Clinical Effectiveness of Peripheral Nerve Blocks for Diagnosis of Migraine Trigger Points

Shiva M. Rangwani, M.D., M.B.A.
Jason C. Hehr, M.D.
Jeffrey E. Janis, M.D.

Columbus, Ohio

Background: With a 13 percent global prevalence, migraine headaches are the most commonly diagnosed neurologic disorder, and are a top five cause of visits to the emergency room. Surgical techniques, such as decompression and/or ablation of neurovasculature, have shown to provide relief. Popular diagnostic modalities to identify trigger loci include handheld Doppler examinations and botulinum toxin injection. This article aims to establish the positive predictive value of peripheral nerve blocks for identifying therapeutic surgical targets for migraine headache surgery.
Methods: Electronic medical records of 36 patients were analyzed retrospectively. Patients underwent peripheral nerve blocks using 1% lidocaine with epinephrine and subsequent surgery on identified migraine headache trigger sites. Patients were grouped into successful and unsuccessful blocks and further categorized into successful and unsuccessful surgery subgroups. Group analysis was performed using paired t tests, and positive-predictive value calculations were performed on subgroups.
Results: The preoperative Migraine Headache Index of patients with positive blocks was 152.71, versus 34.26 postoperatively ($p < 0.001$). Each index component also decreased significantly: frequency (22.11 versus 15.06 migraine headaches per month; $p < 0.001$), intensity (7.43 versus 4.12; $p < 0.001$), and duration (0.93 versus 0.55 days; $p < 0.001$). The positive-predictive value of diagnostic peripheral nerve blocks in identifying a migraine headache trigger site responsive to surgical intervention was calculated to be 0.89 (95 percent CI, 1 to 0.74).
Conclusions: To the authors' knowledge, this is the first study to investigate the positive-predictive value of peripheral nerve blocks as used in the diagnostic workup of patients with chronic migraine headaches. Peripheral nerve blocks serve as a reliable clinical tool in mapping migraine trigger sites for surgical intervention while offering more flexibility in their administration and recording as compared to established diagnostic methods. (*Plast. Reconstr. Surg.* 148: 992e, 2021.)
CLINICAL QUESTION/LEVEL OF EVIDENCE: Diagnostic, IV.

With a 13 percent global prevalence, migraine headaches are the most commonly diagnosed and treated neurologic disorder.[1] The economic burden of migraines reaches $20 billion annually, stemming from missed work and medical treatment.[2] The notion that migraines occur and propagate from insults to peripheral nerves has been discussed for centuries.[3] Surgical intervention to cauterize vasculature to treat migraines has a rich history that began with the famous physician Al-Zahrawi in the tenth and eleventh centuries.[3] More recently, migraine surgery has made strides in part because of the discovery that migraines can be triggered at specific sites of peripheral nerve compression across the head and neck.[4–6] Furthermore, the

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interplay between migraine susceptibility genes and their expression in specific cell types of the central and peripheral nervous systems has advanced our understanding on the genetic basis of migraine headaches.[7] Numerous anatomical studies have been conducted to elucidate and pinpoint trigger sites for migraine headaches to provide more accurate and targeted surgical decompression and improve surgical outcomes.[8–20] Table 1 outlines specific anatomical trigger sites and common surgical procedures performed to address migraine headaches originating from these sites.[21]

Successful surgery reduces baseline frequency, intensity, and duration—all components of the Migraine Headache Index.[22] Studies have shown positive outcomes for migraine surgery in 50 to 95 percent of cases,[5,6,23,24] with 29 percent of patients reporting a complete elimination of migraines.[25] Before surgical intervention, a patient who has been diagnosed with chronic migraine headaches by a board-certified neurologist typically undergoes detailed evaluation of migraine characteristics including location of onset, travel pattern, severity (1 to 10 numerical rating scale), duration (fraction of 24 hours), and frequency (days per month). To pinpoint trigger sites as targets for surgery, surgeons synthesize these subjective patient-reported migraine headache data points in conjunction with diagnostic modalities including handheld Doppler examinations, botulinum neurotoxin A injections, computed tomographic

scans (when applicable), and peripheral nerve blocks with local anesthetic.[26]

