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Review

Frontal Migraine Surgery: Indications and Results

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Abstract

Recent studies have identified that certain types of migraines, including frontal migraines, may be attributed to the irritation of specific extracranial nerves. This systematic review addresses the following questions: Which surgical techniques are most effective for chronic frontal migraines? How do combined surgical approaches compare to isolated procedures regarding efficacy and complication rates? Our objective is to comprehensively analyze surgical options for frontal migraines, including their success rates and safety profiles. A literature search was performed using the PubMed database, following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines, to provide a systematic review of the literature on the surgical treatment of chronic frontal site migraine. A total of 756 citations from PubMed were initially identified. After a title and abstract review, records were considered relevant. Following a full-text examination, only 16 articles from the initial research, published between 2000 and 2024, met the inclusion criteria and were

included in the systematic review. In total, 1004 patients suffering from Frontal Migraine Headaches (FMH) underwent surgical treatment, encompassing all the established procedures. Surgical interventions for migraine demonstrated significant symptom reduction, with response rates ranging from 57% to 94% across techniques. Various surgical interventions for frontal trigger site migraines demonstrate significant effectiveness, with endoscopic approaches showing higher success rates. Techniques like foraminotomy and the integration of botulinum toxin A may further enhance outcomes. However, multi-center, high-quality studies are needed to standardize techniques, evaluate long-term consequences, and assess patient quality of life post-surgery.

Keywords
Migraine; migraine surgery; headache surgery

1. Introduction

Migraine is a prevalent neurological disorder, affecting 20% of women and 8% of men [1]. U.S. population-based studies on migraine prevalence over the past 30 years have reported an overall prevalence ranging from 11.7% to 14.7% [2]. The results indicate that migraine surgery is a safe and effective option, improving patients' quality of life and potentially lowering long-term expenses [3-13]. This suggests that it should be considered for migraine sufferers who haven't responded to medication, provided they are appropriately selected for the procedure.

Recent studies have identified that certain types of migraines, including frontal migraine headaches (FMH), may be attributed to the irritation of specific extracranial nerves [14, 15]. Frontal migraine may result from chronic irritation or compression of some cranial nerves, specifically the supraorbital (SON) and supratrochlear (STN) nerves, as well as other terminal branches of the frontal nerve [8]. The supraorbital (SON) and supratrochlear (STN) nerves are branches of the frontal nerve, the largest branch of the ophthalmic division of the trigeminal nerve. The SON typically divides into a lateral branch, which passes through the supraorbital notch to innervate the forehead skin, and a medial branch, which passes through the frontal notch to innervate the bridge of the nose and medial forehead. Variations in their courses are common, generally dividing into superficial branches over the frontalis muscle and deep branches beneath the corrugator supercilii and frontalis muscles [13]. This anatomical variability highlights two main infraorbital course variants for these nerves. Considering the anatomy of SON and STN and their possible variations, we can identify the most common trigger points: pain starts above the eyebrows and is associated with deep frown lines, corrugator muscle hypertrophy, or eyelid ptosis.

The aim of this systematic review is to comprehensively analyze surgical options for chronic frontal migraine headaches, including their success rates and safety profiles. Also, examine the literature on surgical treatments and techniques for chronic FMH, whether used alone or combined with other invasive therapies.

2. Methods

A literature search was performed using the PubMed database, following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines, to provide a systematic review of the literature on the diagnosis and treatment of chronic FMH.

The following searching strategy was used: *((((((frontal migraine [Title/Abstract]) OR (Frontal Headache [Title/Abstract])) OR (Frontal site [Title/Abstract])) OR (Frontal Trigger Site [Title/Abstract])) OR (supraorbital [Title/Abstract])) OR (supratrochlear [Title/Abstract])) AND ((surgery [Title/Abstract]) OR (nerve decompression [Title/Abstract])) Filters: from 2000/1/1 - 2024/10/15*. Abstracts were screened to identify eligible articles, and the reference lists of relevant articles were analyzed for additional studies.

