Pain Medicine, 2024, **25**, 334–343
https://doi.org/10.1093/pm/pnad154
Advance access publication 23 November 2023
Original Research Article

OXFORD

NEUROMODULATION & MINIMALLY INVASIVE SURGERY SECTION

Treatment delay from onset of occipital neuralgia symptoms to treatment with nerve decompression surgery: a prospective cohort study

Merel H.J. Hazewinkel, MD[1], Katya Remy, MD[2], Grant Black[1], Sierra Tseng[2], Paul G. Mathew, MD[3,4,5], Anna Schoenbrunner, MD[6], Jeffrey E. Janis, MD[6], William G. Austen Jr., MD[2], Rohan Jotwani, MD[7], Lisa Gfrerer, MD, PhD[1,*]

[1]Department of Plastic and Reconstructive Surgery, Weill Cornell Medicine, New York, NY 10065, United States
[2]Department of Plastic and Reconstructive Surgery, Massachusetts General Hospital, Harvard Medical School, Boston, MA 02114, United States
[3]Harvard Medical School, Boston, MA 02115, United States
[4]Department of Neurology, Mass General Brigham Health, Foxborough, MA 02035, United States
[5]Department of Neurology, Harvard Vanguard Medical Associates, Braintree, MA 02184, United States
[6]Department of Plastic and Reconstructive Surgery, The Ohio State University Wexner Medical Center, Columbus, OH 43210, United States
[7]Department of Anesthesiology, Weill Cornell Medicine, New York, NY 10065, United States

*Corresponding author: Department of Plastic and Reconstructive Surgery, Weill Cornell Medicine, 425 East 61st Street, New York, NY 10065, USA. Email: lisa.gfrerer@gmail.com

Abstract

Background: The aims of this study were to (1) evaluate the time between onset of occipital neuralgia symptoms and nerve decompression surgery, (2) perform a cost comparison analysis between surgical and nonsurgical treatment of occipital neuralgia, and (3) report postoperative results of nerve decompression for occipital neuralgia.

Methods: Subjects ($n = 1112$) who underwent screening for nerve decompression surgery were evaluated for occipital neuralgia. Of those, 367 patients (33%) met the inclusion criteria. Timing of occipital neuralgia symptom onset and pain characteristics were prospectively collected. Cost associated with the nonsurgical treatment of occipital neuralgia was calculated for the period between onset of symptoms and surgery.

Results: A total of 226 patients (73%) underwent occipital nerve decompression. The average time between onset of occipital neuralgia and surgery was 19 years (7.1–32). Postoperatively, the median number of pain days per month decreased by 17 (0–26, 57%) ($P < .001$), the median pain intensity decreased by 4 (2–8, 44%) ($P < .001$), and median pain duration in hours was reduced by 12 (2–23, 50%) ($P < .001$). The annual mean cost of nonsurgical occipital neuralgia treatment was $28 728.82 ($16 419.42–$41 198.41) per patient. The mean cost during the 19-year time frame before surgery was $545 847.75($311 968.90–$782 769.82).

Conclusion: This study demonstrates that patients suffer from occipital neuralgia for an average of 19 years before undergoing surgery. Nerve decompression reduces symptom severity significantly and should be considered earlier in the treatment course of occipital neuralgia that is refractory to conservative treatment to prevent patient morbidity and decrease direct and indirect health care costs.

Keywords: occipital neuralgia; headache; migraine; treatment delay; nerve decompression surgery.

Introduction

Surgical nerve decompression is performed routinely throughout the body for the treatment of sensory or motor deficits, as well as for chronic pain when symptoms of nerve compression are present on physical exam.[1] Patients with occipital neuralgia (ON) experience known symptoms of nerve compression, including shooting, stabbing, or sharp pain in the distribution of the greater occipital nerve (GON), the lesser occipital nerve, or the third occipital nerve; tenderness to palpation; and dysesthesia that can transiently improve with injection of local anesthetic.[2] In a recent prevalence study, it was found that up to 25% of patients presenting to a headache specialty clinic with a chief complaint of headache also had a coexisting diagnosis of ON.[3]

In cases of ON refractory to optimal medical management (including physical therapy, medications, botulinum toxin injections, and anesthetic nerve blocks), surgical decompression is a low-risk outpatient surgery that has been shown to be effective.[4,5] However, in clinical practice, surgical management is not routinely considered as part of the ON treatment algorithm. This results in prolonged periods of ineffective treatment, as well as patient morbidity and significant health care costs.

Despite the disabling nature of refractory ON, there are no published data on the time between onset of ON symptoms and nerve decompression surgery or on the economic burden of refractory ON on the health care system and society.

The aims of this study were to (1) evaluate the time between onset of ON symptoms and nerve decompression surgery, (2) perform a cost comparison analysis between surgical and nonsurgical treatment of ON, and (3) report postoperative results of nerve decompression surgery for ON.

Received: 21 August 2023. **Revised:** 16 October 2023. **Accepted:** 10 November 2023

Methods

This institutional review board (IRB)–approved multicenter prospective study was conducted at Massachusetts General Hospital (IRB #2012P001527) and Weill Cornell Medical Center (IRB #23-04025985). Patients ($n = 1112$) were screened for pericranial nerve decompression at the Division of Plastic and Reconstructive Surgery in the two participating centers between September 2012 and November 2022. Inclusion criteria included a diagnosis of ON according to The International Classification of Headache Disorders 3rd edition (ICHD-3) criteria.[6] Exclusion criteria included inability to provide informed consent and incomplete data on the timing of onset of ON symptoms. Verbal informed consent was obtained from all patients.

Screening for ON decompression surgery was performed by authors L.G. and W.G.A. and included (1) history and exam findings consistent with ON, (2) pain relief with occipital nerve blocks, (3) pain drawings suggestive of anatomically consistent nerve pain, and (4) confirmation of failure of conservative management. Table 1 lists screening criteria for occipital nerve decompression surgery. L.G. and W.G.A. performed all nerve blocks and surgical procedures. All surgeries were outpatient procedures performed at an accredited surgery center. Patient data were prospectively collected in Redcap (version 8.1.20; Vanderbilt University, Nashville, TN, United States). Patient surveys were administered preoperatively and postoperatively at 3 months, 12 months, and every year thereafter. Patient data were recorded, including demographic information, timing of ON symptom onset, previous treatments, work status, preoperative and postoperative pain frequency (pain days per month), preoperative and postoperative pain intensity (scale of 0–10), and preoperative and postoperative pain duration (in hours). Pain duration included steady baseline pain in the occiput with superimposed lancinating stabs of pain in the distribution of the GON, lesser occipital nerve, or third occipital nerve. Data on emergency department visits, imaging, and office visits to specialties for headache complaints were retrospectively collected. 3. All charts were reviewed from the start of onset of ON symptoms to surgery. The primary endpoint was the number of years between onset of ON symptoms and nerve decompression surgery. The secondary endpoints were (1) a cost comparison analysis between surgical and nonsurgical treatment of ON and (2) the postoperative results of nerve decompression surgery, which were quantified by the differences in preoperative and postoperative pain frequency (pain days per month), intensity (scale of 0–10), and duration (in hours), as well as the percentage of improvement in ON pain.