Blocks are used to identify migraine trigger sites when patients actively have pain during clinic evaluation. If a patient is able to pinpoint a locus of maximal pain, they are injected with local anesthetic nerve block at this site.[26] If the block significantly reduces or eliminates migraine intensity, determined by preblock and postblock patient-reported pain scores, the surgeon has identified a potential target for surgical intervention. Blocks afford immediate diagnostic power and reduce the need for increased patient follow-up when compared to trigger identification using serial botulinum neurotoxin A injections.[26] This study aims to evaluate the diagnostic capacity of nerve blocks in successfully identifying trigger sites for migraine surgery.

PATIENTS AND METHODS

Design

After obtaining institutional review board approval, a retrospective chart review was performed on all patients receiving a local anesthetic peripheral nerve block for trigger site localization followed by subsequent surgical decompression of peripheral nerves in the treatment of chronic migraine headaches by a single surgeon between the years 2014 and 2019. Patients who were lost to follow-up after administration of a nerve block, did not have accurately recorded preblock or

Table 1. Migraine Trigger Site Characteristics and Procedures*

Trigger Site	Nerves Involved	Structures Involved	Characteristic Symptoms	Common Surgical Procedures
Site I: frontal	Supraorbital/ supratrochlear	Glabellar muscles; surrounding vessels, foramina, fascial bands	Pain at eyebrows radiating to temples; ptosis; prominent frown lines	Nerve decompression/ablation; glabellar resection; supraorbital/ supratrochlear band release; foraminotomy
Site II: temporal	Zygomaticotemporal branch of CNV	Temporalis muscle; deep temporal fascia; accompanying vessels	Pain lateral to lateral canthus; tender temporalis/masseter; bruxism	Nerve decompression/ablation; fascial band release
Site III: rhinogenic	Terminal branches of CNV	Nasal septum; turbinates; concha bullosa	Pain starts behind eye and responds to allergies, weather, hormones; characteristic CT findings (i.e., deviated septum); rhinorrhea	Septoplasty; turbinate reduction; nerve decompression/ablation
Site IV	Greater occipital nerve, third occipital nerve	Semispinalis capitis; fascial bands; occipital artery	Pain caudal to occipital protuberance; tight neck muscles; triggered by exercise and lifting	Nerve decompression/ablation; fascial band release; semispinalis resection
Site V	Auriculotemporal nerve	Superficial temporal artery; fascial bands	Pain cephalad to ZT; pain in hair-bearing region; misinterpreted as TMJ pathology	Nerve decompression/ablation; arterectomy or ligation of superficial temporal vasculature
Site VI	Lesser occipital nerve	Occipital artery branches; fascial bands	Pain lateral to GON often involving ear; vertigo	Nerve decompression/ablation; ligation of occipital artery branches

CNV, cranial nerve V; CT, computed tomographic; ZT, zygomaticotemporal; TMJ, temporomandibular joint; GON, greater occipital nerve.
*Adapted from Gfrerer L, Austen WG, Janis JE. Migraine surgery. *Plast Reconstr Surg Glob Open* 2019;7:2291; and Gfrerer L, Guyuron B. Surgical treatment of migraine headaches. *Acta Neurol Belg*. 2017;117:27–32.

postblock pain scores, or did not proceed to surgical intervention were excluded from the study. All patients in this study had a previously documented history of chronic migraine headaches as diagnosed by a neurologist; had failed traditional, conservative measures for the treatment of chronic migraine headaches; and were not actively receiving any other therapeutic interventions (i.e., botulinum neurotoxin injections) from another provider.

