 months duration) |
|                                |                   | Headache questionnaire                                     | (mean: 29.5)   | Accompanying headache symptoms (photophobia, phonophobia, nausea, and vomiting) were completely abolished in all patients, except in 1 case | Temporary hair loss above the incision → 1 patient (12 months duration) |
| Fallucco et al⁴⁵               | 30                | –                                                          | –             | – Supraorbital foramen → 26.6% of cases                                | –                   |
|                                |                   |                                                           |                | Supraorbital notch → 83.3% of cases                                     |                     |
|                                |                   |                                                           |                | – Fascial band → 86% of supraorbital region that contained a notch and classified into 3 types |                     |
| Ortiz et al⁴⁴                 | 61                | –                                                          | –             | – Supraorbital foramen → 41% of cases                                  | –                   |
|                                |                   |                                                           |                | Supraorbital notch → 49% of cases                                      |                     |
|                                |                   |                                                           |                | – Supraorbital foramen and notch → 9.3% of cases SON (66%) or STN (29%) |                     |
|                                |                   |                                                           |                | Compression → 95% of cases                                             |                     |
|                                |                   |                                                           |                | Nerve edema, flattening, or discoloration → 74%                        |                     |

BTA, botulinum toxin type A; MFD, migraine-free days; MSQEM, Migraine-Specific Quality of Life.
26.5% to 60%. The wide range can be justified by the fact that different surgical techniques were performed. One double-blind controlled clinical trial compared actual surgery and sham surgery (placebo), showing significantly better results in the actual surgery group. Consensus about why some patients remain refractory to frontal migraine surgery has yet to be reached. The frontal migraine crisis pathogenesis remains unclear and additional clinical and anatomical studies have to be accomplished to improve surgical outcomes.

Undeniably, some authors are not convinced that decompression surgery represents an effective treatment for headaches and the neural entrapment theory is still a matter of debate. Certainly, the lack of clarity regarding patient selection criteria, the scarcity of controlled studies, the lack of consistent outcome measures, and the relative brevity of follow-ups represent weak points that can lead to prejudiced results. However, recent studies have described intraoperative findings of SON and STN compression, nerve edema, flattening, or discoloration, thus demonstrating the concreteness and the anatomical-clinical correlation of the neural entrapment theory. In our opinion, standardization of patient selection and outcome measures after decompression surgery are the most critical points needed to convince neurologists of the effectiveness of this type of treatment in selected patients. In fact, the MHI represents a non-validated instrument that may increase the possibility of obtaining positive results. A constructive and open discussion between surgeon and neurologist would surely improve the management of these patients and allow for the building of an integrated therapeutic algorithm to better evaluate the postoperative results.

Postoperative complications were relatively rare and a few were reported. The most common complication was a transient paresthesia, followed by pruritus, eyebrow asymmetry or uneven movement, frontal muscle paralysis, eyelid ptosis, and hematoma formation.

CONCLUSIONS

Our systematic review of the literature suggests that frontal trigger site nerve decompression may be an effective strategy to treat migraine refractory patients, allowing for the resolution or at least a significant improvement of symptoms in a considerable percentage of patients. However, the poor quality of the included studies, the scarcity of controlled trials, the lack of consistent outcome measures, and the multitude of varied surgical techniques do not permit the conclusion of efficacy with respect to frontal migraine surgical treatment. Certainly, higher level studies need to be conducted to confirm the effectiveness of this treatment. Moreover, why some patients are still unresponsive to surgical treatment is still a matter of discussion.

Nowadays, there is not a standard surgical technique. Prospective studies to compare excision or blunt dissection of the glabellar muscles, periosteum release, vessel coagulation and foraminotomy would be helpful to reach a better understanding as to what is the best surgical strategy to treat these patients.

