Headache
ISSN 0017-8748
doi: 10.1111/j.1526-4610.2010.01675.x
Published by Wiley Periodicals, Inc.
© 2010 American Headache Society

Review Article

Peripheral Nerve Blocks and Trigger Point Injections in Headache Management – A Systematic Review and Suggestions for Future Research

Avi Ashkenazi, MD; Andrew Blumenfeld, MD; Uri Napchan, MD; Samer Narouze, MD, MSc; Brian Grosberg, MD; Robert Nett, MD; Traci DePalma, MD; Barbara Rosenthal, MD; Stewart Tepper, MD; Richard B. Lipton, MD, on behalf of the Interventional Procedures Special Interest Section of the American Headache Society

Interventional procedures such as peripheral nerve blocks (PNBs) and trigger point injections (TPIs) have long been used in the treatment of various headache disorders. There are, however, little data on their efficacy for the treatment of specific headache syndromes. Moreover, there is no widely accepted agreement among headache specialists as to the optimal technique of injection, type, and doses of the local anesthetics used, and injection regimens. The role of corticosteroids in this setting is also debated. We performed a PubMed search of the literature to find studies on PNBs and TPIs for headache treatment. We classified the abstracted studies based on the procedure performed and the treated condition. We found few controlled studies on the efficacy of PNBs for headaches, and virtually none on the use of TPIs for this indication. The most widely examined procedure in this setting was greater occipital nerve block, with the majority of studies being small and non-controlled. The techniques, as well as the type and doses of local anesthetics used for nerve blockade, varied greatly among studies. The specific conditions treated also varied, and included both primary (eg, migraine, cluster headache) and secondary (eg, cervicogenic, posttraumatic) headache disorders. Trigeminal (eg, supraorbital) nerve blocks were used in few studies. Results were generally positive, but should be taken with reservation given the methodological limitations of the available studies. The procedures were generally well tolerated. Evidently, there is a need to perform more rigorous clinical trials to clarify the role of PNBs and TPIs in the management of various headache disorders, and to aim at standardizing the techniques used for the various procedures in this setting.

Key words: peripheral nerve blocks, trigger point injections, headache management, systematic review

(*Headache* 2010;50:943-952)

From the Neurologic Group of Bucks/Montgomery County, Doylestown, PA, USA (A. Ashkenazi); The Headache Center of Southern CA – Headache Center, Encinitas, CA, USA (A. Blumenfeld); Albert Einstein College of Medicine – Neurology, Bronx, NY, USA (U. Napchan, B. Grosberg, and R.B. Lipton); Cleveland Clinic Foundation – Pain Management Department, Cleveland, OH, USA (S. Narouze); Texas Headache Associates, San Antonio, TX, USA (R. Nett); Harvard Beth Israel Deaconess Medical Center – Neurology, Waterville, ME, USA (T. DePalma); Ellis Hospital – Neurology, Schenectady, NY, USA (B. Rosenthal); Headache Center – Neurological Institute, Cleveland, OH, USA (S. Tepper).

Address all correspondence to A. Ashkenazi, 305 Fonthill Drive, Apt. C5, Doylestown, PA 18901, USA.

Accepted for publication March 25, 2010.

Conflict of Interest: None

Interventional procedures such as peripheral nerve blocks (PNBs) and trigger point injections (TPIs) have long been used in the treatment of primary headache disorders.[1] These procedures provide rapid relief from headache and associated symptoms for many patients. The most widely targeted sites for PNBs are the greater occipital nerve (GON) and several terminal branches of the trigeminal nerve.[1] Common sites for TPIs include the trapezius and the posterior cervical paraspinal muscles.[2] PNBs and TPIs are amenable to outpatient office practice. Fortunately, adverse effects (AEs) are usually mild and transient, and head pain relief may be prompt and dramatic.[2,3] These procedures are generally safe, with rare serious AEs.

Local anesthetics are used to preferentially block sensory nerves. They generally inhibit conduction through nerve fibers by reversibly inhibiting sodium channels. Local anesthetics may preferentially act on the unmyelinated C-fibers and the thinly myelinated Aδ fibers that mediate pain.[4] This preferential blockade may be based, among other factors, on the easier diffusion of local anesthetics to small fibers. The most commonly used local anesthetics for nerve blockade in headache treatment are lidocaine and bupivacaine. Chemically, both are amides, and are less allergenic than those that belong to the ester group.