Block Administration and Diagnostic Workup

If a patient is capable of outlining current headache pain at a specific location and quantifying it on a scale from 1 to 10, they are eligible for a nerve block. If this pain is present at multiple sites, more than one site may be sequentially blocked. Injection sites are well-elucidated migraine trigger sites, including auriculotemporal, greater occipital, lesser occipital, supraorbital, supratrochlear, and zygomaticotemporal nerves. Subsequently, 1 ml of 1% lidocaine with epinephrine is injected at the trigger site using a 30-gauge, 1-inch-long needle for most sites, except for the greater occipital nerve where a 27-gauge, 1¼ -inch-long needle is used. The patient then reports their resulting migraine intensity within 12 hours after administration of the block. For the purposes of this study, if the patient's pain intensity decreased to 0 or 1 of 10, the block was considered successful in identifying a trigger site for surgery. If the intensity remained the same, decreased but did not meet 0 to 1 of 10 threshold, or worsened, the block was considered unsuccessful. In our senior author's (J.E.J.) practice, patients with negative blocks are not reblocked at the initial negative site. In addition to nerve blocks, the cumulative workup of all migraine headache patients includes one or more of the following, including consideration of the constellation of symptoms, Doppler testing, botulinum toxin injection, and computed tomographic scan, when indicated. These additional modalities allow the surgeon to further characterize migraine trigger sites that may not have been found through the nerve block alone. The synthesis of the information gathered from this workup allows for individualized surgical planning.

Surgical Interventions

Before undergoing surgery, patients were asked to report their baseline migraine data. This included migraine frequency (number of migraines per month), migraine intensity (1 to 10), and migraine duration (as a fraction of 24 hours). A baseline Migraine Headache Index was calculated by multiplying together frequency, intensity, and duration scores. Patients then underwent surgery, based on previously identified trigger site location, migraine characteristics, and the extent of migraine headache effect on quality of life. These techniques and indications are outlined in Table 1. Patients then followed up postoperatively, where postsurgical headache data were obtained and an updated Migraine Headache Index calculated.

Surgery was considered successful if a patient experienced a Migraine Headache Index decrease with greater than or equal to 50 percent decrease in either migraine frequency, migraine intensity, or migraine duration.[19] An operation was considered unsuccessful if none of the Migraine Headache Index contributors failed to decrease by 50 percent or more, or if the patient's overall Migraine Headache Index increased after surgery.

Categorization and Analysis

Patient characteristics including sex, age, and race were recorded. To compare baseline and postsurgical data, descriptive and paired t tests were calculated for migraine frequency, duration, intensity, and Migraine Headache Index. Calculation of the positive-predictive value was used to evaluate the efficacy of blocks in targeting migraine trigger sites. The positive-predictive value is the probability that a patient with a positive block at a location has abnormality at the location, generating migraine symptoms amenable to surgical intervention. True-positives were those who had a positive block and underwent a successful migraine operation. False-positives were patients who had a positive block but an unsuccessful migraine surgery result. Positive-predictive value was calculated by using the following formula: ([true-positives]/[true-positives + false-positives]). All statistical analyses were performed using Microsoft Excel (Microsoft Corp., Redmond, Wash.). A value of $p < 0.05$ was considered significant.

RESULTS

A total of 36 patients underwent diagnostic testing using peripheral nerve blocks and subsequent surgery to relieve migraine headaches. Of these patients, 74.22 percent ($n = 26$) of the patients analyzed were female and 25.78 percent ($n = 10$) were male. The average age of patients in the study was 45.57 years. On average, study subjects received a block at 1.42 sites. Baseline Migraine Headache Index for all patients before

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undergoing surgery was 155.99 (range, 2 to 300). On average, patients experienced 22.79 migraine headaches per month before surgery (range, three to 30), with an intensity of 7.47 on a scale of 1 to 10 (range, 3 to 10), and lasting 0.92 days (range, 0.042 to 1 day). These baseline migraine headache characteristics before surgical intervention can be found in Table 2. Of note, those patients with low preoperative Migraine Headache Indexes had exhausted all conservative/nonsurgical measures as offered by their board-certified neurologist, with minimal to no improvement in migraine headache character or quality of life. These subjects tend to be high-functioning individuals where migraine headache can severely affect productivity and quality of life and who therefore are willing and appropriate candidates to undergo migraine headache surgery, when indicated.

After surgical intervention, the overall Migraine Headache Index decreased to 42.73 ($p < 0.001$), the frequency decreased to 15.29 migraine headaches per month ($p < 0.001$), the intensity decreased to 4.54 of 10 ($p < 0.001$), and the duration decreased to 0.62 days ($p < 0.001$). These data are outlined in Table 2.

