Interventional techniques for headaches

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ABSTRACT

Primary headaches can become quite severe and incapacitating for patients that suffer from them. The management could be challenging even in the hands of experienced physicians. Once the headaches become refractory to pharmacologic management, the use of interventional techniques including peripheral nerve block can be a feasible option to achieve pain relief, and decrease the intensity and frequency of headache. Multiple studies have demonstrated that peripheral nerve blocks are safe and effective for the treatment of a variety of headaches disorders, including migraine, cluster, tension-type headaches, and cervicogenic, among others. These techniques not only provide adequate analgesia but can also help decrease systemic side effects from pharmacologic therapy. They can be performed in patients with comorbidities that preclude them from adequate pharmacologic therapy. The small number of adverse events that have been reported from these procedures make them an attractive therapeutic alternative in the management of primary headaches. In this article, we provide an overview of the most common interventional techniques used for headache treatment and review the literature supporting their efficacy.

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Introduction

The use of interventional techniques in the management of headaches is a well-established practice among pain management and headache specialists for patients with refractory headaches of different types. They also can be utilized in patients that develop intolerable side effects from the pharmacologic regimen, or those with significant comorbidities in whose case the use of pharmacologic treatment is not feasible. For those patients, peripheral nerve blocks are a reasonable, safe, and effective alternative to be considered. The rationale for the utilization of these therapeutic approaches resides in the blockade of conduction of sensory signals for the duration of action of the local anesthetic; however, an effect that exceeds the local anesthetic duration is often achieved. A wide variety of procedures have been described for a diversity of headache types including chronic migraine (CM), cluster headache (CH), cervicogenic headaches (CeH), chronic daily headaches (CDH), chronic tension-type headaches (TTH), and occipital neuralgia (ON), among others. In 2010, the American Headache Society (AHS) conducted a survey among member practitioners on patterns of nerve blocks and trigger point injections for headache treatment. The most common indications for the use of nerve blocks were ON (92.7%) and CM (65.5%), and the most common indication for the use of trigger points were chronic TTH (81.5%) and CM (67.7%).[1] The level of evidence for these interventions varies depending on the procedure and headache type, and is mostly based on noncontrolled, observational studies. In this article, we review the evidence for the most common interventional technique performed for different headache types.

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Greater and lesser occipital nerve block

The use of peripheral nerve blocks in the management of refractory headaches has increased in popularity in the past few decades despite the scarce evidence available. One of the most widely used procedures has been greater occipital nerve block (GONB) for the treatment of ON and CeH. The greater occipital nerve (GON) is composed of sensory fibers (dorsal primary rami) that originate at the C2 and C3 spinal segments and the lesser occipital nerve (LON) originates from the ventral primary rami of the same cervical roots. The presence of pain in trigeminally innervated regions of the head and occipital area innervated by the C2 spinal root in patients with different headache syndromes suggests a functional connectivity between trigeminal and cervical afferents.[2] There is an overlap of processing of nociceptive information at the level of the second-order neurons due to convergence between the trigeminal and C1 and C2 spinal afferents at the trigeminal nucleus caudalis and dorsal horn nuclei of the upper cervical cord.[3,4]

The GONB is performed by palpating the occipital artery approximately one-third between the occipital protuberance and the mastoid process then infiltrating local anesthetic medial to the artery. The LON can be blocked by infiltrating 1-in inferior and medial to the previously infiltrated area (Figure 1). It has been shown to be a very safe procedure with some associations with local alopecia and hypopigmentation at the injection site.[5] While performing a GONB, some practitioners prefer the use of local anesthetics alone or in combination with corticosteroids even though its use has not been supported by the literature.[5,6] Adverse effects have been reported in the literature when high-concentration local anesthetics were used.[7] The local adverse effects related to the local anesthetic that may occur include infection, hematoma, and damage to adjacent structures
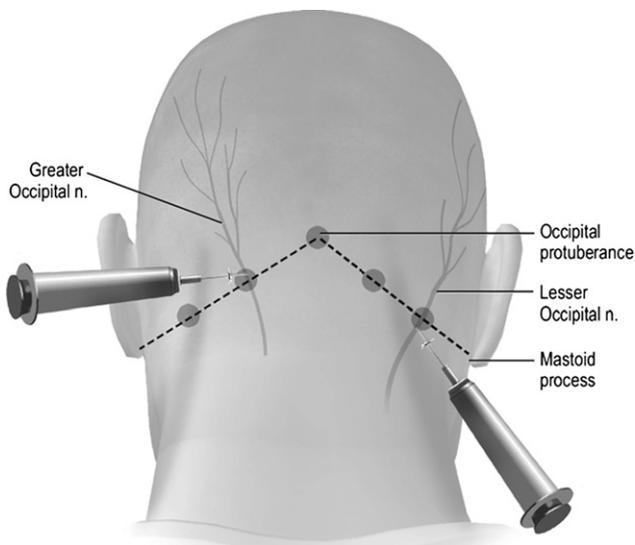

Figure 1 – Greater and lesser occipital nerve blocks. (Figures 1-3, and 8 reprinted with permission from Ashkenazi A and Levin M.[82])

(if use in combination with steroids) and systemic effects such as dizziness, lightheadedness, slurred speech, and nausea.