Although the pharmacokinetic properties of the local anesthetic are one determinant of the duration of a nerve block, headache relief often extends beyond the duration of the nerve blockade. This dissociation between pharmacokinetics and analgesia is incompletely understood.

Although many clinicians and patients report on positive results from PNBs and TPIs, rigorous double blind trials are rare. To assess the evidence base supporting the use of PNBs and TPIs, the Interventional Procedures Special Interest Section of the American Headache Society (IPSIS-AHS) conducted a systematic review of studies of these treatments for headache disorders. We also conducted a survey of AHS members to determine the patterns of use of these procedures among headache specialists. This article focuses on the results of our systematic literature review. On a long-term basis the IPSIS-AHS endeavors to develop a consistent, evidence-based approach to interventional treatments.

METHODS

We performed a PubMed search of the literature to find studies on PNBs and TPIs for headache treatment. The search terms were: nerve block, trigger point injections, headache, migraine, tension type headache, cluster headache, chronic daily headache, cervicogenic headache, posttraumatic headache, and neuralgia. We also looked at headache textbooks and review papers on the topic to identify additional relevant studies. We did not limit our search to a specific time period.

The papers summarized here were chosen if they fulfilled the following criteria: (1) They had to provide original data; (2) they were human studies; (3) they dealt with the efficacy and tolerability of PNBs, TPIs, or both, for one or more types of headache. We classified the abstracted studies based on the procedure performed and the treated condition.

RESULTS

Here we summarize the data from studies on PNBs for headache. There are virtually no data on the efficacy of TPIs for headache management.

Greater Occipital, Lesser Occipital, and Supraorbital Nerve Blocks for Headache.—*Nerve Blocks for Migraine.*—The efficacy of PNBs in migraine treatment was examined in several non-controlled studies (Table 1).[2,3,5,6] Gawel and Rothbart conducted a retrospective study on the efficacy of GON block in refractory migraine patients.[5] A mixture of lidocaine and methylprednisolone was used for nerve blockade. Fifty-four percent of migraine patients reported on being "significantly better" after the blocks, and the duration of response lasted up to 6 months. These authors also studied patients with posttraumatic headache and found a 72% response rate to GON. Caputi and Firetto examined the benefit of PNBs in the treatment of migraine.[6] They assessed 27 migraine patients before and after GON and supraorbital nerve (SON) blocks. Patients were treated with repeated anesthetic blocks, using 0.5-1 mL of bupivacaine 0.5% on alternate days, for a maximum of 10 blocks. Twenty-three patients (85%) responded to

Table 1.—Peripheral Nerve Blocks for Migraine

Study design	n	Intervention	Results	Reference
Retrospective	97	A single or repeated GON block(s) using lidocaine and methylprednisolone	Headache improvement in 54% of subjects for up to 6 months	Gawel and Rothbart[5]
Retrospective	27	Repeated GON and SON blocks using bupivacaine	Headache improvement in 85% of subjects for up to 6 months	Caputi and Firetto[6]
Retrospective	14	A single GON block with or without SON block using lidocaine and epinephrine	Head pain reduction in 6% of subjects at 30 minutes	Bovim and Sand[3]
Prospective, non-controlled	19	A single GON block using lidocaine and triamcinolone, and TPIs using lidocaine	A significant decrease in head pain in 90% of subjects	Ashkenazi and Young[2]

GON = greater occipital nerve; n = number of subjects; SON = supraorbital nerve; TPI = trigger point injections.

treatment, with a significant reduction in headache intensity, duration, and frequency. Bovim and Sand examined the diagnostic value and effects of GON and SON blocks in migraine, tension-type headache (TTH), and cervicogenic headache (CeH).[3] The authors used a single injection of 0.5-1.5 mL of lidocaine 2% with epinephrine 12.5 μg/mL for GON blockade. After GON block, pain reduction was achieved in 6% of the migraine group. Response rates were higher for the CeH group (55%) and the TTH group (14%). Most of the pain reduction was achieved within 5 minutes after the procedure. Ashkenazi and Young examined the effect of GON block and TPIs on head pain and cutaneous allodynia in 19 migraine patients.[2] Twenty minutes after injection, headache was reduced in 90% of patients and allodynia score decreased in all patients.