Patients with successful blocks who underwent surgery had a Migraine Headache Index decrease from 152.71 to 34.26 ($p < 0.05$), with a significant reduction in each component (presurgical versus postsurgical; $p < 0.05$): frequency (22.11 migraine headaches per month versus 15.06 migraine headaches per month; $p < 0.05$), intensity (7.43 versus 4.12; $p < 0.05$), and duration (0.93 day versus 0.55 day; $p < 0.05$). These data can be found in Table 3.

Those undergoing unsuccessful blocks also had a significant reduction in Migraine Headache Index (159.28 versus 52.85; $p < 0.05$). Each component had a significant reduction in this cohort as well: frequency (23.47 migraine headaches

per month versus 15.51 migraine headaches per month; $p < 0.05$), intensity (7.51 versus 4.97; $p < 0.01$), duration (0.90 day versus 0.68 day; $p < 0.05$). These data can be found in Table 4.

Data comparing the preoperative versus postoperative percentage reduction in Migraine Headache Index and its components between subjects with successful and unsuccessful blocks are outlined in Table 5. The overall percentage reduction in Migraine Headache Index is not significantly different between successful versus unsuccessful blocks (81.18 percent versus 72.61 percent; $p = 0.25$). In reviewing the Migraine Headache Index components, however, we can see that those individuals with a successful block had a significantly greater percentage reduction in postoperative migraine frequency compared with those with an unsuccessful block (82.04 percent versus 56.60 percent; $p = 0.02$). There was no significant difference in percentage reduction between the two groups for the remaining Migraine Headache Index components (i.e., intensity and duration).

Table 2. Demographic and Migraine Data for All Patients

	Preoperative	Postoperative
Total no. of patients	36	—
Mean age ± SD, yr	45.57 ± 12.94	—
Sex, %		
Female	74.22	—
Male	25.78	—
Mean follow-up ± SD, mo	11.8 ± 1.3	
Mean baseline MHI ± SD*	155.99 ± 96.70	42.73 ± 77.89
Mean frequency ± SD, MHs/mo*	22.79 ± 8.58	15.29 ± 10.26
Mean intensity ± SD*	7.47 ± 1.65	4.54 ± 3.59
Mean duration ± SD, days*	0.92 ± 0.53	0.62 ± 0.43

MHI, Migraine Headache Index; MH, migraine headaches.
*Difference between preoperative and postoperative values is significant at $p = 0.05$.

Table 3. Demographic and Migraine Data for Those Undergoing Successful Blocks

	Preoperative	Postoperative
Total no. of patients	18	—
Mean age ± SD, yr	46 ± 8.9	—
Sex, %		
Female	64.71	—
Male	35.29	—
Mean follow-up ± SD, mo	11.5 ± 1.2	
Mean baseline MHI ± SD*	152.71 ± 102.30	34.26 ± 76.47
Mean frequency ± SD, MHs/mo*	22.11 ± 7.98	15.06 ± 8.62
Mean intensity ± SD*	7.43 ± 1.20	4.12 ± 2.46
Mean duration ± SD, days*	0.93 ± 0.48	0.55 ± 0.44

MHI, Migraine Headache Index; MHs, migraine headaches.
*Difference between preoperative and postoperative values is significant at $p = 0.05$.

Table 4. Demographic and Migraine Data in Those Undergoing Unsuccessful Blocks

	Preoperative	Postoperative
Total no. of patients	18	—
Mean age ± SD, yr	45.16 ± 13.9	—
Sex, %		
Female	83.33	—
Male	16.67	—
Mean follow-up ± SD, mo	12.1 ± 1.4	
Mean baseline MHI ± SD*	159.28 ± 93.61	52.85 ± 80.37
Mean frequency ± SD, MHs/mo*	23.47 ± 8.01	15.51 ± 6.74
Mean intensity ± SD*	7.506 ± 1.35	4.97 ± 1.94
Mean duration ± SD, days*	0.904 ± 0.50	0.68 ± 0.48

MHI, Migraine Headache Index; MHs, migraine headaches.
*Difference between preoperative and postoperative values is significant at $p = 0.05$.