Although the use of GONB has been proven to be successful for the management of certain types of headaches, such as CeH, CH,[8] ON,[9] and CM[10]; the literature on TTH,[11] posttraumatic headaches (PTH), chronic paroxysmal hemicrania, and chronic daily headache (CDH) is limited; and the presence of medication-overuse headache could increase the risk of GONB failure.[12]

Migraine headache

A retrospective study conducted by Gawel and Rothbart evaluated the efficacy of GONB in patients with CM and PTH, who were unresponsive to medical therapy. In the non–posttraumatic group 54% ($n = 97$) and 72% ($n = 87$) of the posttraumatic group felt "significantly better" after treatment.[13] Bovim and Sand[14] evaluated the effects of GONB and supraorbital nerve block (SONB) in patients with CeH ($n = 24$), CM ($n = 14$) and TTH ($n = 14$). The response rate was higher for the CeH group with maximal pain reduction of 54.5% compared with 14% in the TTH and only 6% in the CM group.[14]

In 1997, Caputi and Firetto investigated the therapeutic value of GONB and SONB in 27 patients with migraine refractory to pharmacologic treatment. The patients received 0.5-1 mL of 0.5% bupivacaine, repeated sessions on alternate days, for a minimum of 5 and a maximum of 10 sessions. The efficacy of the treatment was evaluated by the total number of migraine attacks per month, analgesic consumption, and Total Pain Index (TPI). Positive responders were those who showed a decrease in the TPI of at least 50% within the first month of therapy. A total of twenty-three (85%) patients responded favorably to the nerve blocks for up to 6 months.[10]

A prospective study conducted by Askenazi and Young studied the effect of GONB with or without trigger point injections on dynamic mechanical brush allodynia in patients with CM. A total of 19 patients were evaluated. The pain score was reduced in 89.5% of the patients, 20 minutes after the treatment. The average pain scores were 6.53 and 3.47, before and after treatment, respectively. This study also showed a significant reduction on dynamic mechanical allodynia ($P < 0.001$) in the trigeminal and cervical areas after GONB.[15]

In a more recent prospective study to determine the safety and efficacy of GONB to treat CM, 150 patients were treated with either unilateral or bilateral GONBs. The main treatment outcome was defined as more than 50% reduction in headache days per month over a 30-day period posttreatment. Fifty-two percent had a positive treatment response and 60% reported their headache to be "better" or "much better".[16]

Cervicogenic headache

In 1992, Anthony conducted a retrospective study to determine whether relief from headache could be achieved by blockade of the occipital nerves using local anesthetic and

methylprednisolone. Of a total of 184 patients with a diagnosis of CeH that were included in the study, 94% of patients had complete relief from headache for a period ranging from 10 to 77 days. The mean duration of pain relief was 23.5 days.[17]

Bovim and Sand, treated 24 patients with CeH using GONB and SONB. The response rate was as high as 54.5% maximal pain reduction for the CeH group when compared with the other headache types. Seventy-seven percent of those patients reported a maximal pain relief of more than 40% during the 30 minutes following the procedure.[14] In a prospective, comparative study conducted by Inan et al.[18] the effectiveness of GONB was compared against C2-3 nerve blocks in 28 patients with CeH. In both groups, there was a decrease of approximately 90% in the frequency of headache (no statistical difference) and a mean duration of 2 months. In another study a total of 100 patients diagnosed with CeH responded to repeated GONB.[19]

A randomized, double-blind, placebo-controlled trial conducted by Naja et al.[20] evaluated the effectiveness of nerve stimulator-guided GONB for CeH. Fifty patients were randomized to receive GONB and lesser occipital nerve blocks, with or without facial nerve block, vs normal saline. The patients in the anesthetic block group received 10 mL of a mixture of lidocaine, epinephrine, bupivacaine, fentanyl, and clonidine. There was a significant pain reduction of nearly 50% in visual analog scale (VAS) and TPI from baseline ($P = 0.0001$), 2 weeks after the injection of the anesthetic mixture. There also was a significant reduction in analgesic consumption of paracetamol and dextropropoxyphene ($P = 0.0001$), tramadol ($P = 0.006$), and ketoprophen ($P = 0.01$) in the block group compared with placebo patients. In a subsequent study, 47 patients received GONB or LONB using the same mixture described above. Ninety-six percent of the patients achieved 6 months of pain relief with 87% of them requiring repeated injections.[21]

Cluster headache

Bigo et al.[22] described the efficacy of GONB using methylprednisolone in 16 patients with CH (episodic (eCH) and chronic (cCH)). Sixty-three percent of the patients with eCH ($n = 8$) had no further attacks; however 37% had no benefit. Among the patients with cCH, 50% had partial improvement and 50% had no relief.

Peres et al.[8] evaluated the reduction in mean headache frequency and increase in headache-free days in 14 patients with CH. These patients received a GONB ipsilateral to the painful side. Mean headache intensity, duration, and frequency were assessed before and 1 week after the procedure. The response was considered good (headache free for at least 2 weeks) and moderate to good (headache-free days that lasted less 2 weeks) in 28.5% and 64% of patients, respectively.

A double-blind, placebo-controlled study conducted by Ambrosini et al.[23] compared GONB with 0.5 mL of 2% lidocaine and normal saline vs 0.5 mL of 2% lidocaine with betamethasone in patients with CH. Sixteen episodic and 7 chronic cluster headache patients were included. Eleven (85%) patients in the intervention group became attack free in the first week (within 72 hours) after the injection

compared with none in the placebo group ($P = 0.0001$), of which 73% remained attack free for 4 weeks ($P = 0.0026$). In a prospective study, Busch et al.[2] studied 15 patients with active chronic cCH before and after GONB ipsilateral to the headache. Only 9 out of 15 patients (60%) had some improvement to a minor degree. However, 47% of the patients did not have a repeat attack until the following day after the procedure.