Nerve Blocks for Cluster Headache.—The efficacy of GON block in the management of cluster headache (CH) was examined in a single randomized trial and in several case series (Table 2).[7-10] In the randomized-controlled study, Ambrosini et al evaluated the effect of suboccipital injection of local anesthetics and corticosteroids in patients with CH.[7] Patients received lidocaine 2% (0.5 mL) with either betamethasone or saline. CH attacks disappeared

Table 2.—Peripheral Nerve Blocks for Cluster Headache

Study design	n	Intervention	Results	Reference
Double blind, placebo controlled	23	A single GON block using lidocaine and betamethasone	85% of subjects became attack free within a week. 61% remained attack free for 4 weeks	Ambrosini et al[7]
Retrospective	14	A single GON block using lidocaine and triamcinolone	64% of subjects became attack free for 3-70 days	Peres et al[8]
Retrospective	16	A single GON block using methylprednisolone	31% became headache free	Bigo et al[9]
Case series	15	A single GON block using prilocaine	60% had minor headache improvement	Busch et al[10]
Case series	19	GON injection using lidocaine and methylprednisolone	53% had complete and 16% had partial pain relief	Afridi et al[11]

GON = greater occipital nerve; n = number of subjects.

Table 3.—Peripheral Nerve Blocks for Chronic Daily Headache

Study design	n	Intervention	Results	Reference
Prospective, non-controlled	112	Repeated injections to the vicinity of occipital nerves using lidocaine and betamethasone	65% experienced headache relief lasting at least one week; 56% experienced relief for more than 4 weeks	Saadah and Taylor[12]
Case series	101	GON injection using lidocaine and methylprednisolone	22% had complete response (pain free) and 31% had partial response	Afridi et al[11]
Prospective, randomized controlled	37	GON block and TPIs using lidocaine, bupivacaine + either saline or triamcinolone	Headache severity decreased significantly at 20 minutes in both groups, with no significant between-group difference	Ashkenazi et al[13]
Open label	15	GON block using prilocaine and dexamethasone	No change in headache severity in 73% of subjects; worsening of headache in 20%	Leinisch-Dahlke et al[15]

GON = greater occipital nerve; n = number of subjects; TPI = trigger point injections.

within 72 hours for 4 weeks in 61% of the lidocaine + betamethasone group compared with none of those in the lidocaine + saline group. Injections were well tolerated. Peres et al evaluated the effect of GON block on 14 patients with CH.[8] Nerve blockade was achieved using 3 mL of lidocaine 1% with triamcinolone 40 mg. Nine patients (64%) had a good or moderate response. Bigo et al evaluated the efficacy of methylprednisolone injection to the GON region in 8 individuals with episodic CH and in 8 with chronic CH.[9] Of the 8 patients with episodic CH, 5 had no further attacks (although 3 were at the end of a cluster period), 1 had a reduction in the severity and frequency of attacks, and 3 had no benefit. In the chronic CH group, 4 had partial improvement and the other 4 had no improvement. In contrast to these data, Busch et al reported on only minor headache improvement in 9 of 15 patients with chronic CH after treatment with GON block, using 5 mL of prilocaine 1%.[10] Afridi et al retrospectively reviewed the records of 19 patients with CH who received a total of 22 GON injections using a mixture of lidocaine and methylprednisolone.[11] The authors found that 10 (53%) patients experienced complete pain relief with a median duration of 12 days, and 3 (16%) experienced partial pain relief with a median duration of 21 days.

Nerve Blocks for Chronic Daily Headache.—Data on the efficacy of GON block for the treatment of chronic daily headache (CDH) are limited (Table 3). Saadah and Taylor examined the effect of GON block on head pain in 112 clinic patients with "sustained headache syndrome" of various etiologies ("vascular," tension, postinfectious, posttraumatic, and unclassifiable).[12] The authors used a mixture of lidocaine 1% and betamethasone for nerve blockade. Tenderness in the occipital nerve zone was an inclusion criterion. A total of 188 headache episodes were treated. The duration of headache was variable: in 69% of the patients it was less than 4 weeks; in 16% – 1-6 months, and in 15% – longer than 6 months. Overall, in 65% of treated headache episodes the injections resulted in pain relief that lasted one week or longer. However, response to treatment varied among the different headache types: in 50 (85%) of the 59 treated "vascular headache" episodes, injections resulted in pain relief lasting more than one week, while the corresponding rate for tension headache was 60/85 (71%). Patients with postinfectious and posttraumatic headache fared worst, with headache-episode response rates of 3/20 (15%) and 1/11 (9%), respectively. This study was limited by the fact that headaches were not classified according to standardized criteria. Importantly, a considerable number of patients did not meet the current International Headache Society criteria for CDH.