Table 1. Occipital nerve decompression surgery patient criteria.

A. Diagnosis of ON according to the ICHD-3[6]
B. Failure of conservative treatment, including physical therapy, preventive medication, botulinum toxin, and large-volume nerve blocks (6 cc per side)
C. Pain diaries, pain drawing, and demarcation of pain point with one finger, which should be in the distribution of the GON, LON, or TON
D. Positive response to diagnostic nerve block[31]
E. MRI cervical spine negative for spine pathology requiring intervention
F. +/– positive doppler signal[32]

Abbreviations: ICHD-3= International Classification of Headache Disorders 3rd edition; ON= occipital neuralgia; GON= greater occipital nerve; LON= lesser occipital nerve; TON= third occipital nerve.

Surgical technique

A vertical midline incision within the hairline was used, and the dissection was carried down to the midline raphe. The subcutaneous tissue was elevated off the trapezius fascia on both sides. An incision was made near the raphe through the trapezius fascia. The GON, which is typically located 3 cm distal to the occipital protuberance and 1.5 cm lateral to the midline, was identified. A thorough neurolysis was performed up to the nuchal ridge. At the nuchal ridge, the occipital artery was separated from the GON (if an interaction was present), and an arterectomy was performed. If an enlarged lymph node was present, the lymph node was removed. The nerve was then released toward its subcutaneous attachments. A trapezius fascia cuff was removed at the entrance of the nerve into the trapezial tunnel. If present, fascial bands of the semispinalis capitis muscle and obliquus inferior muscle were also released. After this, the lesser occipital nerve was identified, and a neurolysis was performed. In early cases (2012–2020), an inferiorly based subcutaneous fat flap was placed between the nerve and muscle. In later cases (2020–2023), the GON was buried under either the semispinalis capitis muscle or the trapezius muscle. Finally, layered closure was performed (Figure 1).

Cost analysis

To calculate the direct cost associated with the nonsurgical treatment of ON, health care utilization was calculated for the average time period between onset of ON symptoms and ON decompression surgery. The following variables were included in the analysis: oral medications, nonsurgical treatments, office visits to neurology, office visits to other specialties for headache complaints, hospitalizations, imaging, and emergency department visits. Complete prospective data on the number of botulinum toxin and nerve block injections were available for 32 patients treated longitudinally by neurology and pain management at the two institutions.

Unit cost for each variable was approximated from the literature.[7–13] The quantity of each variable either was calculated or was approximated from the literature.[13–17] The quantity of each variable was multiplied by its utilization among the patients in our cohort. After this, unit costs were applied to each variable. The cost associated with oral medication was extracted from the literature.[18] Finally, total direct cost was calculated across all variables. For the analysis of indirect cost, the number of patients with long-term disability and the number of patients with work absence, including the number of days absent per month, were extracted from our patient surveys. We assumed that patients with long-term disability missed 260 days of work, which is equal to the total working days per year. The average annual work absence days were calculated. The total missed working days per year were multiplied by the average hourly wage of \$33.46, which is an estimate reported by the US Bureau of Labor Statistics.[19] We assumed that employers typically pay 100% of wages for work absence and 70% for long-term disability. All costs are reported in US dollars according to 2022 prices.

Data analysis

Data were analyzed with RStudio (2020) (Integrated Development for R., RStudio, PBC, Boston, MA, United States). Categorical variables were described with frequencies and percentages. We described continuous variables with

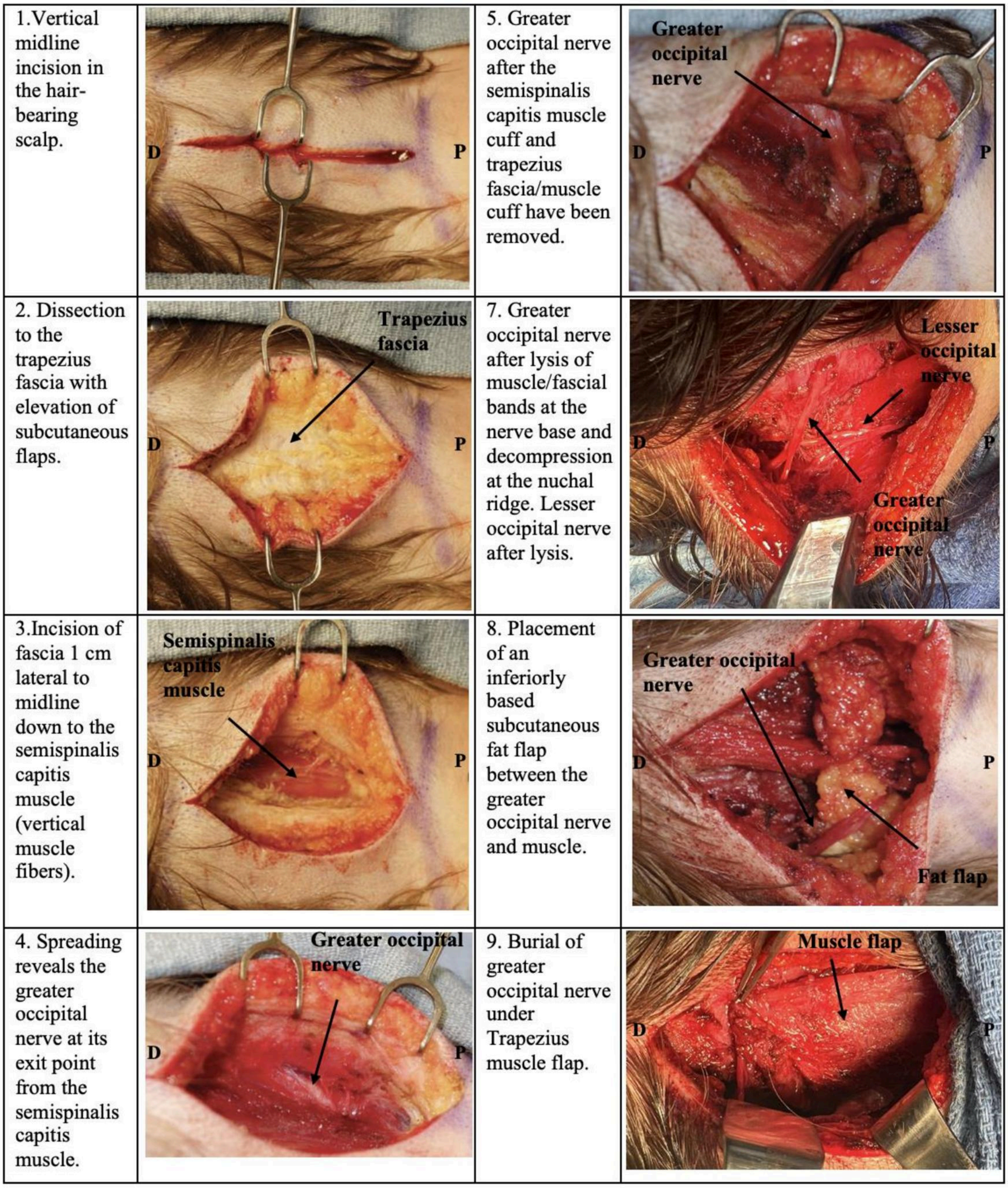

Figure 1. Technical details of greater and lesser occipital nerve decompression. This figure was based on Gfrerer et al. (2021).[49] Permission was obtained.

