Peripheral Nerve Surgery for Chronic Headache: A Comprehensive Evaluation of Safety and Effectiveness

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Abstract

Objectives Headache, a prevalent chronic neurological disorder, often leads to diminished quality of life and functional impairment in patients unresponsive to pharmacological interventions. Peripheral neurectomy, emerging as a potential surgical solution, addresses trigger points contributing to headaches due to trigeminal autonomic cephalalgias and migraine. This study comprehensively evaluates the effectiveness, functional outcomes, and cost-effectiveness of peripheral neurectomy in chronic or drug-refractory headache patients.

Material and Methods A prospective observational study conducted from December 2019 to May 2023 enrolled 51 patients with chronic or drug-refractory headaches responding positively to a bupivacaine block. Primary outcomes assessed pain reduction using the Migraine Headache Index (MHI) and Visual Analog Scale (VAS). Secondary outcomes included functional improvement (Migraine Disability Assessment [MIDAS] and Pain Self-Efficacy Questionnaire [PSEQ]) and postoperative complications. Patient selection criteria involved a positive response to the bupivacaine block and exclusion for patient refusal.

Results Of the 51 patients, 33.33% achieved complete freedom from headaches, and 62.74% experienced over 70% relief, allowing cessation of prophylactic therapy. Baseline MHI (515.88 ± 242.99) significantly decreased to 4.37 ± 4.02 ($p < 0.001$) and remained low at 3.68 ± 3.60 ($p < 0.001$) during the 6-month follow-up. The VAS scores decreased from 7.16 ± 1.05 to 1.29 ± 0.5 ($p < 0.001$). The MIDAS score decreased from 16.86 ± 6.05 to 0.19 ± 0.44 ($p < 0.001$), and the PSEQ score increased

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from 11.96 ± 5.23 to 55.41 ± 2.15 ($p < 0.001$). Complications included two superficial infections and transient numbness in three patients.

Conclusion Peripheral neurectomy emerges as a valuable option for selected chronic headache patients, offering comprehensive relief and potential economic advantages.

Introduction

Headache is a frequent and chronic neurologic problem. Migraine, characterized by recurrent episodes of pulsating head pain, is a chronic neurological disorder affecting millions worldwide. Patients may also be at risk of increased motor vehicle crashes during the initial years.[1] While a spectrum of pharmacological interventions exists, a significant subset of patients exhibits chronic or refractory headaches. Approximately 80% of patients need lifelong medical consultations for it.[2] These individuals often face diminished quality of life and significant functional impairment due to frequent and severe attacks.[3] Surgical intervention, specifically peripheral neurectomy, has emerged as a potential option for a subset of this patient population, offering long-term relief and restored functionality.[4,5]

The rationale for surgical intervention in drug-resistant or side-effect-intolerant headache patients stems from the recognition of peripheral nerve sensitization as a key contributor to migraine pathophysiology.[6,7] Trigger points, where sensory nerves innervating the head and face become compressed or inflamed, are believed to initiate and propagate the characteristic pain of some headache disorders. Peripheral neurectomy addresses these trigger points by dissecting and decompressing the affected nerves, potentially interrupting the pain cascade and leading to significant long-term improvement.

Trigger point deactivation surgery presents a potential for a definitive cure, eliminating the need for ongoing medication and its associated side effects.[4] Furthermore, the cost-effectiveness of surgery compared with chronic medication warrants consideration. While the upfront cost of surgery may be higher, potentially reduced health care utilization through reduction of hospital visits and medicines and improved productivity over time suggest that it can be financially advantageous in the long run.

Our study aims to comprehensively evaluate the surgical and functional outcomes of peripheral neurectomy in chronic headache patients.

Materials and Methods

This prospective observational study, conducted at a tertiary care center from December 2019 to May 2023, investigated the pain and functional outcomes of trigger-point deactivation surgery in patients with chronic or drug-refractory headache who responded positively to a bupivacaine block.