Chronic daily headache

In 1987, Saadah and Taylor evaluated, in a prospective study, the effect of GONB on head pain in 112 patients with various etiologies, including vascular, tension, postinfectious, post-traumatic, and unclassifiable. Overall, 65% of the treated episodes had relief for more than a week and 27% had relief for less than a week. Among the patients with vascular-type headache, 85% of the treated episodes ($n = 59$) had relief for more than 1 week. In those patients with TTH, 71% of the treated episodes ($n = 85$) had relief for more than 1 week and 25% had relief for less than 1 week. For the posttraumatic and postinfectious episodes, 9% ($n = 11$) had relief for more than 1 week and 60% ($n = 20$) had relief for less than a week, respectively.[24]

In a study conducted by Afridi et al.[25] 101 patients with primary CDH including CM (49%), CH (19%), new daily persistent headache (14%), and hemicrania continua (9%), were followed up after a single GONB. Fifty-three percent of the patients showed either complete (22%) or partial (31%) pain relief. The mean duration of response for the CM group was 9 and 61 days for complete and partial response, respectively. In the CH group, the mean duration of complete response and partial response were 17 days and 52 days, respectively. This study demonstrated that a single injection of local anesthetic in the GON exceeds the local analgesic effect, therefore suggesting that the mechanism of action could be due to changes in the nociceptive pathways.

In a randomized, controlled study conducted by Ashkenazi et al.[5] 37 patients with a diagnosis of transformed migraine were included to determine whether the addition of triamcinolone to local anesthetic increased the efficacy of GONB and trigger point injections. There was a decrease in mean headache severity by 3.2 ($P < 0.01$) and 3.1 ($P < 0.01$) points in the groups receiving the local anesthetic alone (Group A) and the combination of local anesthetic and corticosteroid (Group B), respectively. The headache-free interval was 2.7 days and 1.0 days in groups A and B, respectively ($P = 0.67$).

A chart review of 108 patients examined the effect of symptomatic medication overuse on the efficacy of GONB in various types of headaches. Of the 108 patients, 78% had a mean decrease in head pain of 83% with a mean duration of 6.6 weeks. There was a significant difference in response rate among patients, with and without a medication overuse history, of 56% and 84%, respectively ($P < 0.000$). The failure rate in CM was higher than ON.[12]

Chronic tension-type headache

The evidence for the use of GONB in the treatment of chronic TTH seemed to discourage its use due to possible worsening

of symptoms. In an open-label trial, 15 patients with chronic TTH received GONB bilaterally with 50 mg prilocaine 1% and 4 mg dexamethasone. The mean headache intensity and side effects were assessed before and up to 3 weeks after the procedure. A positive treatment response was defined as a reduction of days with headaches of more than 50% or reduction of headache intensity of more than 50% compared with before the GONB. Seventy-three percent of the patients experienced no change in headache intensity or frequency within 2 weeks of the intervention. The headaches were exacerbated in 4 patients.[11]

Supraorbital and supratrochlear nerve block

After the frontal nerves enter the superior orbital fissure they divide into supraorbital and supratrochlear nerves. For blockade of the superior orbital nerve, the supraorbital notch is palpated, the needle advanced until paresthesias are felt in the distribution of the nerve, and infiltration with local anesthetic is performed. Subsequently, the needle is redirected medially, approximately 2 cm toward the bridge of the nose where it meets the supraorbital ridge, for blockade of the supratrochlear nerve (Figure 2). Bovim and Sand evaluated the diagnostic value of GON and SONB in patients with CeH, CM without aura, and TTH. The SONB had poorer differentiation between the headache groups than GONB. The maximal average pain reduction was 28% in the CeH, 30% in the TTH, and 16% in the CM groups. The SONB did not relieve pain outside the innervation areas in the CM and TTH groups.[14] Another study conducted by Caputi and Firetto evaluated the therapeutic value of GONB and SONB in 27 patients with CM headaches. Responders were considered as
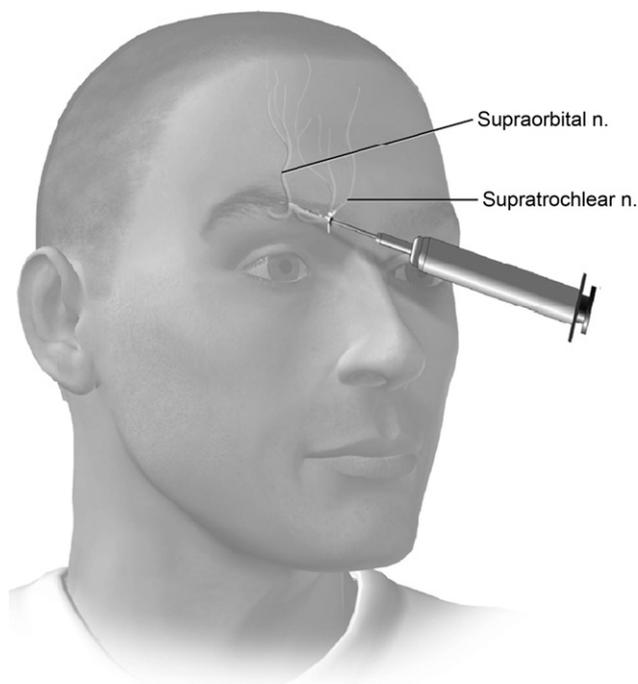
those who showed a decrease in the TPI of at least 50% within the first month. Eighty-five percent of the patients had a positive response.[10]

Auriculotemporal nerve block

The auriculotemporal nerve is the posterior branch of the mandibular branch of the trigeminal nerve that runs with the superficial temporal artery and vein, over the zygomatic arch providing sensory innervations to the auricle; external auditory meatus; portions of the tympanic membrane, pinna, and temporomandibular joint; and the skin over temporal region. The auriculotemporal nerve can be blocked in the area near the root of the zygoma, anterior to the tragus, using a local anesthetic (Figure 3). In spite of the fact that controlled trials proving the effectiveness of this type of block in the treatment of headaches are nonexistent, it may be of benefit in a selected group of patients.