normal distribution using means and standard deviations, whereas continuous variables with a non-normal distribution were described with medians and interquartile ranges. Missing data were reported as frequency counts. Continuous variables were analyzed with the Wilcoxon signed-rank test. A *P* value of <0.05 was considered significant.

Results

Demographics

A total of 367 patients (33%) with ON met the inclusion criteria (see Figure 2). The diagnosis of ON was made by a neurologist in 84% of the patients and by a peripheral nerve surgeon in 16% of patients. See Table 2 for demographic data. The average patient age at the time of screening was 45 (±14) years, and the average age of ON symptom onset was 24 (±15) years. A total of 351 patients (96%) were diagnosed with at least one concomitant headache disorder, including chronic migraine (255 patients, 73%), cluster headache (34 patients, 9.7%), trigeminal neuralgia (10 patients, 2.7%), cervicogenic headache (8 patients, 2.3%), and post-traumatic headache (5 patients, 1.4%). More than half of the patients (183 patients, 52%) had a history of head or neck injury.

ON characteristics

Preoperatively, the median number of pain days was 30 days per month (22–30), the median time spent in pain per day was

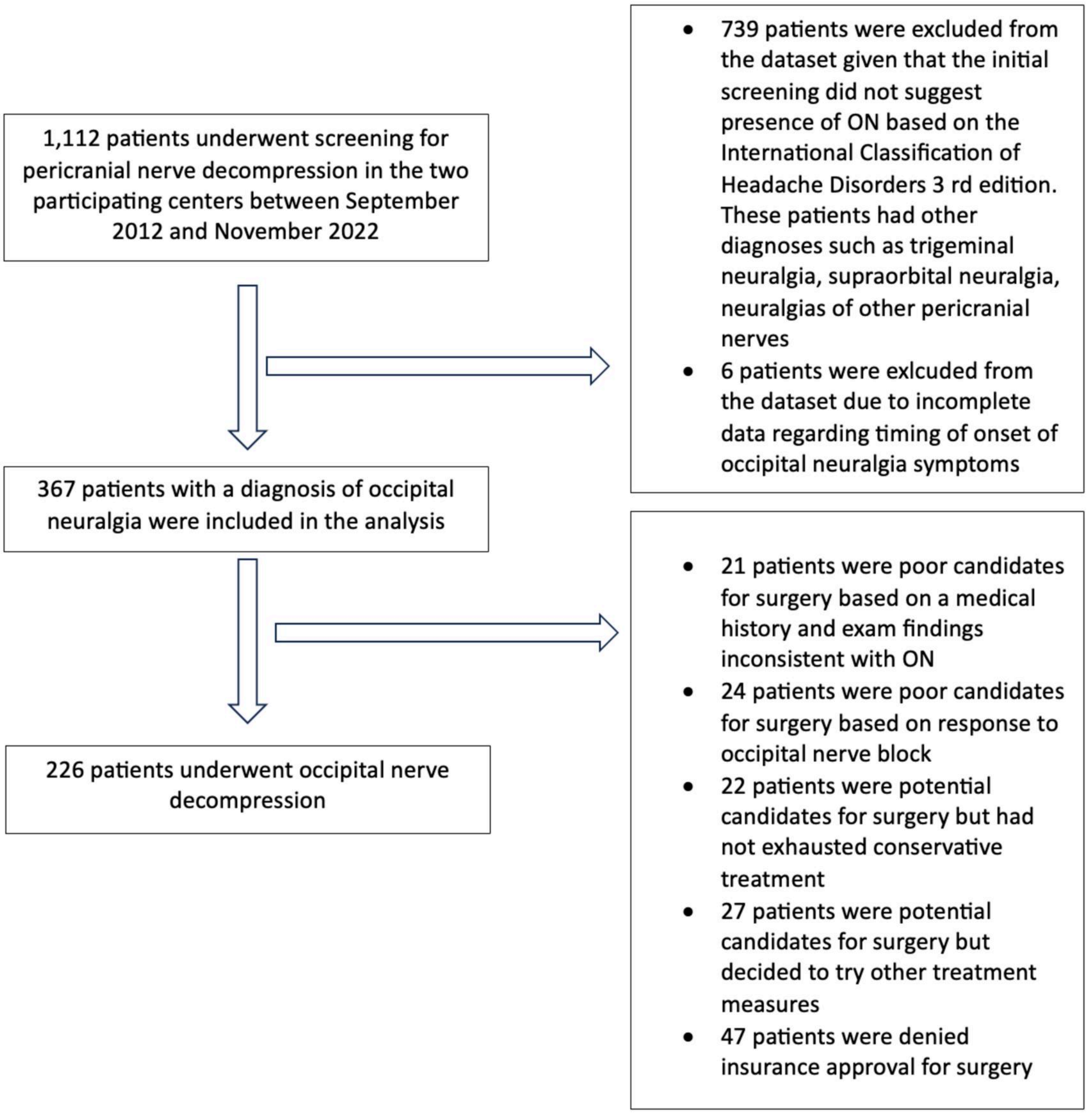

Figure 2. Flow chart of patient inclusion.

Table 2. Demographics.

Variable	All patients ($n = 367$)
Age, mean±SD, years	45±14
Female sex, *n* (%)	287 (78)
Race, *n* (%) [a]	
White	296 (95)
Asian	3 (1.0)
American Indian / Alaska Native	3 (1.0)
Other	12 (3.8)
Working status, *n* (%) [b]	
Employed	257 (75)
Disabled	57 (17)
Retired	26 (7.6)
Age at pain onset, mean±SD, years	24±15

Abbreviation: SD= standard deviation.
[a] 54 missing values.
[b] 26 missing values.

20 (10–24) hours, and the median pain intensity was 9.0 (8.0–10.0). ON pain was bilateral in 239 patients (65%) and unilateral in 128 patients (35%). See Table 3 for ON characteristics.

ON treatment and workup before surgery

Preoperatively, all patients (100%) trialed at least 3 different pharmacological classes of medications, including abortive and preventive drugs. At the time of surgery, 254 patients (74%) were using preventative medications, 221 (64%) were using abortive medications, and 131 (38%) were using opioid medications for abortive therapy.