Primary Outcome

The study's primary aim was to assess the effectiveness of trigger-point deactivation surgery in reducing pain using two validated scales: the Migraine Headache Index (MHI) and the Visual Analog Scale (VAS).

Secondary Outcomes

Secondary outcomes included evaluation of functional improvement utilizing the Migraine Disability Assessment (MIDAS) and the Pain Self-Efficacy Questionnaire (PSEQ), along with recording any complications postsurgery.

Patient Selection

Participants were diagnosed with chronic headache (lasting >3 months) or drug-refractory headache (not responding to standard preventative medications) and experienced temporary pain relief following a bupivacaine block. All patients were taking at least two prophylactic medications (propranolol, flunarizine, divalproex sodium, or sodium valproate). The only exclusion criterion was patient refusal to participate.

Patient Selection

All participants underwent a detailed history and examination. The diagnosis was established according to the criteria of the International Headache Society. A computed tomography/magnetic resonance of the brain was done to rule out secondary causes of headache. ►**Fig. 1** illustrates the patient selection methodology.

Bupivacaine nerve block test: To refine the selection process and identify those most likely to benefit from surgical intervention, we utilized a targeted 0.5% bupivacaine nerve block test. During routine outpatient visits, whenever a headache attack occurred, this local anesthetic was administered at the suspected trigger site. The efficacy of the block was closely monitored throughout its duration (3–8 hours for bupivacaine). A significant reduction in pain intensity and/or duration compared with the participant's typical headache episode constituted a positive response, indicating the potential responsiveness of the identified trigger point to surgical deactivation. This predictive test provided valuable insight, offering a noninvasive means to assess whether surgery would likely offer substantial relief, minimizing unnecessary surgical procedures.

Defining a Positive Response

A stringent criterion was employed to define a positive response to the bupivacaine block. This included a reduction in pain intensity of at least 50% and/or a decrease in headache duration of at least 50% compared with the participant's typical episode.

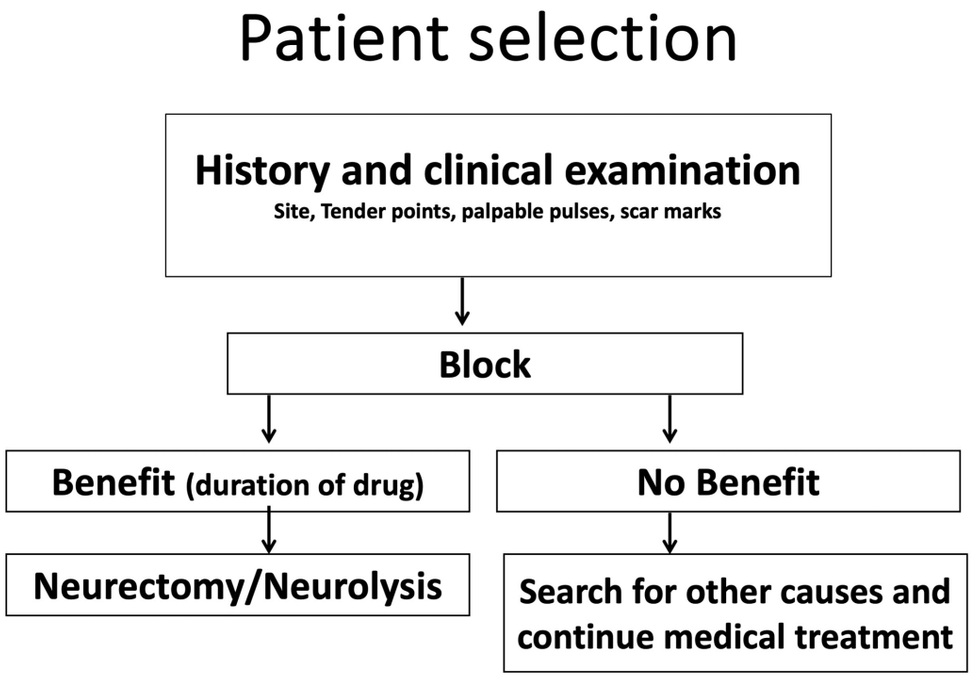

Fig. 1 Flowchart for patient selection.