Radiofrequency of the greater occipital nerve

Radiofrequency neurotomy of the GON after a positive response to GONB has had increased popularity among practitioners. However, the scientific evidence on radiofrequency neurotomy for pain in the GON distribution is limited, with only a 2 C+ recommendation.[26] In 1982, Blume et al.[27] published an observational report of 450 patients with occipital pain and their response to percutaneous radiofrequency neurotomy of the GON. All patients underwent GONB with local anesthetic mixed with methylprednisolone. If temporary pain relief was achieved for several weeks, then
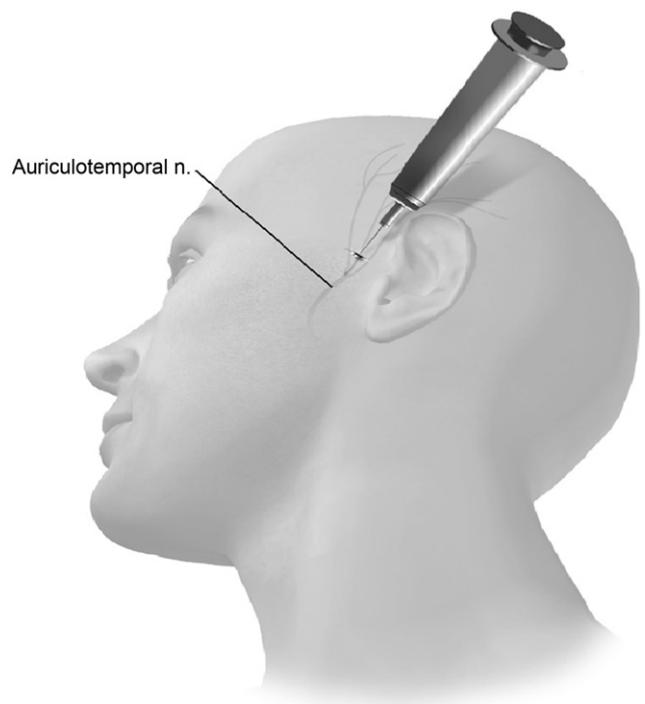

Figure 2 – Supraorbital and supratrochlear nerve blocks. (Reprinted with permission from Ashkenazi A and Levin M.[82])

Figure 3 – Auriculotemporal nerve block. (Reprinted with permission from Ashkenazi A and Levin M.[82])

patients became candidates for radiofrequency neurotomy. The procedure was performed by introducing a 12G 2-in-long needle guide to apply radiofrequency until the tip temperature reached 90 °C and then held for 90-120 seconds. The following criteria were considered for evaluation : excellent, for complete pain relief; good, for relief of all pain except for transitory discomfort in the region of the GON; fair for significant (50%) reduction in frequency and intensity of pain; and no pain relief. Eighty-five percent of the patients had good to excellent results.

A prospective trial by Vanelderen et al. [28] included 19 patients with ON who were treated with pulsed radiofrequency of the GON. Sixty-eight percent, 58%, and 53% of the patients reported pain relief of more than 50% at 1, 2, and 6 months after pulsed radiofrequency, respectively. The mean VAS score before treatment was 7.5 and it declined to 3.5, 3.5 and 3.9 at 1, 2 and 6 months, respectively ($P < 0.001$, $P < 0.001$, $P = 0.006$).

A pilot study conducted by Gabrhelík et al.[29] compared the efficacy of pulsed radiofrequency to the GON vs a GONB using a mixture of local anesthetic and corticosteroid in the management of refractory CeH. A total of 30 patients with refractory CeH were randomly assigned to receive either GONB with 3 mL of a mixture of 0.25% bupivacaine with 10 mg of methylprednisolone (Group A) or pulsed radiofrequency (Group B) at a voltage 45 V for 120 seconds, using a 20G insulated radiofrequency needle with 5 mm active tip. If the temperature of the tip rose above 42 °C, the voltage was reduced to 40-42 V. The median VAS before treatment was 5.5 in Group A and 5.9 in Group B and 2.3 in Group A and 2.6 in Group B, at 3 months ($P < 0.001$). At 9 months, the median VAS was 3.1 in Group B ($P < 0.001$). There also was a significant reduction in the consumption of analgesic medication in both groups at 3 months ($P < 0.001$).

Cervical zygapophyseal joint nerve block

The recognition of pain generators of the cervical spine, such as the cervical zygapophyseal (ZP) joints, has been an important contribution to the literature on CeH and chronic neck pain, in which a main emphasis has been given to the upper cervical region.[30-33] An earlier study by Dwyer et al. created pain charts determining the segmental location of symptomatic cervical ZP joints, by distending of the joint capsule injecting contrast in healthy volunteers (Figure 4). In addition to the cervical ZP joints, there are several anatomical structures that have also been identified as possible pain generators in CeH, such as the upper cervical ligaments and muscles, uncovertebral clefts,[34] medial and lateral atlanto-axial joint,[35-38] the dura mater of the posterior cranial fossa,[39] the cervical intervertebral disks,[40] cervical dorsal roots,[9] GON/LON,[3,4] and TON.[41]