2.1 The Selection of the Studies Was Based on the Following Criteria

1. Studies reporting the surgical treatment of Frontal Migraine Headaches (FMH)/peripheral trigger points for migraine: sites I).
2. Registration of post-operative outcomes of frontal trigger site surgery.
3. Full text available.

2.2 Studies Were Excluded Based on the Following Criteria

1. Studies that did not report surgical outcomes in terms of frontal migraine headache reduction or success rates.
2. Reviews, systematic reviews or meta-analyses of the literature.
3. Cadaver studies.

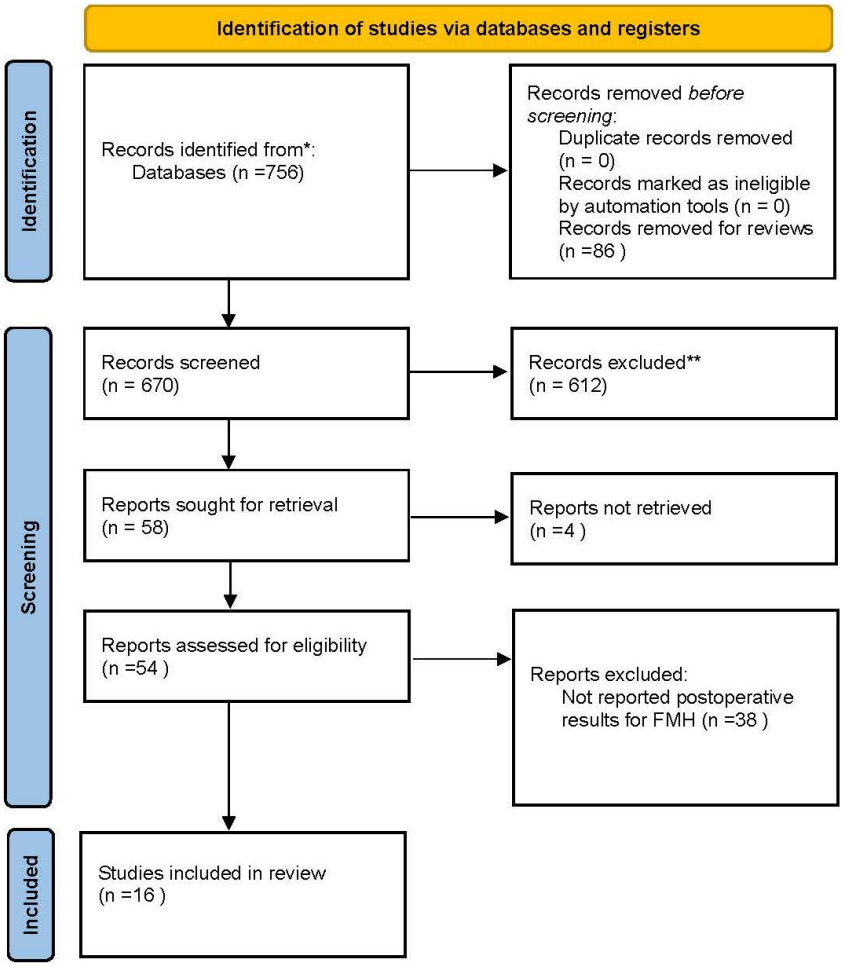
2.3 Data Pooling and Data Analysis

Two independent reviewers evaluated the titles and abstracts of the retrieved articles for relevance. Any differences in opinion were addressed through discussion and consensus. The full texts of articles that appeared to be eligible were subsequently reviewed according to established inclusion and exclusion criteria. The data from the selected studies were combined for analysis. A general overview of the studies includes the author, publication year, number of patients, type of surgery, and reported complications. In this review, we analyzed surgical outcomes, considering the type of surgery, techniques employed, and the potential role of medical treatment in achieving post-operative objectives. Due to the heterogeneity of the studies, a quantitative synthesis of the results was not feasible.