Assessments

All evaluations throughout the study, including baseline, postoperative, and follow-up assessments, were conducted by an independent individual unaffiliated with the treatment team to remove the bias.

Evaluation

Patients underwent assessments to determine the duration of their symptoms and identify trigger sites. Baseline pain levels were gauged through the assessment of MHI, VAS, and PSEQ scores, while disability was measured using the MIDAS score. The percentage of improvement following bupivacaine block was determined based on the VAS scores. Follow-up assessments at 1 and 6 months utilized the same questionnaires for comprehensive evaluation.

Anesthesia and Surgical Procedure

All patients underwent surgery under local anesthesia to elicit feedback for testing and surgical efficacy

Fig. 2 (**A**) The site for supraorbital and supratrochlear neurectomies marked with a *red line*. (**B**) The site for the zygomaticotemporal nerve 16 mm lateral and 6 mm above the lateral canthus (*marked with blue cross*). It is approached endoscopically by making an incision in the hairs bearing the temporal region (*marked with a green line*). The auriculotemporal neurectomy is in front of the tragus (*marked with red arrow*). (**C**) The sites for lesser occipital neurectomy (*red line*) and greater occipital neurectomy (*green line*).

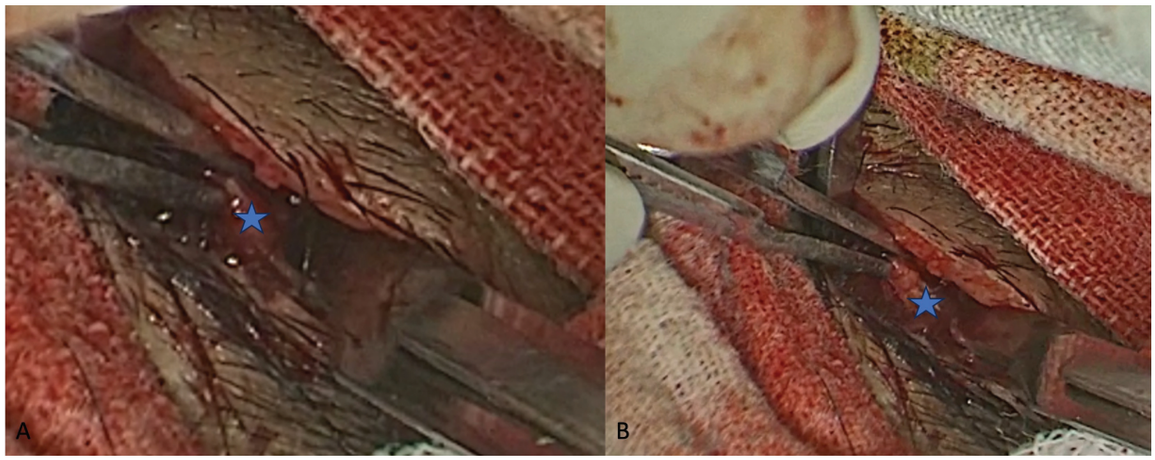

Fig. 3 (A, B) Sequential cutting of supraorbital neurectomy. The nerve is marked with a *blue star*.

intraoperatively. The trigger site was meticulously explored, and neurectomies were performed.

Frontal Site

An incision was made over the supraorbital and supratrochlear nerve sites. This is at the medial one-third of the eyebrow. Both the nerves were lysed in and under the glabellar muscles. ►**Fig. 2A** shows the incision site of supraorbital and supratrochlear neurectomy, and ►**Fig. 3** shows the supraorbital neurectomy.