The prevalence of cervical-ZP joint arthrosis has been shown to increase with age (up to 30%) and affects the upper cervical spine more often than the lower levels, with 12.4% occurring at the C2-3 level, 13.3% at the C3-4 level, and 14.6% at the C4-5 level.[42] However, the mere presence of ZP joint arthrosis does not predict the development of ZP joint pain with or without headaches. The prevalence of ZP joint pain
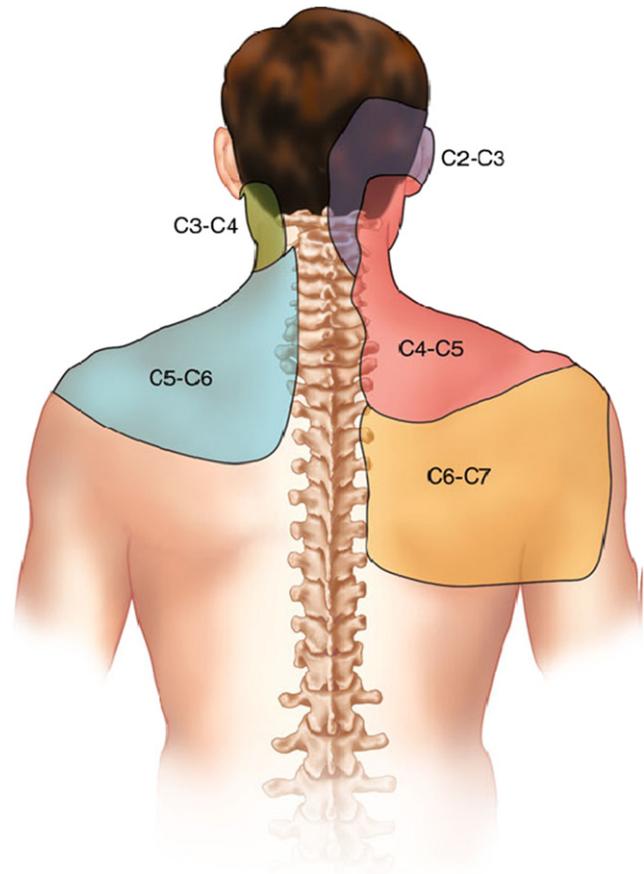

Figure 4 – Zygapophyseal joint referred pain patterns. (Reprinted with permission from Hoppenfeld JD.[83])

among patients with chronic neck pain has been previously reported to be as high as 60%, which cannot be explained solely by the presence of arthrosis.[43]

Despite the high prevalence, not all the patients with ZP joint pain develop CeH. The exact mechanism of the presence of headaches is not completely understood. A recent quantitative sensory-testing study explored the differences in sensory-pain processing in patients with chronic CeH with underlying chronic ZP pain compared with patients with ZP pain without headaches. It showed that the main difference between these patients is the lateralization of pressure hyperalgesia to the painful side of the head and neck, which is accompanied by cold as well as warm relative hyperesthesia on the painful side of the face in patients with CeH. This suggests a rostral neuraxial spread of central sensitization, probably to the trigeminal spinal nucleus.[44]

The cervical ZP joints are innervated by the medial branch block of the dorsal ramus above and below its location, with the exception of the C2-3 joint which has dual innervation by the C3 medial deep branch and the C3 medial superficial branch or TON. Unfortunately, there are no diagnostic imaging techniques of the cervical spine and its associated structures that can specifically detect the source of pain. Therefore, diagnosis and treatment are based on diagnostic nerve blocks to identify the source of the pain generator before considering further interventional or neuroablative treatment (Figure 5).
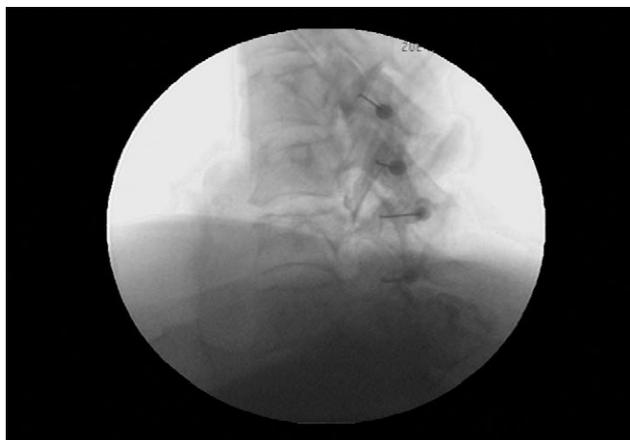
Figure 5 – Zygapophyseal joint nerve blocks. Reproduced with permission from Holly Zoë, MD, http://www.eastidahopain.com.

Several studies have demonstrated the validity of ZP joint nerve blocks in the diagnosis of neck pain and headaches.[45-48] However, other studies have shown significant high rates of false positives when a single diagnostic block is performed.[49-51] True positive responses on 2 separate occasions should be obtained by performing comparative blocks with 2 local anesthetics of different duration of action, or a local anesthetic and placebo injections with normal saline.[45-48]

In a large systematic review Sehgal et al.[48] evaluated the available evidence relating to clinical utility of ZP joint injections in the diagnosis of chronic spinal pain of ZP joint origin. This review found strong evidence for the use of controlled diagnostic blocks with local anesthetics and found them to be reproducible, accurate, and safe. A randomized, double-blind, controlled study conducted by Barnsley et al.[52] investigated the use of local anesthetic blocks for the diagnosis of cervical ZP joint pain. A total of 47 patients with chronic neck pain after whiplash injury were included. They were submitted to the so-called "double diagnostic blocks" of the medial branches of the cervical dorsal rami, with either lidocaine or bupivacaine, and then crossed over to the complementary anesthetic if a positive response was elicited. Seventy-seven percent ($n = 44$) of the patients that had a positive response to both blocks had longer pain relief with bupivacaine ($P = 0.0002$). These "double diagnostic blocks" were validated as a technique in the identification of painful zygapophyseal joints. Some authors argue that the smaller the volume of injectate while performing cervical ZP joint nerve blocks, the higher the specificity.[53]