Afridi et al examined the efficacy of GON block in 101 patients with refractory CDH of various etiologies (migraine, CH, new daily persistent headache [NDPH], hemicrania continua [HC], and others).[11] The authors used a mixture of lidocaine 2% and methylprednisolone for nerve blockade. A total of 116 injections were performed. Overall, 62 (53%) of the injections resulted in pain relief. Twenty-two percent of the injections resulted in a complete response (pain free) with a median duration of 7 days, and an additional 31% resulted in partial response (reduction of headache severity or frequency by >30%) with a median duration of 20 days. The response to treatment varied among the different headache types: of the 57 injections performed for migraine headaches, 9 (16%) resulted in complete response and 17 (30%) resulted in partial response, while the corresponding figures for NDPH were 4/16 (25%) and 6/16 (38%), and those for HC were 1/10 (10%) and 5/10 (50%), respectively. AEs were uncommon and included transient dizziness, syncope, worsening of headache, and local alopecia. Tenderness over the GON area was associated with response to treatment while anesthesia in the distribution of the nerve was not.

In a randomized controlled study, Ashkenazi et al examined the effect of GON block and TPIs on headache in patients with transformed migraine (TM).[13] The treatment included lidocaine 2% and bupivacaine 0.5% with either saline or triamcinolone. Twenty minutes after injection, there was a significant decrease in the severity of headache and associated symptoms in both groups, with no significant between-group difference in the majority of outcome measures (the exception was the decrease in phonophobia that was more pronounced in the group that received triamcinolone with the local anesthetics).

In a retrospective clinic-based study, Tobin and Flitman examined the effect of symptomatic medication overuse (SMO) on the efficacy of GON block in the treatment of various headache types.[14] The authors used bupivacaine 0.5% and methylprednisolone for nerve blockade. Data on a total of 108 injections were analyzed. Overall, 78% of injections resulted in headache relief, with a mean decrease in head pain of 83% and a mean response duration of 6.6 weeks. Response rate was significantly affected by the presence of SMO: in patients with SMO, it was 56% while in those without SMO, it was 84%. The modulatory effect of SMO on the efficacy of GON block differed among the various headache types, being most pronounced in patients with migraine.

Data on the efficacy of GON block in the treatment of TTH are inconsistent. One open-label study that examined the efficacy of this procedure for chronic TTH was negative.[15] In another study, Bovim and Sand used a mixture of lidocaine and epinephrine to block the GON in 14 patients with TTH.[3] After injection, there was only a moderate pain reduction (14%) in this group. Conversely, Saadah and Taylor reported that 71% of their patients with "tension headache" experienced pain relief lasting more than one week after occipital nerve blocks.[12] These inconsistent data may be explained by different inclusion criteria in the 3 studies: Saadah and Taylor used occipital nerve tenderness as an inclusion criterion, while in the other studies this was not done.

Nerve Blocks for Cervicogenic Headache.— Occipital nerve blocks have also been evaluated in the treatment of CeH (Table 4).[16-18] Anthony injected depot methylprednisolone in the GON and lesser occipital nerve (LON) regions to 180 patients with CeH.[16] Ninety-four percent of these individuals experienced complete pain relief lasting between 10 and 77 days (mean: 23.5 days). In another double-blind and randomized study, 50 patients with CeH received injections of either a mixture of lidocaine, bupivacaine, epinephrine, fentanyl and clonidine, or normal saline to the GON, LON, and facial nerves.[17] Nerve blockade resulted in 50% improvement from baseline in pain intensity, as measured using a visual analog scale (VAS) and Total Pain Index, at 2 weeks. In addition, in the nerve blockade group, there were statistically significant improvements in headache frequency, duration of pain relief, nausea, vomiting, photophobia, phonophobia, appetite, and daily activity, as compared with the control group. In a case series from the same group, 47 patients received repetitive injections to the GON, LON, and facial nerves with a mixture of lidocaine/bupivacaine/epinephrine/fentanyl/clonidine to achieve 6 months of pain relief.[18]