3. Results

A total of 756 articles were identified from the PubMed databases. Of all these, only 16 articles met the inclusion criteria (Figure 1). In total, 1004 patients suffering from FMH underwent surgical treatment, encompassing all the established procedures. These patients were studied and followed up to track outcomes (Table 1).

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only



*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).

**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

Source: Page MJ, et al. BMJ 2021;372:n71. doi: 10.1136/bmj.n71.

Figure 1 PRISMA 2020 flow diagram for new systematic reviews which included searches of databasesand registers.

Table 1 Main scientific studies analyzed in the research.

Study	Patients (n)	Intervention	Comparison	Outcomes	Complications
Giorgio Raposio [16], 2022	90	Selective myotomies of frontal muscles via endoscopic or transpalpebral approach	None	87% showed improvement, with 32% achieving complete recovery after three months	Cutaneous numbness, paresthesia, and itching of the undermined area lasting several months
Bahman Guyuron [17], 2009	29	Removal of glabellar muscles through an upper eyelid incision	Sham surgery	57.1% reduction in migraine frequency, intensity, duration, and improved quality of life, 1-year follow-up	Temporary intense itching in 2 patients, residual muscle function in 1 patient
Bahman Guyuron [18], 2000	39	Endoscopic, transpalpebral, or open resection of corrugator supercilii muscle	None	79.5% experienced improvement or elimination, with 38.5% reporting complete elimination, follow-up up averaged 47 (5 to 122) months	None reported
Robert R. Hagan [19], 2016	45	Transpalpebral decompression of supraorbital and supratrochlear nerves	None	MIDAS scores decreased significantly at 3 and 12 months post-op	Persistent swelling (2 patients, resolved in 6 weeks), minor hematoma (1 patient), cellulitis (1 patient), neuroma (1 patient)
Giorgio Raposio [20], 2023	98	Complete neurolysis of supraorbital and supratrochlear nerves	None	87% achieved a reduction in attacks of at least 50%, with 32% achieving complete recovery in 3 months	Rare complications, including paresthesias and dysesthesias of the frontal area
Edoardo Raposio [8],	70	Bilateral decompression of supratrochlear and	None	94% positive response (32% complete relief, 62% significant	Edema and itching after surgery (5.7%), hypertrophic

2020		supraorbital nerves via endoscopic or transpalpebral approach		improvement) with mean follow-up of 24 (3-97) months, 6% no change in symptoms.	scar (2.7%), incisional cellulitis (1%)
David E. Kurlander [21], 2016	34	Transpalpebral corrugator resection	None	88% of patients experienced successful outcomes, and 59% completed elimination, including visual aura and symptom relief beyond headaches	Numbness and itching common; eyelid ptosis in 5.8% of cases
Kyle J. Chepla [22], 2012	43	Supraorbital foraminotomy with nerve release	Myectomy	Foraminotomy + myectomy group had fewer migraines per month, lower severity, and less forehead pain than the myectomy group	None reported
Edoardo Raposio [23], 2015	43	Endoscopic resection of corrugator supercilii, depressor supercilii, and procerus muscles	None	81.4% positive response after 6 months, with 39.5% complete elimination, 41.9% significant improvement, follow up 6 months to 2 years	None reported
Lisa Gfrerer [3], 2014	26	Non-endoscopic transpalpebral incision with supraorbital and supratrochlear nerve decompression	None	61.5% had >80% resolution, 30.8% had partial resolution (50-80%), and 7.7% had <50% improvement	None reported
Mengyuan T. Liu [24], 2012	253	Transpalpebral nerve decompression or endoscopic nerve decompression	Comparison between two decompression types	Endoscopic decompression had a higher success rate (89%) and elimination rate (67%) compared to transpalpebral, mean follow up 34 months	None reported