Temporal Site

Temporal pain occurs because of either the zygomaticotemporal nerve (ZTN) or the auriculotemporal nerve (ATN). The ZTN lies 16 mm lateral and 6 mm cranial to the lateral canthus under the superficial temporal fascia. The incision for the ZTN trigger site is given in the hair-bearing region and the nerve is lysed under endoscopic control. One should avoid injuring the facial nerve branch which courses above the superficial temporal fascia. The ATN courses anterior to the tragus alongside the superficial temporal artery. The incision is given directly over it and the lysis was done. ►**Fig. 2B** shows the incision sites of ZTN and ATN neurectomies, and ►**Fig. 4** shows the endoscopic ZTN neurectomy.

Occipital Sites

The greater occipital nerve lies approximately 1.5 cm lateral to midline, deep to the trapezius fascia. The lesser occipital nerve lies one-third of the distance between the mastoid and external occipital protuberance. The incisions were given directly over them and lysis was done.

Analysis

The data were entered and analysis was done using the Microsoft Excel software. The preoperative and postoperative indices were compared using the paired *t*-test. A *p*-value of less than 0.05 was considered statistically significant.

Results

The study included 51 patients who had a positive response to the bupivacaine block. There were 38 females (13 males), all diagnosed with chronic headaches. The average age of the participants was 29.15 ± 4.14 years. The duration of symptoms varied from 12 to 60 months. Localization was observed in 24 patients on the left, 23 on the right, and 4 bilaterally. Specifically, there were 16 cases of frontal sites, 15 temporal sites, 10 with both frontal and temporal involvement, and 10 with occipital sites.

MHI: The baseline MHI was 515.88 ± 242.99, which significantly decreased to 4.37 ± 4.02 ($p < 0.001$) at 1 month. The effect was also persistent till the last follow-up of 6 months and was 3.68 ± 3.60 ($p < 0.001$).

VAS: The baseline VAS was 7.16 ± 1.05, which significantly reduced to 1.23 ± 0.47 ($p < 0.001$) at 1 month and to 1.29 ± 0.5 at 6 months ($p < 0.001$).

MIDAS: The mean MIDAS score was 16.86 ± 6.05, significantly reducing to 0.19 ± 0.44 ($p < 0.001$) at 6 months.

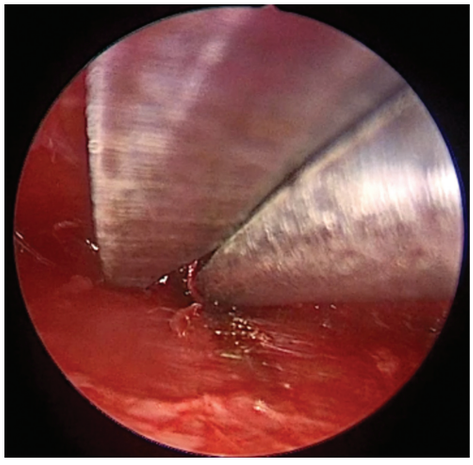

Fig. 4 Endoscopic cutting of the zygomaticotemporal nerve deep to the superficial temporal fascia.

PSEQ score: The mean PSEQ score was 11.96 ± 5.23, significantly increasing to 55.66 ± 2.12 ($p < 0.001$) at 1 month and to 55.41 ± 2.15 ($p < 0.001$) at 6 months.

Headache Freedom

Among the 51 patients in the study at 6 months of follow-up, 17 individuals (33.33%) achieved complete freedom from pain episodes without the need for any medications. For 32 patients (62.74%), there was a substantial relief of more than 70%, leading to the cessation of prophylactic therapy while occasionally using analgesics. Two patients experienced relief at levels of 60 and 70%, but continued to require prophylactic antimigraine therapy.

Complications

Two patients had superficial surgical site infections, which were treated with antibiotics. Three patients had transient numbness in the temporal region that recovered spontaneously.