Table 4.—Peripheral Nerve Blocks for Cervicogenic Headache

Study design	n	Intervention	Results	Reference
Case series	180	GON and LON block using methylprednisolone	94% experienced complete pain relief lasting a mean of 24 days	Anthony[16]
Double blind, placebo controlled	50	GON and LON block, with or without facial nerve block, using lidocaine, epinephrine, bupivacaine, fentanyl, and clonidine	Significant head pain improvement at 2 weeks, with decreased analgesic use	Naja et al[17]
Case series	47	GON and LON block, with or without facial nerve block, using lidocaine, epinephrine, bupivacaine, fentanyl, and clonidine	96% achieved 6 months of pain freedom; 87% required repeated injection	Naja et al[18]
Prospective, comparative	28	GON block *or* C_2/C_3 nerve block using lidocaine and bupivacaine	Both treatments resulted in decreased frequency and duration of pain, with no significant between-group differences	Inan et al[19]
Prospective, non-controlled	41	GON block using bupivacaine	A significant reduction in mean head pain during 1 week post injection	Vincent et al[20]
Retrospective	24	A single GON block with or without SON block using lidocaine and epinephrine	77% of those who received GON block had pain relief of >40%. Those who received SON block had 28% pain relief	Bovim and Sand[3]

GON = greater occipital nerve; LON = lesser occipital nerve; n = number of subjects; SON = supraorbital nerve.

Forty-five (96%) patients achieved 6 months of pain freedom, with 41 patients (87%) requiring repeated injection.

In a prospective study, Inan et al compared the effect of GON block to that of C_2/C_3 nerve blocks on pain in 28 patients with CeH.[19] The authors used lidocaine 1% followed in a week by bupivacaine 0.25% for nerve blockade. Both treatments resulted in decreased frequency and duration of pain that lasted for at least 2 months, with no significant between-group differences. Vincent et al studied the effect of GON blocks using 0.5% bupivacaine in 41 patients with CeH.[20] The authors found a significant reduction in head pain at 1 week post injection, as compared with pain during the week before injection. Bovim and Sand treated 24 CeH patients with GON block, SON block, or both, using a mixture of lidocaine and epinephrine.[3] Seventeen of 22 (77%) patients who received GON blocks experienced pain relief of >40% 30 minutes after injections, while those who received SON block alone had 28% pain relief at that time.

Peripheral Nerve Blocks for Other Headaches.—TRIGEMINAL NEURALGIA.—In a single case report, an individual with trigeminal neuralgia who received GON block with 1% lidocaine and 40 mg Depo-medrone experienced partial pain relief.[21]

POST-DURAL PUNCTURE HEADACHE.—Nerve blocks have also been used successfully for the treatment of post-dural puncture headache (PDPH). In a prospective study of 50 patients with PDPH, 25 individuals received hydration and bed rest while the other 25 individuals received nerve-stimulator-guided GON and LON blocks using a mixture of lidocaine/bupivacaine/epinephrine/fentanyl/clonidine.[22] Individuals in the nerve block group had lower pain VAS scores at 6 days, shorter lengths of hospital stay, less sick leave time, and they consumed fewer analgesics. Nearly one-third of patients required up to 4 nerve blocks for pain relief. All patients in the nerve block group experienced complete pain relief at 4 days, while all patients in the control group experienced pain relief at 8 days.

Trigeminal Nerve Blocks for Headache.—A number of studies examined the efficacy of trigeminal nerve blocks (TNBs) in headache management.[3,6,23,24] Sjaastad et al reported on 5 patients with supraorbital neuralgia who responded favorably to SON block, and subsequently to decompression surgery.[23] Common features of their headache before treatment were moderate to severe pain in the frontal and ocular areas that was typically unilateral, and tenderness over the SON. Dimitriou et al examined the effect of a combined SON + supratrochlear nerve (STN) block on acute headache in 70 women with migraine, using lidocaine 2% and epinephrine.[24] Acute attack symptoms were relieved in 82% of the subjects, and the therapeutic effect was complete within 10-15 minutes of the injections. Controlled studies are needed to further assess the efficacy of TNBs in headache treatment.

