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EVIDENCE-BASED REVIEW

Update of Evidence-Based Interventional Pain Medicine According to Clinical Diagnoses

11. Cervicogenic headache and occipital neuralgia

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Abstract

Introduction: Cervicogenic headache (CEH) and occipital neuralgia (ON) are headaches originating in the occiput and that radiate to the vertex. Because of the intimate relationship between structures based in the occiput and those in the upper cervical region, there is significant overlap between the presentation of CEH and ON. Diagnosis starts with a headache history to assess for diagnostic criteria formulated by the International Headache Society. Physical examination evaluates range of motion of the neck and the presence of tender areas or pressure points.

Methods: The literature for the diagnosis and treatment of CEH and ON was searched from 2015 through August 2022, retrieved, and summarized.

Results: Conservative treatment includes pain education and self-care, analgesic medication, physical therapy (such as reducing secondary muscle tension and improving posture), the use of TENS (transcutaneous electrical nerve stimulation), or a combination of the aforementioned treatments. Injection at various anatomical locations with local anesthetic with or without corticosteroids can provide pain relief for a short period. Deep cervical plexus block can result in improved pain for less than 6 months. In both CEH and ON, an occipital nerve block can provide important diagnostic information and improve pain in some patients, with PRF providing greater long-term pain control. Radiofrequency ablation of the cervical facet joints can result in improvement for over 1 year. Occipital nerve stimulation (ONS) should be considered for the treatment of refractory ON.

Conclusion: The treatment of CEH preferentially consists of radiofrequency treatment of the facet joints, while for ON, pulsed radiofrequency of the occipital nerves is indicated. For refractory cases, ONS may be considered.

KEYWORDS

cervicogenic headache, evidence-based medicine, local injection treatment, occipital nerve stimulation, occipital neuralgia, pharmacological treatment, pulsed radiofrequency, radiofrequency, transcutaneous electrical nerve stimulation

INTRODUCTION

Cervicogenic headache (CEH) is a secondary headache typically characterized by unilateral presentation. The pain typically starts in the neck or at the occipital-nuchal area and spreads to the ipsilateral oculofrontal-temporal area where the maximal pain is frequently located. The headache is thought to arise from cervical nociceptive

structures, such as the facet joints, intervertebral discs, muscles, fascia, ligaments, the atlantoaxial joint, and the atlanto-occipital joint.¹ Involvement of the lower cervical regions has been implicated as a possible cause of CEH, though there is scant research to support this claim. The prevalence varies depending on the population studied (population based vs hospital based), ranging from 4.1% to 20%.²

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Because of overlap in the affected cervical structures, there is significant overlap between CEH and occipital neuralgia (ON). The C2 and C3 nerve trunks give rise to the greater occipital nerve (GON) and the lesser occipital nerve (LON), with the third occipital nerve arising as a branch of the posterior root of C3. ON presents with a paroxysmal stabbing or shooting pain within the dermatomes of the three occipital nerves. The incidence of ON is reported to be 3.2%.³ The incidence peaks between 60 and 69 years of age, with a slight predisposition in women (3.6 vs. 2.8). It can be idiopathic or secondary to irritation of the nerve due to trauma (closed head injury), compression of the cervical nerve root due to degeneration of a neuroma, giant cell arthritis, or compression due to tumors.⁴ Frequently no cause can be identified.

Treatments for both conditions can include physiotherapy, analgesic medications, transcutaneous electrical nerve stimulation (TENS), and interventional treatments such as local injection and radiofrequency treatments.

DIAGNOSIS

History

The evaluation of CEH and ON starts with a basic headache pain history. This includes inciting event(s) (i.e., spontaneous or after an acute or repetitive traumatic event), the duration of symptoms, frequency, location, provocative and attenuating factors, previous treatments, and medications. It is important to note signs indicating a primary headache disorder, such as migraine. A patient with migraines may report nausea, vomiting, photophobia or phonophobia, and aura. These complaints can also be present in CEH; however, these symptoms occur less frequently and are less prominent. It is critical to rule out any red flags that can suggest a malignant cause or surgical emergency (myelopathy, atlantoaxial subluxation) for the complaints.

In CEH, the pain is often unilateral, but can be bilateral. It originates in the neck and radiates through the posterior side of the head, often spreading to the ipsilateral oculofrontal-temporal area. It is usually nagging in character and nonpulsating. The pain can be unpredictable in duration, ranging from a few hours to several days. Due to convergence between the C1–C3 afferent fibers of the dorsal roots and the postganglionic fibers of the caudal part of the trigeminal nucleus, pain may be referred into the orbital, frontal, and parietal regions.^{1,5} Symptoms that suggest a cervical origin are limitations in the cervical range of motion, especially rotation to the affected side, and provocation of the complaints during movements of the neck. Both diagnostic criteria by Sjaastad et al. (see Table 2) and those formulated by the International Headache Society (IHS) (see Table 1) can be used. A diagnostic block confirms the diagnosis and is recommended in both diagnostic algorithms.