In terms of the use of cervical ZP joint nerve blocks for therapeutic purposes, the scientific evidence is moderate. In a prospective study 100 patients that met the diagnostic criteria for ZP joint pain were submitted to therapeutic blocks after positive "double diagnostic blocks" with local anesthetics. Each level was infiltrated with 1-2 mL of local anesthetic, with or without Sarapin or Depo-Medrol, or both. The treatments did not exceed 6 times per year in the therapeutic phase (1 year). This study showed a significant pain relief of more than 50% in 92% of the patients at 3 months, 82% at 6 months, and 56% at 12 months as well as an improvement in numeric pain assessment at the same time periods.[54]

In a retrospective study conducted by Zhou et al.[55] 31 patients with refractory CeH underwent C1-2, C2-3 ZP joint injections and C2, C3 spinal rami blocks using a mixture of 0.25% bupivacaine and 3 mg betamethasone. Twenty-eight (90%) of the patients had a more than 50% pain relief after treatment, with a diminution in pain intensity from 7.5 to 2.7 immediately after the procedure ($P < 0.0001$), mean duration 21.7 days.

A total of 120 patients with chronic neck pain of ZP origin participated in a randomized, double-blind, controlled trial to evaluate the clinical outcomes of therapeutic cervical medial branch blocks with local anesthetic, with or without steroids. Eighty-five percent of the patients in Group A (bupivacaine with or without Sarapin) and 93% of the patients in Group B (bupivacaine plus steroid with or without Sarapin) had significant pain relief (more than 50%) at the 2-year follow-up. The average number of treatments for 2 years was 5.7, with an average duration of pain relief of 17-19 weeks in the 2 groups.[56]

ZP joint block has been proven to be a safe procedure for the treatment of facetogenic pain. Even though minor side effects are common, major complications are extremely rare. A recent prospective study conducted by Manchikanti et al.[57] investigated the incidence and characteristics of adverse effects and complications of ZP joint nerve blocks. A total of 3370 cervical encounters were reported. The most common, minor complications were intravascular penetration (20%), local bleeding (66.9%), and oozing (28.9%). There were no serious complications reported, such as nerve damage, spinal cord irritation, epidural hematomas, or infections.

Radiofrequency neurotomy of cervical zygapophyseal joints

Chronic neck pain originating in the cervical ZP joints is a common problem but its treatment may be challenging. Once a clinically significant pain reduction is established, after diagnostic or therapeutic ZP joint nerve blocks, percutaneous radiofrequency neurotomy can relieve the pain by denaturing the nerves innervating the painful joint for a long-lasting pain-relief effect. A radiofrequency cannula is inserted under fluoroscopic guidance to the target nerve. Using a radiofrequency neurotomy generator, a lesion is created by heating the surrounding tissues to destroy any sensory inputs to the ZP joint. However, it does entail a constant temperature, usually between 75°C and 80°C, for 60-90 seconds. Multiple lesions per level (up to 3) may be required due to the anatomical variability of the nerves[58]; Figure 6. This technique has been proven to be effective in the treatment of patients with chronic neck pain.[59,60] In addition, radiofrequency neurotomy of the cervical ZP joints for CeH has been investigated numerous times with variable success.[61]

Although it has been proven to be a safe procedure, radiofrequency has been associated with complications related to needle placement and neurolysis. For the most part, the complications are short-lived and self-limited, including local swelling and pain at the needle-insertion site. General complications related to needle placement may include pneumothorax, dural puncture, neural trauma, and spinal cord trauma, among others; whereas those related to the
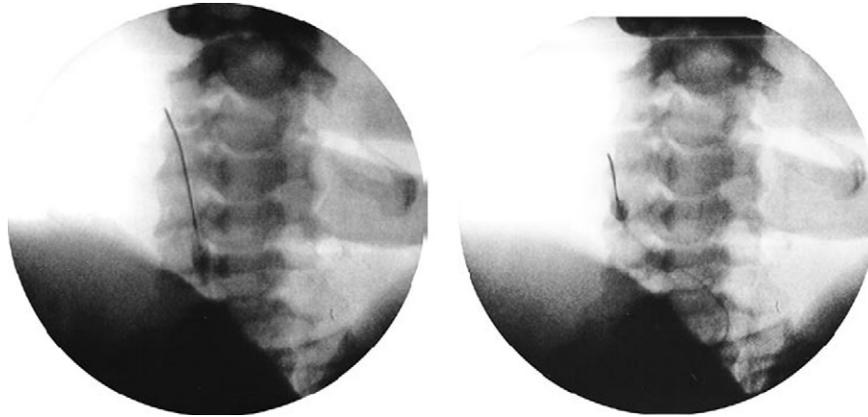
Figure 6 – Radiofrequency neurotomy of zygapophyseal joints. (Figures 6 and 7 reprinted with permission from Manchikanti et al.[84])

thermoneurolysis comprise worsening of pain, burning or dysesthesias, decreased sensation and allodynia in the paravertebral skin, and possible deafferentation pain.