Trigger Point Injections for Headache.—There are virtually no data as to the efficacy of TPIs for various headache disorders, although this procedure is frequently used in conjunction with PNBs. In addition, as is the case with PNBs, the optimal drug regimen and injection schedule for TPIs are currently unknown.

Adverse Effects of Local Injections.—Localized AEs, such as hematoma and local pain, may occur. Less commonly, alopecia and cutaneous atrophy after the injection of corticosteroids in the GON region have been reported.[25] Caution is advised in individuals with previous cranial surgeries, as loss of consciousness has been reported in a patient with an occipital bone defect receiving an LON block with mepivacaine.[26]

In addition, cases of methemoglobinemia induced by local anesthetics have been reported. In a recent review of 242 cases, 4 local anesthetics (prilocaine, benzocaine, lidocaine, and tetracaine) have been implicated as possibly causing methemoglobinemia.[27] Lidocaine cases were rare and there were no cases due to bupivacaine. Allergic reactions (type I and IV hypersensitivity) to local anesthetics have been reported, and clinicians must be aware of this possibility.[28] These allergic reactions are less common with the amide local anesthetics, such as lidocaine and bupivacaine, as compared with the ester local anesthetics.

Systemic toxicity with local anesthetic use may occur with increased plasma levels in the setting of consuming excessive doses or inadvertent intravascular injections. Central nervous system symptoms range from mild (eg, dizziness, lightheadedness, metallic taste, periorbital numbness, tinnitus, and blurry vision) to serious (eg, muscle twitching, convulsions, coma, and cardiovascular or respiratory depression and arrest). The cardiovascular system can also be affected, and individuals may experience chest discomfort or pain, shortness of breath, palpitations, and syncope. Toxic doses of local anesthetics may cause cardiac arrhythmias, cardiac depression, and hypotension. These AEs are very rare with proper use of the drugs and with caution to avoid intravascular injection. Injecting epinephrine while performing GON block has been reported to cause scalp necrosis due to vasospasm of the nearby occipital artery, which is an end artery.[29]

DISCUSSION

Our literature review reveals paucity of controlled data on the efficacy of PNBs and TPIs in headache management. Few studies have addressed this issue, and the majority of those that did had significant limitations, including a small number of patients, a retrospective, non-controlled design, and heterogeneous groups of patients. In addition, the studies that have been done so far differ in the technique used for nerve blockade, the type and doses of local anesthetics used, the injected volume, the location and number of injections, the time intervals between injection sessions, and the way treatment efficacy was assessed. Clearly, there is a need to obtain more data on the efficacy of these treatments in the management of various headache disorders in order to formulate a standardized approach to their use in headache patients.

The majority of studies that examined the efficacy of PNBs in headache treatment focused on blockade of the GON, but some reported on trigeminal blocks as well. There is scientific evidence for both anatomic connections and functional interactions between the GON and the trigeminal system.[30,31] These data lend support to the use of GON blocks in headache disorders, even when head pain is located outside of the GON territory, in trigeminal dermatomes. Some of the above studies support this notion.

Nerve Block for Headache: Optimizing Outcomes.—There are few data regarding symptoms that are predictive of efficacy of PNBs. Afridi et al found that local tenderness at the GON area was associated with a positive response to blocking the nerve, whereas numbness in the dermatomal area of the nerve was not.[11] Tobin and Flitman found that patients who overused pain medications fared significantly worse after GON block, compared with those who did not.[14] The negative effect of medication overuse on the response to nerve blockade was most pronounced in patients with migraine. Conversely, Afridi et al found no significant association between medication overuse and response to GON block in their sample of patients with CDH.[11] There are currently no data as to the optimal dose, volume, or type of local anesthetic to be used for PNBs or TPIs in headache management. Comparative studies are needed to clarify this issue. As for the use of corticosteroids, the study by Ashkenazi et al does not support the routine use of these agents when performing GON block in patients with TM.[13] However, there are data that support their use in the treatment of CH.[7] Adding corticosteroids to local anesthetics when performing PNBs has been associated with rare but serious AEs, such as Cushing syndrome.[32] Therefore, these agents should be used with caution in this setting.