All patients underwent nerve block injections (100%), and 284 patients (77%) underwent injection with botulinum toxin. Furthermore, additional treatments included acupuncture therapy ($n = 101$, 28%), physical therapy ($n = 83$, 23%), chiropractic therapy ($n = 62$, 17%), and radiofrequency ablation ($n = 37$, 10%) (Table 4). The majority of the patients ($n = 257$, 70%) underwent diagnostic imaging, including MRI of the head and/or neck ($n = 184$, 60%), CT scan of the head and/or neck ($n = 125$, 41%), cervical X-ray ($n = 25$, 8.1%), and ultrasound of the affected nerve(s) ($n = 13$, 4.0%). Twenty percent of the patients presented to the emergency department for headache complaints. The average number of emergency department visits was 0.6 (±1.8).

Table 3. ON characteristics.

Variable	All patients ($n = 367$)
Laterality, *n* (%)	
Bilateral	239 (65)
Unilateral	128 (35)
Quality, *n* (%)	
Ache/pressure	255 (69)
Throbbing/pounding	277 (75)
Lancinating, electric, shooting, stabbing, sharp	162 (44)
Like a tight band	147 (40)
Dull	54 (15)
Constricting, squeezing	31 (8.4)
Dysesthesia and/or allodynia and/or tenderness to palpation, *n* (%)	367 (100)

Abbreviation: ON= occipital neuralgia.

Table 4. Treatment delay.

Variable	All patients ($n = 367$)
Number of different specialties visited, mean±SD [a]	3±1.5
Number of different treatments received, *n* (%)	
2	49 (14)
3	162 (44)
4	72 (20)
>4	84 (23)
Type of treatment received, *n* (%)	
Oral medication	367 (100)
Nerve blocks injection	367 (100)
Injection with botulinum toxin	284 (77)
Acupuncture	101 (28)
Physical therapy	83 (23)
Chiropractic therapy	62 (17)
Radiofrequency ablation	37 (10)
Nerve stimulation	18 (4.9)
Neuro/biofeedback	18 (4.9)
Medication use, *n* (%) [b]	
Anti-inflammatory medication	198 (58)
Preventive medication	254 (74)
Abortive medication	221 (64)
Opioid medication	131 (38)
Nerve medication	149 (43)
Antiemetic medication	221 (64)

Abbreviation: SD= standard deviation.
[a] 59 missing values.
[b] 23 missing values.

Time to nerve decompression surgery

The median time between onset of ON symptoms and screening for nerve decompression surgery was 18 years (6.8–31). The median time between onset of ON symptoms and occipital nerve decompression surgery was 19 years (7.1–32).

Surgical outcome

After screening, 226 (73%) patients were considered good candidates for surgery and underwent occipital nerve decompression (ie, greater occipital nerve decompression, lesser occipital nerve decompression, or both) (see Figure 2).

The average time of postoperative follow-up was 9.1 (± 6.6) months. The median number of pain days per month decreased by 17 days (0–26, 57%) ($P < .001$), the median pain intensity decreased by 4 (2–8, 44%) ($P < .001$), and the median pain duration in hours decreased by 12 hours (2–23, 50%) ($P < .001$).

Fifty-eight patients (30%) reported 100% resolution of their ON pain. Sixty patients (31%) reported 80% or more improvement of their ON pain, 32 patients (17%) reported 50% or more improvement of their ON pain, 17 patients (8.8%) reported 20% or more improvement of their ON pain, and 26 patients (13%) reported 20% or less improvement of their ON pain (Table 5).

Cost analysis

The annual mean direct cost of nonsurgical ON treatment was $14 209.88 ($4994.70–$23 425.06) per patient. The primary expenditure was nerve block injections, which accounted for 38% ($5418.11) of direct nonsurgical ON treatment cost. This was followed by injection with botulinum toxin ($4537.68, 32%), oral medication ($2713.00, 19%), and neurology office visits ($560.90, 3.9%) (Table 6). The annual mean indirect cost of nonsurgical treatment was $14 518.95 ($11 424.72–$17 773.35) (Table 7). Work absence accounted for 63% ($9160.00) of the indirect costs, and long-term disability accounted for 37% ($5358.95) of the indirect costs. In total, the annual mean direct and indirect costs resulted in $28 728.82 ($16 419.42–$41 198.41) per patient. In comparison, ON decompression surgery, with an average cost of $12 000.00, is equal to 5.01 months of nonsurgical ON treatment.[20] The cost of nonsurgical ON treatment for the average period between onset of ON symptoms and nerve decompression surgery was $545 847.75 ($311 968.90–$782 769.82).

Discussion

In cases of ON refractory to medical management, nerve decompression surgery has been shown to be safe and effective.[4,5,21] However, in clinical practice, nerve decompression is not routinely considered as part of the ON treatment algorithm of non-surgeons. In the present study, we evaluated the time between onset of ON symptoms and nerve decompression surgery. We found that (1) on average, patients underwent decompression surgery 19 years after onset of ON symptoms; (2) the annual mean cost of nonsurgical ON treatment was $28 728.82, and the cost for the 19-year time frame before surgery was $545 847.75; and (3) patients with ON benefited from nerve decompression surgery.

Treatment delay

In this cohort, patients suffered from ON for an average of 19 years before undergoing nerve decompression surgery. During that time, patients visited multiple specialists, visited the emergency room repeatedly, underwent a variety of imaging studies, and trialed numerous treatment modalities. This delay in surgical intervention not only negatively impacts patient quality of life, including the ability to maintain gainful employment and participate in life events, but also increases avoidable health care costs.

The cause of delay in surgical treatment of ON is multifactorial.

First, the clinical diagnosis of ON is challenging. The ICHD-3 has defined a specific set of diagnostic criteria for ON, including pain that is shooting, stabbing, or sharp in quality; tenderness upon pressure over the nerve; and improvement of symptoms with nerve blocks.[6] Our group has shown that patients diagnosed with ON by board-certified headache specialists demonstrated the majority of symptoms outlined in the ICHD-3 criteria but also reported additional symptoms, making the diagnosis difficult.[22] For example, besides experiencing short paroxysmal attacks of pain lasting from a few seconds to minutes, patients presented with a baseline steady achy pain in the same distribution as the superimposed lancinating pain. Furthermore, allodynia, a required criterion according to the ICHD-3, was present in only 80% of the patients.[22] These findings demonstrate that patients diagnosed with ON often exhibit symptoms beyond those outlined in the current ICHD-3 criteria.