In an open-label study by Hildebrant patients with head and neck pain underwent percutaneous nerve block of the ZP joints. Good and acceptable results were obtained in 37% and 28% of the patients, respectively. However, there was no description of the headache- type as cervicogenic.[62] A prospective study of 15 consecutive patients with CeH evaluated the clinical efficacy of radiofrequency cervical ZP joint neurotomy at baseline, short-term, intermediate, and long-term follow-ups. It showed a significant reduction in headache severity in 80% of the patients at short- and long-term follow-up assessment by means of reduction in VAS (mean VAS decrease of 31.4 mm (P < 0.001) and 53.5 mm (P < 0.0001) respectively), Verbal Rating Scale, number of days with headache per week (P = 0.001), and reduction in average analgesic intake per week (P = 0.003).[63]

Lang and Buchfelder showed that radiofrequency neurotomy of the ZP joint was effective in patients suffering from long-term severe headache due to underlying disease, such as cervical fusions and traumatic fractures, resulting in a mean pain relief of 156.3 days in these 2 groups. Thirty-one patients that had a history of cervical fusion followed by postoperative pseudoarthrosis (21 patients), traumatic cervical fractures without fusion (4 patients), and arthritis (6 patients) were included in the study. Radiofrequency neurotomy was performed to achieve coagulation of the TON and the medial branches of the cervical dorsal rami of C3 and C4 at 80 °C for 90 seconds. The duration of pain relief was defined as the period until the 50% of the baseline pain returned. Seventy percent pain relief was observed in all the groups with 62% having complete pain relief. The mean percentage of pain relief during the first 24 hours after the procedure was 91.6% with a median duration of pain relief of 125 days. Sixty-two percent of the patients who had previously been unable to work due to pain could return to work permanently, even if repeat radiofrequencies were needed.[64]

A total of 30 consecutive patients suffering from CeH for longer than 6 months and showing more than 50% pain relief from diagnostic/prognostic ZP joint nerve blocks were included in a study by Lee et al.[65] These patients were treated

with radiofrequency neurotomy of the cervical ZP joints with a final lesion generated at 80 °C for 90 seconds; and were subsequently assessed at 1 week, 1 month, 6 months, and at 12 months following the treatment. The results of this study showed that radiofrequency neurotomy of the cervical ZP joints significantly reduced the severity of headache in 22 patients (73.3%) at 12 months after the treatment. The average number of days with headache per week decreased from 6.2 to 2.8 days. In conclusion, radiofrequency cervical ZP joint neurotomy has shown to provide substantial pain relief in patients with chronic CeH when carefully selected. The lateral atlantoaxial joint has been reported as a source of CeH. A retrospective study of 86 patients who underwent lateral C1-2 joint pulsed radiofrequency neurotomy showed the percentage of patients who had more than 50% pain relief at 2, 6, and 12 months were 50%, 50%, and 44.2%, respectively.[66]

In contrast to the above studies, in Stovner's randomized, double-blind, sham-controlled study, 12 patients with CeH were randomized to receive radiofrequency neurotomy of ZP joints C2-6 ipsilateral to the pain vs sham treatment. This study found that patients who were treated with radiofrequency neurotomy showed some improvement at 3 months, but later there were no marked differences between the groups. However, it did not find much evidence that radiofrequency treatment of the C2-6 ZP joints was a promising procedure for most patients fulfilling purely clinical criteria for CeH, thus concluding that the procedure is probably not beneficial in this patient population.[67]

Haspeslagh et al. [68] conducted a randomized controlled trial including 30 patients with CeH to receive radiofrequency neurotomy of the cervical ZP joint followed by the dorsal root ganglion vs local injections of a mixture of local anesthetic and steroid to the GON followed by transcutaneous electrical nerve stimulation (TENS). There was no significant difference found between the 2 groups in terms of pain relief, global perceived effects, or quality-of-life scores. They concluded that a sequence of radiofrequency treatments (beginning with a cervical facet joint denervation) is not better than a more conservative sequence of therapies including local occipital nerve injections and TENS. However, there were 50% of patients in the radiofrequency group and 46% of patients in the in GONB/TENS group with significant pain reduction at 1-year follow up.

Cervical epidural steroid injections

The use of cervical epidural steroid injections (CESI) for the management of neck pain, with or without radicular symptoms, has been well documented in the literature.[69,70] However, their use in the management of headaches has been controversial throughout decades. There have been concerns of nonselectivity of the injection and potential life-threatening complications without a significant benefit.[9] Cronen and Waldman[69] investigated the use of CESI in patients suffering from TTH not responsive to traditional therapies. The average number of CESIs performed was 4 per patient. The average VAS prior to the intervention, 6 weeks and 3 months after were 4.8, 0.95, and 0.35, respectively. These results suggested that CESIs may be beneficial in patients with TTH. A second study conducted by Reale et al.[71] also suggested that CESIs are an effective treatment for patients with CeH due to the potential anti-inflammatory effects and blockade of nociceptive signals. Until new controlled clinical trials demonstrate the efficacy of CESIs in patients suffering from headaches, they should not be part of the treatment options for refractory head pain.

Third occipital nerve block

The TON is the superficial medial branch of the C3 dorsal ramus which crosses the latero-posterior aspect of the C2-3 ZP joint innervating the underlying joint. Third occipital nerve blocks (TONB) have a good diagnostic value for pain arising from the C2-3 ZP joint due to the fact that it is the only innervation at this point. However, this procedure requires the use of fluoroscopic imaging and skilled physicians with knowledge on the technique and anatomy. To effectively block the nerve, multiple injections must be performed to cover all the possible anatomical variants.

The concept of third occipital headache and its responsiveness to nerve blocks was introduced by Bogduk and Marsland [72,32] after a small study where 7 out of 10 patients were found to have pain mediated by the TON. Subsequent studies were also able to confirm these results. The prevalence has been shown to be up to 27% in patients with whiplash injuries.[41] After an appropriate confirmatory-TONB has been performed, radiofrequency neurotomy of the third occipital nerve can achieve complete pain relief that is enduring (Figure 7). A study conducted by Lord et al. [73] reported against radiofrequency neurotomy for pain stemming from the C2-3 ZP joint showing only modest responses after using.