Discussion

This study aimed to evaluate the efficacy of peripheral neurectomy in patients with chronic headaches who responded positively to a bupivacaine block. The rationale for exploring surgical intervention in this patient population stems from the limited success and adverse effects associated with pharmacological treatments,[8] as well as the potential of peripheral nerve sensitization in headache pathophysiology.[6,7,9] The surgical treatment also offers the potential for long-term relief/cure of the disease,[4] which is lacking with available medical treatment. Surgical treatment has also been found to be more effective than medical treatment[5] and botulinum toxin injections.[10]

The significant reduction in pain intensity, as reflected by the MHI and VAS scores, highlights the positive impact of peripheral neurectomy. These improvements persisted over the 6-month follow-up period, reinforcing the potential for long-term relief offered by surgical intervention. The notable reduction in the MIDAS scores further supports the functional benefits of surgery, with patients experiencing substantial improvements in their ability to carry out daily activities. The PSEQ results reveal a significant increase in patients' confidence in managing pain postoperatively. This improvement in self-efficacy is a crucial aspect of overall well-being, emphasizing the holistic benefits of surgical intervention beyond pain reduction alone.

The observation that 33.33% of patients achieved complete freedom from headaches without the need for any medications is particularly promising. For the majority (62.74%), there was a substantial relief of more than 70%, allowing discontinuation of prophylactic therapy while occasionally using analgesics. These findings underscore the potential of peripheral neurectomy to offer a definitive cure, alleviating the need for ongoing medication and its associated side effects.

While two patients experienced relief at levels of 60 and 70% but continued to require prophylactic therapy, this subset highlights the variability in individual responses to surgical intervention. It emphasizes the importance of patient selection based on rigorous criteria, such as the positive response to the bupivacaine block utilized in our study.

The reported complications, including superficial surgical site infections and transient numbness, are relatively minor and manageable. These findings align with the existing literature on the safety profile of peripheral neurectomy, emphasizing its feasibility as a surgical option.

The economic considerations in headache management are paramount, particularly given the costliness of both medical therapy and botulinum toxin treatments.[11] These recurrent, often lifelong, treatments can pose a substantial financial burden on patients and health care systems. Not only does this surgical intervention offer long-term relief for a significant subset of patients but also the upfront costs may be outweighed by the potential reduction in health care utilization,[11] particularly when conducted under local anesthesia, and improved productivity over time. By providing a potentially definitive cure and minimizing the need for ongoing and costly medications, peripheral neurectomy stands out as a promising and economically viable option in the comprehensive management of headaches.

The surgical procedure is aesthetically satisfactory, as all scars are concealed within hair-bearing regions. The frontal incision is discreetly placed within the eyebrow, the ATN incision is situated in the hair-bearing area anterior to the tragus, and the occipital incision encompasses both greater and lesser occipital sites at the back of the head. For the ZTN site, endoscopic surgery is required, involving an incision made discreetly behind the hairline.

Our study contributes to the growing body of evidence supporting the role of peripheral neurectomy in the management of chronic or drug-refractory headaches.[4,5,11] A recent multicenter study comparing peripheral point deactivation and Botulinum toxin injections for headache management found both treatments effective. However, the peripheral deactivation arm showed lower pain intensity and work-related disabilities compared with the Botulinum toxin arm, highlighting its potential as a favorable alternative for long-term relief.[10]

Our study has a few limitations, which should be acknowledged, including the relatively small sample size and the single-center nature of the study. Further research with larger cohorts and multicenter collaborations is warranted to validate our findings and explore the long-term outcomes and cost-effectiveness of this surgical approach.

Conclusion

Peripheral neurectomy can be a valuable and effective option for carefully selected patients suffering from chronic or drug-refractory headaches. The improvements in pain, functionality, and medication independence observed in our study underscore the potential benefits of surgical intervention in this challenging patient population.

Institutional Review Board Permission

Approval for the study was obtained from the institutional review board.

Funding
None.

Conflict of Interest
None declared.

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