Second, the diagnosis of ON can be complex because of symptom overlap with several other headache disorders.[23] In our study cohort, 96% of patients were diagnosed with concomitant headache disorders, including chronic migraine (73%), cluster headache (9.7%), trigeminal neuralgia (2.7%), cervicogenic headache (2.3%), and post-traumatic headache (1.4%). This overlap in headache disorders complicates the differential diagnosis. For example, a patient with throbbing frontal headaches with photophobia, phonophobia, and nausea would likely be diagnosed with migraine, but the physician might not ask additional questions or perform physical examination maneuvers that would suggest the coexistence of ON. One such maneuver is an occipital Tinel's sign, which is positive in 75% of ON cases.[8] Interestingly, although only 1.4% of patients had a diagnosis of post-traumatic headache, we found that 52% of the patients had a history of head or neck injury. A high occurrence of head and neck injury has also been reported in previous publications, but this association has not been further investigated.[24] In the present study, the onset of ON symptoms occurred on average at age 24 years, a notably younger age than that reported in epidemiological studies of ON, which report age of ON symptom onset ranging from 37 to 54 years.[25–27] In our cohort, the percentage of patients who experienced head or neck injuries is high (52%) and could explain the observed young age of ON symptom onset in our study.

Third, no criteria have been established to define when referral for nerve decompression surgery is indicated. Our group has formulated a set of criteria for candidacy for occipital nerve decompression.[22]

Candidacy criteria

1) The patient should have an accurate diagnosis of ON based on the ICHD-3 criteria, with the understanding that many patients do not exhibit all of the ICHD-3 symptoms or experience additional symptoms.[6]

Table 5. Postoperative outcomes.

Variable	All patients ($n = 226$)	*P* value
ON pain characteristics, median (IQR) [a]		
Decrease of pain frequency, days per month	17 (0–26)	<.001*
Decrease of pain duration, hours	12 (0–23)	<.001*
Decrease of pain intensity, 0–10	4 (2–8)	<.001*
Percent improvement in ON pain, *n* (%) [b]		
≥80%	118 (61)	
≥50%	32 (17)	
≥20%	17 (8.8)	
≤20%	26 (13)	

Abbreviations: IQR= interquartile range; ON= occipital neuralgia.
* Using Wilcoxon signed-rank test +.
a 27 missing values.
b 32 missing values.

Table 6. Cost analysis.

Variable	Unit costs	Quantity (per 19 years) [a]	Utilization (per 19 years)	Total (average)	Range: Minimum	–	Maximum
Oral medication	$2713	19	100% [a]	$51 547.00			
Injection with botulinum toxin	$610–$6176	33 [a,c]	77% [a]	$ 86 216.13	156 932.16	–	156 932.16
Nerve block injection	$252–$4324	45 [a,c]	100% [a]	$102 960.00	194 580.00	–	194 580.00
Acupuncture	$50–$150	6 [b]	28% [a]	$168.00	252.00	–	252.00
Physical therapy	$30–$400	11.25 [b]	23% [a]	$ 556.31	1035.00	–	1035.00
Chiropractic therapy	$50–$250	8 [b]	17% [a]	$204.00	340.00	–	340.00
Radiofrequency ablation	$2618–$5267	7.5 [b]	10% [a]	$2956.88	3950.25	–	3950.25
Neuro/biofeedback	$125–$160	35 [b]	4.9% [a]	$244.39	274.40	–	274.40
Transcutaneous electrical nerve stimulation	$20–$100	10 [b]	4.9% [a]	$29.40	49.00	–	49.00
Office visit, new patient, neurology	$170–$220	1 [a]	100% [a]	$195.00	220.00	–	220.00
Office visit, established patient, neurology	$122–$157	75 [b]	100% [a]	$10 462.50	11 775.00	–	11 775.00
Office visit, new patient	$251–$510	3 [a]	100% [a]	$1141.50	1530.00	–	1530.00
Office visit, established patient	$159–$419	6 [a]	100% [a]	$1734.00	2514.00	–	2514.00
Inpatient hospitalization after emergency department visit	$7135–$7499	2 [a]	11% [a]	$1609.74	1649.78	–	1649.78
MRI head/neck	$500–$11 800	2 [a]	60% [a]	$7380.00	14 160.00	–	14 160.00
CT head/neck	$1000–$9300	1 [a]	40% [a]	$2060.00	3720.00	–	3720.00
Ultrasound	$140–$350	1 [a]	4.0% [a]	$9.80	14.00	–	14.00
Cervical X-ray	$90–$220	1 [a]	25% [a]	$38.75	55.00	–	55.00
Emergency department visit	$768–$782	3 [a]	20% [a]	$474.30	478.58	–	478.58
Total				$269 987.70	94 899.22	–	445 076.17
Total per year				$14 209.88	4994.70	–	23 425.06

a Calculated from cohort data ($n = 367$).
b Approximated from literature.[13–17]
c Complete prospective data on the number of botulinum toxin and nerve block injections were available for 32 patients treated longitudinally by neurology and pain management at the two institutions.

Table 7. Annual indirect cost.

Variable	Days missed, average (SD)	%	Hourly wage, average (SD)	Total cost [a]	Range Minimum	–	Maximum
Long-term disability, not able to work	260 [b]	11% [a]	$33.46 (7.5) [b]	$5358.95	$4317.91	–	$6560.15
Work absence	58 (7.9) [a]	59% [a]	$33.46 (7.5) [b]	$9160.00	$7106.81	–	$11 213.20
Total				$275 860.05	$217 069.68	–	$337 693.65
Total per year				$14 518.95	$11 424.72	–	$17 773.35

Abbreviation: SD= standard deviation.
[a] Calculated from cohort data ($n = 367$).
[b] Approximated from literature.[19]
We assumed that employers typically pay 100% of wages for work absence and 70% for long-term disability.

2) The patient should have failed conservative treatment, including physical therapy, medications, botulinum toxin injections, and large-volume nerve blocks.

3) The patient should be able to easily identify the maximum pain point by pointing with an index finger and should have completed pain diaries and pain drawings that corroborate the history and physical examination. It has been shown that patient pain drawings can predict poor outcomes in headache surgery.[28] A typical ON pain drawing depicts the origin of the pain at the skull base, with superior radiation toward the apex / forehead / behind the eye (GON) or toward the ear/temple (lesser occipital nerve) or along the posterior midline (third occipital nerve) (see Figure 3).[29]

4) The administration of a diagnostic nerve block (0.5–1 cc per nerve) should yield at least temporary relief from pain. Research has demonstrated that a positive response to nerve blocks (defined by at least a 50% reduction in intensity) provides a reliable indication of the success of decompression surgery in treating ON, with a positive predictive value of 0.89.[30] A subsequent prospective cohort study revealed improved postoperative results among patients with relative pain reduction of >60% after a nerve block and among patients with a nerve block response of ≥24 hours.[31]

5) The MRI Cervical spine should be negative for spine pathology requiring proximal intervention.