Franz Dirnberger [14], 2004	60	Resection of corrugator supercilii and depressor muscles	None	31.7% of patients had 90-100% reduction in headache days, 26.7% had 50-90% reduction, follow up 6 months	None reported
Jeffrey E. Janis [25], 2013	20	Endoscopic bilateral corrugator supercilii muscle resection	Botulinum toxin A injections	83.3% of patients experienced improvement, with 35% achieving complete elimination, mean follow up 661 days	None reported
Bahman Guyuron [2], 2005	80	Endoscopic forehead surgery with glabellar muscle resection	Botulinum toxin A	99% had a positive change, 64% complete elimination at 1-year followup	Scalp itching, small hematoma on upper eyelid
Ricardo Ortiz [26], 2020	61	Resection of corrugator supercilii and portions of depressor supercilii, with foraminotomy	None	82% response rate, with no significant difference in outcomes between patients with and without foramina	None reported
James R. Gatherwright [15], 2018	13	Myectomy alone or combined with foraminotomy/fasciotomy or arterectomy	None	Significant improvement in migraine frequency and severity, especially with arterectomy group	None reported

Mangialardi et al conducted frontal trigger site surgery involving selective myotomies through either an endoscopic or transpalpebral approach, resulting in 87% of patients showing improvement, with 32% achieving complete recovery [27]. Complications included cutaneous numbness, paresthesia, and itching in the undermined area. In another study, Guyuron et al compared frontal trigger site surgery with sham surgery, finding a 57.1% reduction in migraine frequency, intensity, and duration in the surgical group. However, some patients experienced temporary intense itching and residual muscle function [17].

3.1 Comparison of Surgical Approaches for Nerve Decompression

Liu compared transpalpebral nerve decompression with endoscopic decompression in patients with frontal migraine [24]. The endoscopic group showed a higher success rate (89%) compared to the transpalpebral group (79%) and a significantly higher rate of complete migraine elimination (67% vs. 52%). Raposio also reported on supraorbital and supratrochlear nerve decompression, achieving a 50% or more significant reduction in migraine attacks in 87% of patients, with minimal complications, mainly paresthesia [8].

3.2 Endoscopic and Transpalpebral Decompression Surgeries

Raposio et al reported that endoscopic or transpalpebral decompression of the supraorbital and supratrochlear nerves led to a 94% positive response among patients with frontal trigger site migraine [16, 20]. Minor complications included postoperative edema and itching. Hagan et al performed bilateral or unilateral transpalpebral decompression with positive outcomes at both 3 and 12 months, though some patients developed complications like persistent swelling, hematoma, and neuroma [19].

3.3 Foraminotomy and Myectomy

Chepla et al analyzed supraorbital foraminotomy in comparison with traditional resection and found statistically significant improvements in migraine frequency and severity among the foraminotomy group [22]. Persistent forehead pain was less common in this group compared to the traditional resection group. Gatherwright et al examined patients undergoing myectomy alone, myectomy with foraminotomy, and arterectomy, with the arterectomy group showing significantly improved frequency and severity of migraines [15].

3.4 Botulinum Toxin and Myotomy

In studies by Guyuron and Janis, endoscopic forehead surgery combined with botulinum toxin A showed favorable outcomes [17, 25]. Guyuron et al observed a 99% positive change, with 64% achieving complete elimination of migraines; minor complications included scalp itching and small hematomas [17]. Janis et al reported that 83.3% of patients experienced an improvement, with significant symptom reduction and no notable complications [25].

3.5 Long-Term Outcomes and Additional Surgical Techniques

Kurlander et al reported on transpalpebral corrugator resection, with 88% of patients achieving positive outcomes [21]. Symptoms such as visual aura and blurred vision resolved postoperatively, though eyelid ptosis occurred in 5.8% of cases. Dirnberger et al reported that 31.7% of patients experienced a 90-100% reduction in headache days, with no significant adverse events noted during follow-up [14].