In 2003, Govind et al.[74] evaluated the efficacy of a revised percutaneous technique for radiofrequency neurotomy for third occipital headache. After undergoing double diagnostic of the TON, 49 patients underwent TON radiofrequency. Forty-three patients satisfied the criteria for a positive outcome with duration of pain relief of more than 90 days. The technique used included multiple lesions along the superior articular process using oblique as well as sagittal passes. The lesions were made by maintaining the temperature between 80 °C and 85 °C for 90 seconds. The initial success was 88%,

Figure 7 – Radiofrequency neurotomy of third occipital nerve. (Reprinted with permission from Manchikanti et al.[84])
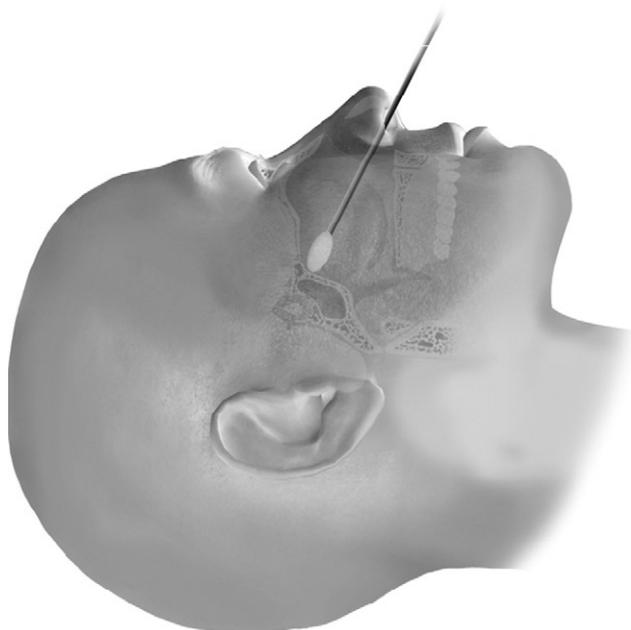

Figure 8 – Sphenopalatine ganglion block. (Reprinted with permission from Ashkenazi A and Levin M.[82])

with a median duration of complete relief of 297 days. No complications were encountered but several side effects such as numbness, ataxia, and dysesthesia were reported.

Sphenopalatine ganglion block

Interventions targeted at the sphenopalatine ganglion (SPG), including nerve blocks and radiofrequency, are options for pain relief in patients with headaches whose pain is not

amenable to traditional treatment modalities. The SPG consists of sensory, sympathetic, and parasympathetic fibers and lies in close proximity to several neuroanatomical structures and pathways involved in pain perception, thus making it a target in the treatment of a variety of head and facial pain conditions, particularly those with parasympathetic features, such as CH.[75,76] Its location in the pterygopalatine fossa is accessible via transnasal, transoral, and infrazygomatic arch routes (Figure 8). The latter is the preferred route for precise needle placement and successful SPG block or radiofrequency treatments. This therapy is indicated for a variety of head pain conditions including sphenopalatine neuralgia, cluster headaches, trigeminal neuralgia, acute migraine, and atypical neuralgia.

SPG-targeted interventions are not without potential for adverse effects. Complications include epistaxis, cheek hematomas, and sensory deficits including hypesthesia, dysesthesia, or deafferentation pain in the palate, maxilla, or posterior pharynx.[77] The latter can largely be avoided by precise needle placement and confirmation via stimulation.

Nonetheless, SPG-directed therapy remains a promising option, particularly in cases where all standard treatment options have been unsuccessful. Case reports note successful pain relief in atypical trigeminal neuralgia and PTH when treated with an intranasal SPG block in combination with V2 pulsed radiofrequency, and pulsed radiofrequency neurotomy of the SPG, respectively.[78,79] Minimally invasive intranasal SPG blocks using lidocaine delivered via cannula, which can also be self-administered by patients in the form of a nasal spray, has also been described as a potential treatment for facial and head pain.[80] However, lack of randomized, double-blind, controlled trials makes the efficacy of this method difficult to characterize.

Radiofrequency neurotomy directed at the SPG has demonstrated promising results in patients with eCH. In a study by Sanders and Zuurmond [81] 60.7% of the patients with eCH and 30% with cCH achieved complete pain relief after radiofrequency neurotomy with follow-up ranging from 12 to 70 months. Using an infrazygomatic approach for needle placement, a total of 3 lesions at 70 °C for 60 seconds were performed. The electrode was advanced 1-2 mm medially after each lesion until it entered the sphenopalatine foramen. Similarly, statistically significant pain relief was achieved using radiofrequency neurotomy of the SPG applied at 80 °C for 60 seconds to patients with cCH who experienced temporary pain relief after SPG block.[77] Patients in this study experienced improvements in attack intensity, frequency, and pain disability index. Forty-six percent of the patients noted a change in headache pattern from chronic to episodic type after the procedure which resulted in decrease in medication use.[77]

Despite the above mentioned outcomes, these interventions for cluster headaches have only a 2 C+ recommendation; they are preferable for use in a study-related fashion, due to the lack of randomized controlled trials and largely observational studies in this area.[76] In fact, a double-blind, placebo-controlled study of SPG block for myofascial pain of the head, neck, and shoulders demonstrated that SPG block was no more efficacious than a placebo, and actually less efficacious when compared with the standard therapy of trigger point injections.[75]

Conclusion

The management of refractory headaches can be challenging for the physicians and incapacitating for those who suffer from them. If symptoms persist after pharmacologic treatment has been optimized or adverse effects limit medication titration, further evaluation of an interventional procedure as complementary therapy must be considered. The scientific evidence varies greatly, depending on the procedure and headache type. Nonetheless, these interventions have been proven to be reasonable, safe, and beneficial for the right patient population in the hands of skilled practitioners.

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