There is currently no evidence to support the use of polypharmacy, as done by Naja et al when performing PNBs.[17] In addition, the authors do not recommend the routine use of epinephrine when performing GON block because of the risk of scalp necrosis due to vasoconstriction of the adjacent occipital artery. The occipital artery has variable anatomy in relation to the GON.[33,34] Injecting epinephrine in the vicinity of the artery may induce vasospasm, and since it is an end artery, may result in scalp necrosis.[29]

As for the location of injections, the authors recommend the following sites based on anatomical data: GON block – one-third of the distance between the external occipital protuberance and the mastoid process; LON block – two-thirds of the distance between the same points; auriculotemporal nerve block – just above the posterior portion of the zygoma and anterior to the ear; STN block – just above the eyebrow at its medial border; SON block – 2 cm lateral to the site of STN block, at the mid-pupillary line; infraorbital nerve block – at the inferior margin of the orbit, on the same vertical line as the site of SON block.[1]

Goals for Future Research.—Future studies should examine the efficacy of specific PNBs in the treatment of headache in a prospective standardized manner. Each study should include a homogenous group of patients (eg, episodic migraine, chronic migraine, etc.). The treatment protocol, as well as the outcome measures, should be predetermined. Efficacy of treatment should be evaluated in a blinded manner. The studies should be controlled, using sham injections for the control group. Blinding of patients to the type of treatment they receive will be challenging since many patients in the local anesthetic arm will experience numbness in the distribution of the blocked nerve, while those in the sham injection arm will not. Studies should include a large enough number of patients to obtain statistically meaningful results.

In addition, different treatment regimens should be compared, possibly using the model designed by Ashkenazi et al with regards to the effect of adding corticosteroids to local anesthetics when performing PNBs.[13] In these studies, blinding of patients will be easier, since local anesthetics will be used in both arms.

The efficacy of TPIs for headache should be examined independently of the effects of PNBs. This can be done by giving PNBs-only to one group while giving PNBs + TPIs to the other. Again, the study population should be homogenous in order to obtain clinically applicable results.

Data from future, more rigorously designed studies will help us understand what nerve blockade or TPI regimens are optimal for any given headache diagnosis. Using these data, we will be able to tailor a treatment plan that will be the most effective for the individual patient, and to improve the outcomes of this important treatment modality for headache patients.