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REFERENCES

1. Lipton RB, Bigal ME, Diamond M, et al; AMPP Advisory Group. Migraine prevalence, disease burden, and the need for preventive therapy. Neurology. 2007;68:343–349.
2. Bigal ME, Lipton RB. The epidemiology, burden, and comorbidities of migraine. Neurol Clin. 2009;27:321–334.
3. Buse DC, Manack AN, Fanning KM, et al. Chronic migraine prevalence, disability, and sociodemographic factors: Results from the American Migraine Prevalence and Prevention Study. Headache. 2012;52:1456–1470.
4. Irimia P, Palmia JA, Fernandez-Torrón R, et al. Refractorymigraine in a headache clinic population. BMC Neurol. 2011;11:94.
5. D’Amico D, Leone M, Grazzi L, et al. When should “chronic migraine” patients be considered “refractory” to pharmacological prophylaxis? Neurol Sci. 2008;29 Suppl 1:S55–S58.
6. Kung TA, Guyuron B, Cederna PS. Migraine surgery: A plastic surgery solution for refractory migraine headache. Plast Reconstr Surg. 2011;127:181–189.
7. Guyuron B, Varghais A, Michelow BJ, et al. Corrugator supercilii muscle resection and migraine headaches. Plast Reconstr Surg. 2000;106:429–434; discussion 435.
8. Guyuron B, Tucker T, Davis J. Surgical treatment of migraine headaches. Plast Reconstr Surg. 2003;112;164S–170S.
9. Guyuron B, Krieger JS, Davis J. Comprehensive surgical treatment of migraine headaches. Plast Reconstr Surg. 2005;115:1-9.
10. Poggi JT, Grizzell BE, Helfer SD. Confirmation of surgical decompression to relieve migraine headaches. Plast Reconstr Surg. 2008;122:115–122; discussion 123.
11. Faber C, Garcia RM, Davis J, et al. A socioeconomic analysis of surgical treatment of migraine headaches. Plast Reconstr Surg. 2012;129:871-–877.
12. Behin F, Behin B, Behin D, et al. Surgical management of contact point headaches. Headache. 2005;45:204–210.
13. Guyuron B, Krieger JS, Davis J, et al. Five-year outcome of surgical treatment of migraine headaches. Plast Reconstr Surg. 2011;127:603–608.
14. Raposio E, Bertozzi N. Trigger site inactivation for the surgical therapy of occipital migraine and tension-type headache: Our experience and review of the literature. Plast Reconstr Surg Glob Open. 2019;7:e2507.
15. Raposio E, Bertozzi N, Bordin C, et al. Surgical therapy of headaches: minimally invasive approaches. In: Clinical Advances in Head & Neck Surgery. Las Vegas, USA: Openaccess eBooks; 2018:1–23.
16. Raposio E, Bertozzi N, Bordin C, et al. Surgical therapy of migraine and tension-type headache. In: Turkheimer, ed. Current Perspectives on Less-known Aspects of Headache. London, U.K.: InTech; 2017.
17. Raposio E, Caruana G. Tips for the surgical treatment of occipital nerve-triggered headaches. Eur J Plast Surg. 2017;40:177–182.
18. Bertozzi N, Simonacci F, Lago G, et al. Surgical therapy of temporal triggered migraine headache. Plast Reconstr Surg Glob Open. 2018;6:e82.
19. 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.
20. Olla D, Sawyer J, Sommer N, et al. Migraine treatment. *Clin Plast Surg.* 2020;47:295–303.
21. Miller TA, Rudkin G, Honig M, et al. Lateral subcutaneous brow lift and interbrow muscle resection: Clinical experience and anatomic studies. *Plast Reconstr Surg.* 2000;105:1129–7; discussion 1128.
22. Knize DM. A study of the supraorbital nerve. *Plast. Reconstr.Surg.* 1995;96:564.
23. Cuzalina AL, Holmes JD. A simple and reliable landmark for identification of the supraorbital nerve in surgery of the forehead: an in vivo anatomical study. *J Oral Maxillofac Surg.* 2005;63:25–27.
24. Janis JE, Ghavami A, Lemmon JA, et al. The anatomy of the corrugator supercilii muscle: Part II. Supraorbital nerve branching patterns. *Plast Reconstr Surg.* 2008;121:233–240.
25. Janis JE, Hatem DA, Hagan R, et al. Anatomy of the supratrochlear nerve: Implications for the surgical treatment of migraine headaches. *Plast Reconstr Surg.* 2013;131:745–750.
26. Guyuron B, Nahabet E, Khansa I, et al. The current means for detection of migraine headache trigger sites. *Plast Reconstr Surg.* 2015;136:860–867.