4. Discussion

This review synthesizes current literature on the surgical treatment of frontal migraine headaches (FMH), highlighting the efficacy of various surgical techniques and comparing these with non-surgical interventions. Also, the main point is that surgical interventions for migraines demonstrated significant symptom reduction, with response rates ranging from 57% to 94% across techniques.

Pharmacological treatments remain the first line of defense against migraines [28]. However, approximately two-thirds of patients with migraines do not respond adequately to these treatments, necessitating alternative approaches. This review underscores that surgical decompression of the supraorbital (SON) and supratrochlear (STN) nerves has shown promising results in patients with FMH who are refractory to medical treatment. For instance, Guyuron et al. demonstrated substantial reductions in migraine duration, frequency, and severity post-surgery [2]. These findings, along with reports from other literature [29-34], indicate that surgical intervention can offer a viable and often superior alternative for patients unresponsive to medication. Similarly, Raposio et al. reported a 94% positive response rate to surgery, with significant improvements or complete relief in most cases [23, 35].

Botulinum toxin has been employed as a diagnostic and therapeutic tool in migraine management. It helps identify trigger points and provides temporary relief, which can guide surgical planning. In 30 randomized controlled trials with 2680 patients, nerve block and surgery significantly reduced headache frequency, while all treatments decreased severity [36-38]. Migraine surgery had the longest-lasting effects at 11.5 months, compared to nerve ablation (6 months), botulinum toxin (3.2 months), and nerve block (11.9 days).

Both endoscopic and transpalpebral approaches aim to alleviate nerve compression by performing selective myotomies. The endoscopic approach is preferred for its minimally invasive nature and has proven effective in relieving symptoms. However, the transpalpebral approach offers better anatomical exposure, particularly for addressing supraorbital nerve (SON) and supratrochlear nerve (STN) vascular compressions. This may contribute to better outcomes in specific cases.

Detailed anatomical evaluation and tailored surgical interventions are crucial for optimizing patient outcomes. The heterogeneity of techniques and outcome measures across studies makes a quantitative synthesis challenging. Variations in patient selection, surgical approach (e.g., endoscopic vs. transpalpebral), and follow-up duration impact results.

Complication rates reported across studies are generally low and include minor, transient symptoms such as numbness, itching, and occasional swelling. While endoscopic approaches are associated with a favorable safety profile, complications like temporary cutaneous numbness and paresthesia in the operated area are reported in transpalpebral approach procedures (Table 1).

Furthermore, more invasive techniques, such as foraminotomy, may have a slightly higher risk of post-surgical numbness or localized discomfort. However, studies like those by Ortiz et al. have shown that these symptoms tend to be resolved without long-term impact [26]. The overall low incidence and mild complications support the safety of these surgical interventions, mainly when performed by experienced surgeons.

4.1 Limitations

Limitations include small sample sizes, lack of randomized controlled trials, varied surgical techniques, short follow-up, subjective outcomes, potential bias, inconsistent complication reporting, and differing diagnostic criteria. These limit generalizability and highlight the need for larger, standardized, long-term studies. One possible limitation of this study is the uncertainty regarding reimbursement for these procedures by national health systems worldwide, which may lead to financial burdens for patients and introduce a conflict of interest not accounted for in the analysis.

5. Conclusion

Different surgical methods for treating frontal trigger site migraines have shown considerable effectiveness, with endoscopic techniques potentially yielding higher success rates. Procedures such as foraminotomy and the use of botulinum toxin A may improve results even further. However, there is a need for multi-center, high-quality, randomized controlled studies to standardize these techniques, evaluate long-term outcomes, and examine the quality of life for patients after surgery.

Author Contributions

SM, AM and GR performed the analysis and wrote the paper, ER supervised the whole project.

Competing Interests

The authors have declared that no competing interests exist.

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