REFERENCES

1. Ashkenazi A, Levin M, Dodick DW. Peripheral procedures: Nerve blocks, peripheral neurostimulation and Botulinum neurotoxin injections. In: Silberstein SD, Lipton RB, Dodick DW, eds. *Wolff's Headache and Other Head Pain*. New York: Oxford University Press; 2007:767-792.
2. Ashkenazi A, Young WB. The effects of greater occipital nerve block and trigger point injection on brush allodynia and pain in migraine. *Headache*. 2005;45:350-354.
3. Bovim G, Sand T. Cervicogenic headache, migraine without aura and tension-type headache. Diagnostic blockade of greater occipital and supra-orbital nerves. *Pain*. 1992;51:43-48.
4. Barrett J, Harmon D, Loughnane F, et al. Local anesthetics. In: Barrett J, Harmon D, Loughnane F, et al, eds. *Peripheral Nerve Blocks and Peri-Operative Pain Relief*. Edinburgh: Saunders; 2004:11-18.
5. Gawel MJ, Rothbart PJ. Occipital nerve block in the management of headache and cervical pain. *Cephalalgia*. 1992;12:9-13.
6. Caputi CA, Firetto V. Therapeutic blockade of greater occipital and supraorbital nerves in migraine patients. *Headache*. 1997;37:174-179.
7. Ambrosini A, Vandenheede M, Rossi P, et al. Suboccipital injection with a mixture of rapid- and long-acting steroids in cluster headache: A double-blind placebo-controlled study. *Pain*. 2005;118:92-96.
8. Peres MF, Stiles MA Siow HC, et al. Greater occipital nerve blockade for cluster headache. *Cephalalgia*. 2002;22:520-522.
9. Bigo A, Delrieu F, Bousser MG. [Treatment of vascular pain of the face by methylprednisolone injection into the area of the greater occipital nerve: 16 cases]. *Rev Neurol (Paris)*. 1989;145:160-162.
10. Busch V, Jakob W, Juergens T, et al. Occipital nerve blockade in chronic cluster headache patients and functional connectivity between trigeminal and occipital nerves. *Cephalalgia*. 2007;27:1206-1214.
11. Afridi SK, Shields KG, Bhola R, et al. Greater occipital nerve injection in primary headache syndromes – Prolonged effects from a single injection. *Pain*. 2006;122:126-129.
12. Saadah HA, Taylor FB. Sustained headache syndrome associated with tender occipital nerve zones. *Headache*. 1987;27:201-205.
13. Ashkenazi A, Matro R, Shaw JW, et al. Greater occipital nerve block using local anaesthetics alone or with triamcinolone for transformed migraine: A randomised comparative study. *J Neurol Neurosurg Psychiatry*. 2008;79:415-417.
14. Tobin JA, Flitman SS. Occipital nerve blocks: Effect of symptomatic medication overuse and headache type on failure rate. *Headache*. 2009;49:1479-1485.
15. Leinisch-Dahlke E, Jurgens T, Bogdahn U, et al. Greater occipital nerve block is ineffective in chronic tension type headache. *Cephalalgia*. 2005;25:704-708.
16. Anthony M. Cervicogenic headache: Prevalence and response to local steroid therapy. *Clin Exp Rheumatol*. 2000;18:S59-S64.
17. Naja ZM, El-Rajab M, Al-Tannir MA, et al. Occipital nerve blockade for cervicogenic headache: A double-blind randomized controlled clinical trial. *Pain Pract*. 2006;6:89-95.
18. Naja ZM, El-Rajab M, Al-Tannir MA, et al. Repetitive occipital nerve blockade for cervicogenic headache: Expanded case report of 47 adults. *Pain Pract*. 2006;6:278-284.
19. Inan N, Ceyhan A, Inan L, et al. C2/C3 nerve blocks and greater occipital nerve block in cervicogenic headache treatment. *Funct Neurol*. 2001;16:239-243.
20. Vincent MB, Luna RA, Scandiuzzi D, et al. Greater occipital nerve blockade in cervicogenic headache. *Arq Neuropsiquiatr*. 1998;56:720-725.
21. Weatherall MW. Idiopathic trigeminal neuropathy may respond to greater occipital nerve injection. *Cephalalgia*. 2008;28:664-666.
22. Naja Z, Al-Tannir M, El-Rajab M, et al. Nerve stimulator-guided occipital nerve blockade for postdural puncture headache. *Pain Pract*. 2009;9:51-58.
23. Sjaastad O, Stolt-Nielsen A, Pareja JA, et al. Supraorbital neuralgia. On the clinical manifestations and a possible therapeutic approach. *Headache*. 1999;39:204-212.
24. Dimitriou V, Iatrou C, Malefaki A, et al. Blockade of branches of the ophthalmic nerve in the manage-

ment of acute attack of migraine. *Middle East J Anesthesiol*. 2002;16:499-504.

25. Shields KG, Levy MJ, Goadsby PJ. Alopecia and cutaneous atrophy after greater occipital nerve infiltration with corticosteroid. *Neurology*. 2004;63:2193-2194.
26. Okuda Y, Matsumoto T, Shinohara M, et al. Sudden unconsciousness during a lesser occipital nerve block in a patient with the occipital bone defect. *Eur J Anaesthesiol*. 2001;18:829-832.
27. Guay J. Methemoglobinemia related to local anesthetics: A summary of 242 episodes. *Anesth Analg*. 2009;108:837-845.
28. Caron AB. Allergy to multiple local anesthetics. *Allergy Asthma Proc*. 2007;28:600-601.
29. Brandy DA. Scalp lifting. An 8-year experience with over 1230 cases. *J Dermatol Surg Oncol*. 1993; 19:1005-1014.
30. Goadsby PJ, Bartsch T, Dodick DW. Occipital nerve stimulation for headache: Mechanisms and efficacy. *Headache*. 2008;48:313-318.
31. Bartsch T, Goadsby PJ. Stimulation of the greater occipital nerve induces increased central excitability of dural afferent input. *Brain*. 2002;125:1496-1509.
32. Lavin PJ, Workman R. Cushing syndrome induced by serial occipital nerve blocks containing corticosteroids. *Headache*. 2001;41:902-904.
33. Bovim G, Bonamico L, Fredriksen TA, et al. Topographic variations in the peripheral course of the greater occipital nerve. Autopsy study with clinical correlations. *Spine*. 1991;16:475-478.
34. Becser N, Bovim G, Sjaastad O. Extracranial nerves in the posterior part of the head. Anatomic variations and their possible clinical significance. *Spine*. 1998;23:1435-1441.