6) In some but not all cases, the presence of a positive Doppler signal might suggest nerve compression by a vessel (Table 1).[32]

Finally, although occipital nerve decompression surgery was introduced in the early 2000s, surgical treatment is not well known among non-surgeons treating patients with ON, and further education is required to integrate surgical strategies into the treatment algorithm. Multiple studies have been published that report the anatomy of the occipital nerves and identify potential sites of compression that could be addressed through surgery.[29,33,34] In addition, international studies have confirmed good outcomes after nerve decompression, and by approximately 2005, nerve decompression gained considerable acknowledgment as a therapeutic strategy for occipital compression.[35–37] This was substantiated by a series of clinical studies that were performed by Guyuron et al., including a placebo-controlled surgical trial, reporting the efficacy and safety of occipital nerve decompression.[5,38–40]

Nerve decompression for ON, similar to other nerve decompressions, is a low-risk outpatient surgery that has been associated with few adverse events. A recent systematic review assessed the adverse effects after nerve decompression surgery and reported that the most frequently reported adverse events include transient paresthesia and numbness (12.1%), itching (4.9%), hypersensitivity (1.8%), and neck stiffness (1.7%).[41]

Direct and indirect health care costs

We found that the annual mean cost of nonsurgical ON treatment was $28 728.82 and that the cost for the average period between onset of ON symptoms and nerve decompression surgery was $545 847.75. Direct health care costs accounted for 49% of the total cost. The primary expense was attributed to nerve block injections, which accounted for 38% of the total direct costs. A response to nerve blocks is part of the ICHD-3 diagnostic criteria for ON. Literature shows that nerve blocks can provide prolonged relief lasting for weeks to months.[42] As such, nerve blocks can serve as an option for preventive treatment, as well.[43] However, our results show that this treatment strategy is associated with high costs, and long-term injection might not be an economical treatment strategy for patients with chronic ON.

Another substantial expenditure was injection with botulinum toxin. Schoenbrunner et al.[20] performed a cost-effectiveness study to determine the cost-effectiveness of long-term injections with botulinum toxin versus nerve decompression surgery for the treatment of headaches. The authors concluded that nerve decompression surgery is more effective and less costly than long-term injections with botulinum toxin over the course of a patient's lifetime. As a result, they recommended early consideration of nerve decompression surgery for patients experiencing refractory headaches as a means to reduce health care expenses.[20]

The indirect cost of nonsurgical ON treatment was $14 518.95, attributed to work absence (63%) and long-term disability (37%). Diminished on-the-job performance was not included in our analysis because of insufficient data. However, is it widely known that headache disorders are a major cause of reduced work performance.[44] In the Eurolight study, the authors report that two-thirds of the indirect costs of migraine were attributable to reduced productivity.[45] This shows that the indirect cost presented in our study is likely an underestimate of the total indirect cost of nonsurgical ON treatment.

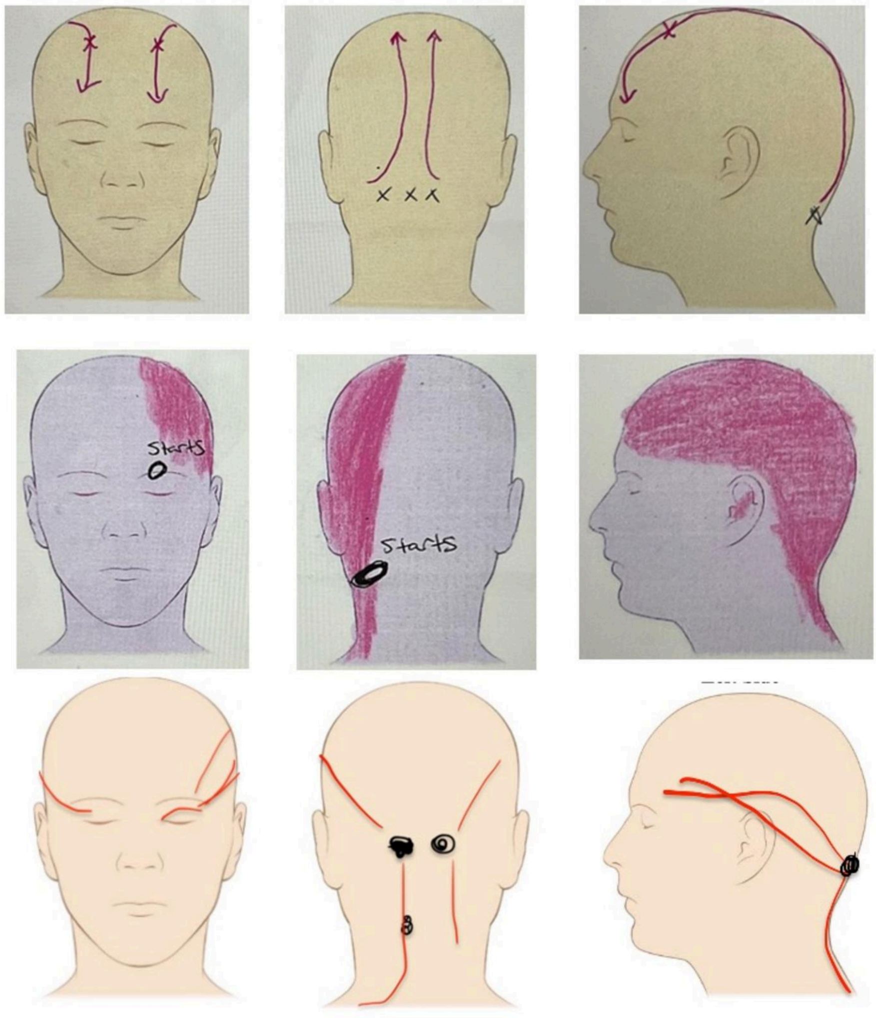

Figure 3. Pain drawings made by patients preoperatively showing pain along the trajectory of the occipital nerves.

Surgical outcomes

In this study, 30% of the patients reported 100% resolution of their ON pain, 31% of the patients reported 80% or more improvement, 17% of the patients reported 50% or more improvement, 8.8% of the patients reported 20% or more improvement, and 13% of the patients reported 20% or less improvement. Given that the majority of patients (78%) improved their symptoms >50%, the annual mean cost of treating lingering postoperative ON symptoms is significantly less than the nonsurgical ON treatment cost in the surgery-naïve patient of $28 728.82 per year, which would result in an overwhelming cost savings.

Comparable to previous studies, our analysis demonstrates that the majority of patients with a diagnosis of ON benefit from surgery.[21] Studies examining operative outcomes for ON nerve decompression report reductions in pain days per month ranging from –7 to –20 and a decrease in pain intensity of 4–6 points on a 10-point scale, which is consistent with our observations.[5] Although there are limited data on changes in pain duration, existing studies have revealed reductions of 50% or more, mirroring our own results.[46]

Although the present study reports the significant benefits of nerve decompression surgery in patients with ON, it is important to acknowledge the existence and efficacy of alternative surgical interventions, such as nerve stimulation and C2 ganglionectomy. Research shows that these interventions offer substantial relief in numerous cases of ON.[47,48] A comprehensive comparison of these surgical strategies is warranted to provide more nuanced treatment algorithms.