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Table 5. Outcome Comparison for Successful versus Unsuccessful Blocks

	Postoperative Reduction	
	Successful Block	Unsuccessful Block
No.	118	18
Migraine headache severity indicator		
MHI, %	81.18	72.61
MHI components, %		
Frequency*	82.04	56.60
Intensity	43.61	24.41
Duration	64.02	44.98

*Difference between percentage change is significant at $p = 0.05$.

Positive-Predictive Value Analysis

Each of the 36 patients received block(s) before surgical intervention. Eighteen of these patients had successful blocks, with 17 experiencing a migraine headache intensity reduction to 0 of 10 and one migraine headache intensity reduction to 1 of 10. There was a total of 18 unsuccessfully blocked patients, using the definition above. The patients with successful blocks underwent surgery on the site identified by the positive block outcome. The patients with unsuccessful blocks underwent migraine surgery at other trigger sites that were confirmed by other modalities.

Of the 18 patients who received positive blocks and underwent surgery at the identified trigger sites, 16 experienced a successful operation (true-positive) and two experienced an unsuccessful operation (false-positive). These data are summarized in Table 6. Positive-predictive value was calculated to be 0.89 (95 percent CI, 1 to 0.74).

DISCUSSION

Nerve blocks as a diagnostic method for migraine headache trigger sites subvert the disadvantages of botulinum injections, specifically, the length of time, cost, and multiple visits needed for detection of these sites using this modality alone.[23,27] Blocks offer an immediate quantification of pain reduction, which is ideal for patients who are unable to follow the schedule of botulinum injections or are unable to afford costs associated with repeated injections. Furthermore, they allow for identification of other types of nerve compression as compared to botulinum injection,

Table 6. Positive Predictive Value Calculation

	Successful Block	Unsuccessful Block
Successful surgery	16 (true-positive)	14 (false-negative)
Unsuccessful surgery	2 (false-positive)	4 (true-negative)

which only identifies muscular nerve compression. To our knowledge, this is the first study to evaluate the diagnostic efficacy of nerve blocks for migraine headache.

In our study, 30 of 36 patients (83.33 percent) experienced at least a 50 percent decrease in either migraine headache intensity, duration, or frequency following surgical intervention. These data are similar to existing literature of success rates of migraine surgery.[23,24] As outlined in Table 2, each component of the Migraine Headache Index decreased significantly following migraine surgery, with the frequency of migraine headache experiencing the greatest drop.

Overall success rate for block administration was 50 percent, with 18 of 36 patients experiencing a reduction of migraine headache intensity to an absolute value of either 0 or 1 after block administration. Each of the subjects receiving a positive block underwent a surgical procedure that targeted the successfully blocked site. Table 7 outlines the outcomes of the successfully blocked sites and their subsequent surgical procedures. Each time a site was blocked successfully, that site was targeted by surgery, often in conjunction with additional intervention sites as diagnosed by further workup, including handheld Doppler studies, botulinum toxin, computed tomographic scan, or further blocks to other sites. At an average follow-up of 11.5 months, 16 of the 18 patients (89 percent) had at least a 50 percent decrease in any of the Migraine Headache Index components. These patients are considered true-positives—the nerve block identified a trigger site for migraine propagation that was successfully targeted by surgical procedures. Two of the 18 patients (11 percent) had no significant improvement in migraine headache after surgical intervention on a site identified as a potential migraine trigger by peripheral nerve blocks; these were considered false-positives. These data yield a positive-predictive value of 89 percent.