27. 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.
28. Dimberger F, Becker K. Surgical treatment of migraine headaches by corrugator muscle resection. *Plast Reconstr Surg.* 2004;114:652–657; discussion 658.
29. Bearden WH, Anderson RL. Corrugator superciliaris muscle excision for tension and migraine headaches. *Ophthalmic Plast Reconstr Surg.* 2005;21:418–422.
30. Guyuron B, Reed D, Kriegler JS, et al. A placebo-controlled surgical trial of the treatment of migraine headaches. *Plast Reconstr Surg.* 2009;124:461–468.
31. de Ru JA, Schellekens PP, Lohuis PJ. Corrugator superciliaris transection for headache emanating from the frontal region: A clinical evaluation of ten patients. *J Neural Transm (Vienna).* 2011;118:1571–1574.
32. Chepka RJ, Oh E, Guyuron B. Clinical outcomes following supraorbital foraminotomy for treatment of frontal migraine headache. *Plast Reconstr Surg.* 2012;129:656e–662e.
33. Lee M, Monson MA, Liu MT, et al. Positive botulinum toxin type A response is a prognosticator for migraine surgery success. *Plast Reconstr Surg.* 2013;131:751–757.
34. Liu MT, Chim H, Guyuron B. Outcome comparison of endoscopic and transpalpebral decompensation for treatment of frontal migraine headaches. *Plast Reconstr Surg.* 2012;129:1113–1119.
35. Caruana G, Grignaffini E, Raposio E. Endoscopic forehead muscle resection for nerve decompensation: A modified procedure. *Plast Reconstr Surg Glob Open.* 2015;3:e342.
36. Caruana G, Bertozzi N, Boschi E, et al. Endoscopic forehead surgery for migraine therapy personal technique. *Ann Ital Chir.* 2014;85:583–586.
37. Polotto S, Simonacci F, Grignaffini E, et al. Surgical treatment of frontal and occipital migraines: A comparison of results. *Plast Reconstr Surg Glob Open.* 2016;4:e655.
38. Raposio E, Caruana G. Frontal endoscopic myotomies for chronic headache. *J Craniofac Surg.* 2015;26:e201–e203.
39. Kurlander DE, Ascha M, Sattar A, et al. In-depth review of symptoms, triggers, and surgical deactivation of frontal migraine headaches (Site I). *Plast Reconstr Surg.* 2016;138:681–688.
40. Punjabi A, Brown M, Guyuron B. Emergence of secondary trigger sites after primary migraine surgery. *Plast Reconstr Surg.* 2016;137:712e–716e.
41. Gatherwright JR, Wu-Fienberg Y, Guyuron B. The importance of surgical maneuvers during treatment of frontal migraines (site I): A prospective, randomized cohort study evaluating foraminotomy/fasciotomy, myectomy, and arterectomy. *J Plast Reconstr Aesthet Surg.* 2018;71:478–483.
42. Filipovic B, de Ru JA, Hakim S, et al. Treatment of frontal secondary headache attributed to supratrochlear and supraorbital nerve entrapment with oral medication or botulinum toxin type A vs Endoscopic Decompression surgery. *JAMA Facial Plast Surg.* 2018;20:594–600.
43. 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.
44. Ortiz R, Gréder L, Henssler MA, et al. Migraine surgery at the frontal trigger site: An analysis of intraoperative anatomy. *Plast Reconstr Surg.* 2020;145:523–530.
45. Janis EJ, Barker JC, Javadi C, et al. A review of current evidence in the surgical treatment of migraine headaches. *Plast Reconstr Surg.* 2014;134(4 Suppl 2):131S–141S.
46. Raposio E. *Atlas of Surgical Therapy for Migraine and Tension-Type Headache.* New York: Springer; 2019.
47. Raposio E. *Atlas of Endoscopic Plastic Surgery.* New York: Springer; 2015.
48. Simonacci F, Lago G, Raposio E. *Endoscopic Plastic Surgery.* In: *Advances of Plastic and Reconstructive Surgery.* Irving, Tex.: Austin Publishing Group; 2019:42–74.
49. Pourtaheri N, Guyuron B. Computerized tomographic evaluation of supraorbital notches and foramen in patients with frontal migraine headaches and correlation with clinical symptoms. *J Plast Reconstr Aesthet Surg.* 2018;71:840–846.
50. Mathew PG A critical evaluation of migraine trigger site deactivation surgery. *Headache.* 2014;54:142–152.
51. McGeeeney BE. Migraine trigger site surgery is all placebo. *Headache.* 2015;55:1461–1463.