Limitations

The findings of the present study should be interpreted within the context of its limitations. One limitation pertains to the self-reported nature of the onset of ON symptoms, which introduces the potential for recall bias. Second, the availability of data on the specific number of botulinum toxin injections and nerve blocks received between the onset of ON symptoms and nerve decompression surgery was restricted to a subset of patients. We calculated the average number of these interventions for the entire cohort and applied it to our cost analysis. Additionally, we were not able to calculate the cost associated with oral medication because of insufficient data. Consequently, we derived the cost estimates from a recent study that reported the direct and indirect health care resource utilization and costs among patients with migraine in the United States.[18] Notably, within our cohort, a significant majority of 348 patients (95%) reported the use of migraine medication, including both preventive and abortive medications. Hence, the inclusion of costs related to migraine medication in our analysis was justified. Finally, occipital nerve decompression was not widely available until around 2005, potentially contributing to the surgical delay observed in our study.[40]

Conclusion

The results of this study demonstrate that patients suffer from ON for an average of 19 years before undergoing nerve decompression surgery. Occipital nerve decompression is an effective treatment for patients with ON and should be considered earlier in the treatment course to prevent patient morbidity and reduce direct and indirect health care costs.

Funding

No funding.

Conflicts of interest: None declared.

References

1. Silver S, Ledford CC, Vogel KJ, Arnold JJ. Peripheral nerve entrapment and injury in the upper extremity. Am Fam Physician. 2021; 103 (5):275-285.
2. Dougherty C. Occipital neuralgia. Curr Pain Headache Rep. 2014; 18 (5):411. https://doi.org/10.1007/s11916-014-0411-x
3. Mathew PG, Najib U, Khaled S, Krel R. Prevalence of occipital neuralgia at a community hospital-based headache clinic. Neurol Clin Pract. 2021; 11 (1):6-12. https://doi.org/10.1212/CPJ.0000000000000789
4. Gfrerer L, Guyuron B. Surgical treatment of migraine headaches. Acta Neurol Belg. 2017; 117 (1):27-32. https://doi.org/10.1007/s13760-016-0731-1
5. Guyuron B, Kriegler JS, Davis J, Amini SB. Five-year outcome of surgical treatment of migraine headaches. Plast Reconstr Surg. 2011; 127 (2):603-608. https://doi.org/10.1097/PRS.0b013e3181fed456
6. Olesen J. Headache Classification Committee of the International Headache Society (IHS) The International Classification of Headache Disorders, 3rd edition. Cephalalgia. 2018; 38 (1):1–211. https://doi.org/10.1177/0333102417738202
7. Insinga RP, Ng-Mak DS, Hanson ME. Costs associated with outpatient, emergency room and inpatient care for migraine in the USA. Cephalalgia. 2011; 31 (15):1570-1575. https://doi.org/10.1177/0333102411425960
8. New Choice Health. Accessed May 15, 2023. https://www.newchoicehealth.com/
9. GoodRx. Accessed May 15, 2023. https://www.goodrx.com/
10. MdSave. Accessed May 15, 2023. https://mdsave.com
11. Medical Expenditure Panel Survey. Accessed May 15, 2023. https://meps.ahrq.gov/
12. Kim SJ, Nang QG, RoyChoudhury A, et al. Cost comparison of intra-detrusor injection of botulinum toxin versus augmentation cystoplasty for refractory neurogenic detrusor overactivity in children. J Pediatr Urol. 2022; 18 (3):314-319. https://doi.org/10.1016/j.jpurol.2022.01.021
13. Mallory M, Bauer B, Chon T. Occipital neuralgia treated with acupuncture: a case report. Glob Adv Health Med. 2019; 8 :2164956119890546. https://doi.org/10.1177/2164956119890546
14. Stokes DA, Lappin MS. Neurofeedback and biofeedback with 37 migraineurs: a clinical outcome study. Behav Brain Funct. 2010; 6 :9. https://doi.org/10.1186/1744-9081-6-9
15. Bryans R, Descarreaux M, Duranleau M, et al. Evidence-based guidelines for the chiropractic treatment of adults with headache. J Manipulative Physiol Ther. 2011; 34 (5):274-289. https://doi.org/10.1016/j.jmpt.2011.04.008
16. Hoffman LM, Abd-Elsayed A, Burroughs TJ, Sachdeva H. Treatment of occipital neuralgia by thermal radiofrequency ablation. Ochsner J. 2018; 18 (3):209-214. https://doi.org/10.31486/toj.17.0104
17. National Headache Foundation. Accessed May 15, 2023. https://headaches.org/physical-therapy-headache/
18. Bonafede M, Sapra S, Shah N, Tepper S, Cappell K, Desai P. Direct and indirect healthcare resource utilization and costs among migraine patients in the United States. Headache. 2018; 58 (5):700-714. https://doi.org/10.1111/head.13275
19. US Bureau of Labor Statistics. Accessed May 15, 2023. https://www.bls.gov/news.release/empsit.t19.htm
20. Schoenbrunner AR, Khansa I, Janis JE. Cost-effectiveness of long-term, targeted OnabotulinumtoxinA versus peripheral trigger site deactivation surgery for the treatment of refractory migraine headaches. Plast Reconstr Surg. 2020; 145 (2):401e-406e. https://doi.org/10.1097/PRS.0000000000006480
21. Robinson IS, Salibian AA, Alfonso AR, Lin LJ, Janis JE, Chiu ES. Surgical management of occipital neuralgia: a systematic review of the literature. Ann Plast Surg. 2021; 86(3S suppl 2) :S322-S331. https://doi.org/10.1097/SAP.0000000000002766
22. William G, Austen Jr. M, Katya Remy M, et al. Refractory occipital neuralgia treatment with nerve decompression surgery—a case series. In: American Headache Society Meeting, Austin, TX, 2023.
23. Eskilsson A, Ageberg E, Ericson H, Marklund N, Anderberg L. Decompression of the greater occipital nerve improves outcome in patients with chronic headache and neck pain—a retrospective cohort study. Acta Neurochir (Wien). 2021; 163 (9):2425-2433. https://doi.org/10.1007/s00701-021-04913-0
24. Janis JE, Dhanik A, Howard JH. Validation of the peripheral trigger point theory of migraine headaches: single-surgeon experience using botulinum toxin and surgical decompression. Plast Reconstr Surg. 2011; 128 (1):123-131. https://doi.org/10.1097/PRS.0b013e3182173d64
25. Koopman JSHA, Dieleman JP, Huygen FJ, de Mos M, Martin CGM, Sturkenboom MCJM. Incidence of facial pain in the general population. Pain. 2009; 147 (1-3):122-127. https://doi.org/10.1016/j.pain.2009.08.023
26. Taylor M, Silva S, Cottrell C. Botulinum toxin type-A (BOTOX®) in the treatment of occipital neuralgia: a pilot study. Headache. 2008; 48 (10):1476-1481. https://doi.org/10.1111/j.1526-4610.2008.01089.x
27. Pedraza MI, Ruiz M, Rodríguez C, et al. Occipital neuralgia: Clinical and therapeutic characteristics of a series of 14 patients. Rev Neurol. 2013; 57 (5):193-198. https://doi.org/10.33588/rn.5705.2013173
28. Gfrerer L, Hansdorfer MA, Ortiz R, et al. Patient pain sketches can predict surgical outcomes in trigger-site deactivation surgery for headaches. Plast Reconstr Surg. 2020; 146 (4):863-871. https://doi.org/10.1097/PRS.0000000000007162
29. Mosser SW, Guyuron B, Janis JE, Rohrich RJ. The anatomy of the greater occipital nerve: implications for the etiology of migraine headaches. Plast Reconstr Surg. 2004; 113 (2):693. https://doi.org/10.1097/01.PRS.0000101502.22727.5D
30. Rangwani SM, Hehr JC, Janis JE. Clinical effectiveness of peripheral nerve blocks for diagnosis of migraine trigger points. Plast Reconstr Surg. 2021; 148 (6):992e-1000e. https://doi.org/10.1097/PRS.0000000000008580
31. Knoedler L, Chartier C, Casari ME, et al. Relative pain reduction and duration of nerve block response predict outcomes in headache surgery—a prospective cohort study. Plastic Reconstr Surg. 2023;152(6):1319-1327. https://doi.org/10.1097/PRS.0000000000010552
32. Guyuron B, Riazi H, Long T, Wirtz E. Use of a Doppler signal to confirm migraine headache trigger sites. Plast Reconstr Surg. 2015; 135 (4):1109-1112. https://doi.org/10.1097/PRS.0000000000001102