Moreover, it is important to note the self-imposed constraints of our positive block results. In establishing a threshold for a positive block as an absolute postblock value of 0 to 1, we likely excluded patients with meaningful block results in attempting to critically evaluate our data. For example, a patient with a preblock intensity of 9 and postblock intensity of 3 with symptomatology matching the blocked locus, may technically have had a "negative block" but may still benefit from surgical intervention when taking other diagnostic modalities into account. To account for this, we reset the definition of a "positive block"

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Table 7. Charting of Successful Blocks

Patient	Initial Block Site	Intensity		Surgery Site	MHI	
		Preblock	Postblock		Preoperative	Postoperative
1	Bilateral GON	4	0	Decompression: bilateral GON Ablation: bilateral TON, bilateral occipital arteries	210	0
2	Bilateral GON; bilateral LON	3	0	Decompression: Bilateral GON Exploration, ablation: bilateral LON, TON, occipital arteries	90	18.9
3	Bilateral SON/ STN; bilateral ZT	5	0	Decompression: SON/STN, ZT	25	0
4	Bilateral GON	10	0	Decompression: bilateral GON Ablation: bilateral TON, bilateral occipital arteries, bilateral STA branches	300	26.667
5	Bilateral GON	6	0	Decompression: bilateral GON Exploration, ablation: bilateral LON, bilateral occipital arteries Ablation: bilateral TON	180	8.333
6	Bilateral GON	5	0	Decompression: bilateral GON Exploration, ablation: bilateral occipital arteries Ablation: bilateral TON	14	0
7	Bilateral SON/ STN; bilateral ZT	5	0	Decompression: bilateral SON/STN Ablation: Bilateral TON, right LON, bilateral supraorbital/supratrochlear arteries and veins Endoscopic avulsion: ZT	105	0
8	Bilateral GON; bilateral AT	5	0	Decompression: bilateral GON, bilateral SON/STN Release: bilateral AT Ablation: bilateral TON, SON/STN Endoscopic avulsion: ZT	110	0
9	Bilateral SON/ STN; bilateral ZT	4	0	Neuroplasty/transposition: bilateral SON/STN, bilateral ZT Ablation: bilateral supraorbital veins, superficial temporal artery and vein branches Exploration: left AT	300	2.999
10	Bilateral GON	6	0	Decompression: bilateral GON Exploration, dissection, ablation: bilateral occipital arteries, bilateral superficial temporal arteries Decompression, ablation, neurotization: bilateral TON	210	240
11	Bilateral AT	5	1	Exploration, ablation: bilateral AT, bilateral superficial temporal artery/vein Ablation: right ZT	120	0
12	Bilateral GON	5	0	Decompression: bilateral GON Exploration, dissection, ablation: bilateral occipital arteries Decompression, ablation, neurotization: bilateral TON	14	5.25
13	Bilateral GON	5	0	Decompression: bilateral GON Exploration, dissection, ablation: bilateral occipital arteries Decompression, ablation, neurotization: bilateral TON, right LON	105	0
14	Bilateral SON/ STN; bilateral GON	4	0	Decompression: bilateral GON Exploration, dissection, ablation: bilateral occipital arteries Decompression, ablation: bilateral TON	300	3
15	Left AT	6	0	Exploration, ablation: left AT, left superficial temporal vein/artery	210	240
16	Left SON/STN; left ZT	8	0	Neuroplasty, neurolysis/decompression: bilateral SON/STN Ablation: bilateral AT Exploration, dissection, ablation: bilateral supratrochlear/supraorbital arteries, veins	270	64
17	Left AT	3	0	Exploration, ablation: left AT, left superficial temporal vein/artery	5.833	0.5
18	Bilateral SON/STN	7	0	Neuroplasty, neurolysis/decompression: bilateral SON/STN Ablation: right AT Exploration, dissection, ablation: bilateral supratrochlear/supraorbital arteries, veins	180	7

MHI, Migraine Headache Index; GON, greater occipital nerve, TON, third occipital nerve; LON, lesser occipital nerve; SON, supraorbital nerve; STN, supratrochlear nerve; ZT, zygomaticotemporal nerve; AT, auriculotemporal nerve.

to a relative definition, specifically, a 50 percent improvement in intensity after a block. Using this relative decrease as the threshold, our alternative positive-predictive value calculation yields 91 percent (95 percent CI, 1 to 0.78), which is not significantly different (Table 8). To analyze this further, we also reset the definition of a "positive" nerve block to a 75 percent improvement and also 90 percent improvement. This analysis did not change the positive-predictive value, either, and it remained 89 percent. Therefore, it does not seem to make a significant difference in terms of whether an absolute or relative definition is used, and where a relative definition is used, a 50 percent improvement seems to be a reasonable, statistically sound threshold for improvement.

To our knowledge, this is the first study to quantify the diagnostic efficacy of nerve blocks in identifying locations of peripheral nerve targets as sites of migraine triggers. We believe that peripheral nerve blocks can be used by surgeons to plan for sites of surgical intervention for the treatment of migraine headache. With the administration of an accurate and successful nerve block, a surgeon can reasonably deduce that the site of block administration is a locus of migraine activity.

Those patients undergoing unsuccessful blocks are outlined in Table 9. As can be seen, if a block at a specific target was unsuccessful, patients underwent further diagnostic testing to identify potential trigger sites. Furthermore, patients with an unsuccessful block at one site did not undergo surgery solely at the site of an unsuccessful block— surgery was targeted at other sites with or without intervention at the initial blocked site. Overall, 10 of the 16 patients with unsuccessful blocks had an operation that included the site of an unsuccessful block (Table 9); it is important to note that although a successful block provides great presurgical information, an unsuccessful block does not necessarily eliminate the targeted trigger site as a migraine locus and should be interpreted within the context of other diagnostic modalities. The fact that patients with an unsuccessful block site still had successful surgical outcomes shows that nerve blocks serve as only one tool in the diagnostic array of techniques. Other workup modalities,

specifically including, but not limited to, constellation of symptoms, botulinum toxin type A, Doppler, and computed tomographic scan (when appropriate) allow for accurate surgical planning in these patients and therefore still allows for a successful operation to be performed. A surgeon performing migraine surgery needs to have a holistic approach to their workup, with peripheral nerve blocks serving as one of several tools aimed at the diagnosis and treatment of migraine headache. We believe that this article shows that a positive nerve block at a migraine trigger site can provide sound evidence for surgical planning; however, a negative nerve block needs to be considered globally in conjunction with patient history and alternative diagnostic procedures.

Although the percentage change in the Migraine Headache Index is similar between both cohorts with a successful and unsuccessful block (Table 5), the frequency reduction is greater in the successfully blocked cohort. This, perhaps, shows that peripheral nerve blocks can more accurately identify common migraine headache propagators in patients, although further data should be collected to make this connection.

Our study is not without limitations. Our data represent a single surgeon's experience at a single center, thereby reducing the generalizability of the study. Furthermore, there were no strict inclusion criteria for patients to receive a block, with the only requirement being an active headache at the time of evaluation. Furthermore, as migraine operations target numerous diagnosed trigger sites, patients rarely underwent single-site surgery. Therefore, there are potential confounding factors in a positive migraine surgery outcome. Future studies should evaluate the site-specific positive-predictive values of peripheral nerve blocks to more accurately reflect positive-predictive value of peripheral nerve blocks at that trigger site. We also included only patients that met all inclusion criteria and were not lost to follow-up or did not proceed to surgery. Finally, our study contains multiple confounding variables that may impact outcomes, including surgery at other sites, and other diagnostic modalities used.

CONCLUSIONS

This retrospective review of a single-surgeon experience is the first of its kind to elucidate the clinical value of peripheral nerve blocks in the diagnosis of migraine headache trigger sites. Patients who had successful blocks underwent surgical intervention at sites of the successful

Table 8. Alternative Positive-Predictive Value Calculation*

	Successful Block	Unsuccessful Block
Successful surgery	20 (true-positive)	11 (false-negative)
Unsuccessful surgery	2 (false-positive)	4 (true-negative)

*50 percent reduction in migraine headache intensity.

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Table 9. Charting of Unsuccessful Blocks