33. Peled ZM, Pietramaggiori G, Scherer S. Anatomic and compression topography of the lesser occipital nerve. Plast Reconstr Surg Glob Open. 2016; 4 (3):e639. https://doi.org/10.1097/GOX.0000000000000654
34. Lee M, Brown M, Chepla K, et al. An anatomical study of the lesser occipital nerve and its potential compression points: implications for surgical treatment of migraine headaches. Plast Reconstr Surg. 2013; 132 (6):1551-1556. https://doi.org/10.1097/PRS.0b013e3182a80721
35. Bovim G, Fredriksen TA, Stolt-Nielsen A, Sjaastad O. Neurolysis of the greater occipital nerve in cervicogenic headache. A follow up study. Headache. 1992; 32 (4):175-179. https://doi.org/10.1111/j.1526-4610.1992.hed3204175.x
36. Gille O, Lavignolle B, Vital JM. Surgical treatment of greater occipital neuralgia by neurolysis of the greater occipital nerve and sectioning of the inferior oblique muscle. Spine (Phila Pa 1976). 2004; 29 (7):828-832. https://doi.org/10.1097/01.BRS.0000112069.37836.2E
37. Magnússon T, Ragnarsson T, Björnsson A. Occipital nerve release in patients with whiplash trauma and occipital neuralgia. Headache. 1996; 36 (1):32-36. https://doi.org/10.1046/j.1526-4610.1996.3601032.x
38. Guyuron B, Kriegler JS, Davis J, Amini SB. Comprehensive surgical treatment of migraine headaches. Plast Reconstr Surg. 2005; 115 (1):1-9. https://doi.org/10.1097/01.PRS.0000145631.20901.84
39. Guyuron B, Reed D, Kriegler JS, Davis J, Pashmini N, Amini S. A placebo-controlled surgical trial of the treatment of migraine headaches. Plast Reconstr Surg. 2009; 124 (2):461-468. https://doi.org/10.1097/PRS.0b013e3181adcf6a
40. Gfrerer L, Raposio E, Ortiz R, Austen GW. Surgical treatment of migraine headache: back to the future. Plast Reconstr Surg. 2018; 142 (4):1036-1045. https://doi.org/10.1097/PRS.0000000000004795
41. Elhawary H, Barone N, Baradaran A, Janis JE. Efficacy and safety of migraine surgery: a systematic review and meta-analysis of outcomes and complication rates. Ann Surg. 2022; 275 (2):e315-e323. https://doi.org/10.1097/SLA.0000000000005057
42. Hazewinkel MHJ, Bink T, Hundepool CA, Duraku LS, Zuidam JM. Nonsurgical treatment of neuralgia and cervicogenic headache: a systematic review and meta-analysis. Plast Reconstr Surg Glob Open. 2022; 10 (7):e4412. https://doi.org/10.1097/GOX.0000000000004412
43. Mathew PG. Cranial peripheral nerve blocks. In: Bajwa ZH, Wootton RJ, Warfield CA, eds. Principles and Practice of Pain Medicine, 3rd ed. New York, NY: McGraw-Hill Education; 2016. Accessed December 01, 2023. https://accessanesthesiology.mhmedical.com/content.aspx?bookid=1845§ionid=13369184.
44. Hawkins K, Wang S, Rupnow MFT. Indirect cost burden of migraine in the United States. J Occup Environ Med. 2007; 49 (4):368-374. https://doi.org/10.1097/JOM.0b013e31803b9510
45. Linde M, Gustavsson A, Stovner LJ, et al. The cost of headache disorders in Europe: the Eurolight project. Eur J Neurol. 2012; 19 (5):703-711. https://doi.org/10.1111/j.1468-1331.2011.03612.x
46. Afifi AM, Carbullido MK, Israel JS, Sanchez RJ, Albano NJ. Alternative approach for occipital headache surgery: the use of a transverse incision and "W" flaps. Plast Reconstr Surg Glob Open. 2019; 7 (4):e2176. https://doi.org/10.1097/GOX.0000000000002176
47. Slavin KV, Nersesyan H, Wess C. Peripheral neurostimulation for treatment of intractable occipital neuralgia. Neurosurgery. 2006; 58 (1):112. https://doi.org/10.1227/01.NEU.0000192163.55428.62
48. Acar F, Miller J, Golshani KJ, Israel ZH, McCartney S, Burchiel KJ. Pain relief after cervical ganglionectomy (C2 and C3) for the treatment of medically intractable occipital neuralgia. Stereotact Funct Neurosurg. 2008; 86 (2):106-112. https://doi.org/10.1159/000113872
49. Gfrerer L, Dayan E, Austen WG. Trigger-site deactivation surgery for nerve compression headaches. Plast Reconstr Surg. 2021; 147 (6):1004e-1021e. https://doi.org/10.1097/PRS.0000000000007931

Pain Medicine, 2023, 25, 334–343
https://doi.org/10.1093/pm/pnad154
Original Research Article