Patient	Initial Block Site	Intensity		Next Diagnostic Evaluation	Surgery Site	MHI	
		Preblock	Postblock			Preoperatively	Preoperatively
1	Bilateral SON/STN; bilateral ZT	6	5	Botox at bilateral SON/STN, ZT, GON trigger point regions	Decompression: bilateral GON Ablation: bilateral TON, bilateral occipital arteries	195	2.85
2	Bilateral GON	8	5	Botox at bilateral GON and point of maximal pain in temples	Bilateral GON, TON, supraorbital nerves, supratrochlear nerves	240	28
3	Bilateral GON	9	3	Botox at bilateral SON/STN, ZT trigger point regions	Decompression: bilateral GON Ablation: bilateral TON, LON Exploration/ablation: bilateral occipital arteries	240	0
4	Bilateral SON/STN	7	3	Block at bilateral GON	Decompression: bilateral GON Ablation: bilateral TON Exploration/ablation: bilateral occipital arteries	300	50
5	Bilateral GON	7	3	Botox at bilateral SON/STN, ZT trigger point regions; block at AT	Decompression: SON/STN, GON Endoscopic avulsion: ZT	126	23.625
6	Bilateral SON/STN; right ZT	9	9	Block at bilateral GON	Decompression: bilateral AT, bilateral TON	270	210
7	Bilateral GON	8	5	Botox at bilateral SON/STN, ZT trigger points	Decompression: bilateral GON, SON/STN Ablation: bilateral TON	28	3.125
8	Bilateral AT	7	7	Botox at bilateral SON/STN, ZT trigger point regions	Ablation: bilateral SON/STN, bilateral supratrochlear/supraorbital arteries and veins, bilateral AT	2	0
9	Bilateral SON/STN; bilateral ZT; bilateral AT	8	7	Botox at bilateral SON/STN, ZT trigger point regions	Ablation: bilateral AT	240	150
10	Right SON, STN; right ZT ; right AT	5	3	Botox at bilateral SON/STN, ZT, GON trigger sites	Decompression: bilateral SON/STN, right AT Release/avulsion: bilateral ZT	35	8
11	Bilateral AT	7	7	Repeated Doppler examination	Ablation: bilateral AT, bilateral superficial temporal artery and vein	210	210
12	Right AT	5	4	Doppler examination	Ablation: bilateral AT, bilateral superficial temporal artery and vein	180	0
13	Bilateral GON	6	6	No further diagnostic study performed	Decompression: bilateral GON Ablation: bilateral occipital arteries Ablation: bilateral TON	150	210
14	Bilateral GON	7	7	Botox at bilateral SON/STN, ZT, GON trigger sites	Decompression: bilateral SON/STN Ablation: bilateral AT, bilateral supratrochlear/supraorbital arteries and veins Release/avulsion: bilateral ZT	270	32
15	Left LON	2	2	Botox at bilateral GON trigger point regions	Decompression: bilateral GON Ablation: bilateral TON, bilateral occipital arteries and veins	90	0
16	Bilateral SON/STN	9	6	Botox at bilateral SON/STN, ZT, GON trigger point regions	Ablation: bilateral AT, bilateral superficial temporal artery and vein	128	6.667
17	Bilateral SON/STN; bilateral ZT	5	2	Botox at bilateral GON trigger point regions	Decompression: bilateral GON Ablation: bilateral TON, bilateral occipital arteries	35	0
18	Bilateral SON/STN; bilateral ZT	8	6	Botox at bilateral GON trigger point regions; repeated SON/STN block	Ablation: bilateral AT, bilateral superficial temporal artery and vein	128	17

MHI, Migraine Headache Index; SON, supraorbital nerve; STN, supratrochlear nerve; ZT, zygomaticotemporal nerve; GON, greater occipital nerve, TON, third occipital nerve; LON, lesser occipital nerve; AT, auriculotemporal nerve.

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block, with 83.33 percent experiencing a greater than 50 percent decrease in either migraine headache intensity, duration, or frequency. Our study provides a quantification of the diagnostic capacity of peripheral nerve blocks in the identification of a primary migraine locus in patients suffering migraine headaches. Those undergoing unsuccessful blocks had operations on different sites than the initial block, or sites in addition to those of the initial block. Therefore, we believe that peripheral nerve blocks afford a time-efficient and logistically simple alternative to botulinum toxin A diagnostic mapping of migraine trigger sites without losing positive predictive power. This study serves as a starting point to further evaluate the sensitivity and specificity of peripheral nerve blocks at various migraine headache trigger sites.

Jeffrey E. Janis, M.D.
915 Olentangy River Road
Columbus, Ohio 43212
jeffrey.janis@osumc.edu
Twitter: @jjanismd

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