TABLE 1 IHCD-3 diagnostic criteria for cervicogenic headache.⁶

ICHCD-3 Diagnostic criteria for CEH according to IHS

- A Any headache fulfilling criterion C.
- B Clinical and/or imaging evidence of a disorder or lesion within the cervical spine of soft tissues of the neck, known to be able to cause headache.
- C Evidence of causation demonstrated by at least two of the following:
 1. Headache has developed in temporal relation to the onset of the cervical disorder or appearance of the lesion.
 2. Headache has significantly improved or resolved in parallel with improvement in or resolution of the cervical disorder or lesion.
 3. Cervical range of motion is reduced, and headache is made significantly worse by provocative maneuvers.
 4. Headache is abolished following diagnostic blockade of a cervical structure of its nerve supply.
- D No better accounted for by another ICHD-3 diagnosis.

TABLE 2 Diagnostic criteria for CEH according to Sjaastad et al.⁷

Diagnostic criteria for CEH according to Sjaastad et al.

1. Symptoms that indicate pain arises from the neck:
 - a. Provocation of the headache radiating from the neck by: Neck movement and/or continuous backward tilting of the head; and/or external pressure of the occipital or higher cervical region on the symptomatic side.
 - b. Limited movement of the neck.
 - c. Ipsilateral neck, shoulder, or arm pain of mostly nonradicular nature.
2. Positive response to diagnostic/prognostic block with a local anesthetic.
3. Unilateral headache.

Note: The diagnosis of CEH can be made if the patient fulfills 1a and 2. If the patient does not exhibit the symptoms of 1a, the combination of 1b, 1c, 2, and 3 is suggestive of CEH. A bilateral form of CEH exists.

ON is described by the IHS as unilateral or bilateral paroxysmal, shooting, or stabbing pain in the posterior part of the scalp, in the distribution(s) of the greater, lesser, and/or third occipital nerves, sometimes accompanied by diminished sensation or dysesthesia in the affected area, and commonly associated with tenderness over the involved nerve(s).⁶ The GON is typically the culprit in occipital entrapment neuropathies; however, the lesser occipital nerve is also affected in between 10% and over two thirds of cases, though it represents the sole nerve compressed in under 15% of cases. The third occipital nerve can also be a source of neck pain.^{8,9} The attacks can last seconds to minutes and tend to be side-locked. There may be involvement of the temporal, orbital, or frontal region of the face due to convergence with the trigeminal nucleus. The diagnostic criteria are noted in Table 3. Besides the characteristic symptoms, patients can also experience vision impairment/ocular pain (67%), tinnitus (33%), dizziness (50%), nausea (50%), and a congested nose (17%) due to connections between cranial nerves VIII, IX, X, and cervical sympathetic nerves.^{10,11}

TABLE 3 The diagnostic criteria for ON formulated by the International Classification Committee of the IHS.⁶

Diagnostic criteria for ON according to IHS	
A	Unilateral or bilateral pain in the distribution of the greater, lesser, and/or third occipital nerves fulfilling criteria B–D
B	Pain has at least two of the following three characteristics: 1. Recurring paroxysmal attacks lasting from a few seconds to minutes. 2. Severe in intensity. 3. Shooting, stabbing, or sharp in quality.
C	Pain is associated with both of the following: 1. Dysesthesia and/or allodynia apparent during innocuous stimulation of the scalp and/or hair. 2. Either or both of the following: a. Tenderness over the affected nerve branches. b. Trigger points at the emergence of the greater occipital nerve or in the distribution of C2.
D	Pain is eased temporarily by local anesthetic block of the affected nerve(s).
E	Not better accounted for by another ICHD-3 diagnosis.

Physical examination

Physical examination in CEH is mainly focused on the neck.¹² Range of motion is tested through flexion, extension, lateral flexion, and rotation. Segmental palpation of the facet joints can help determine the levels that are involved. Although the diagnostic value of pressure points or tenderness remains inconclusive, they can help identify the structures involved, which can also aid in guiding treatment. The pressure points may include:

- The course of the greater occipital nerve (GON).
- The lesser occipital nerve (LON).
- The third occipital nerve (TON).
- Pressure pain along the musculus trapezius and its insertions.

The physical examination for ON not only consists of the examination of the neck and pressure points, but also focuses on allodynia, hyperesthesia, and dysesthesia within the innervated area of the suspected occipital nerve(s). If a tender pressure point along the occipital nerve in combination with concordant sensory disturbances are appreciated, this should alert the physician for probably ON.

Additional tests

The additive value of imaging is limited for both conditions (CEH and ON). A cervical x-ray can show signs of (degenerative) changes of the cervical spine and identify certain red flags such as subluxation. The relationship between radiographic (x-rays) and radiological findings and pain is at best modest.^{13,14} However, high-quality reproducibility studies correlating radiographic and radiological features with pain are lacking.¹⁵ In one systematic review comparing cervical MRI findings in patients with nonspecific neck pain or whiplash-associated disorder

and healthy controls, the only finding based on two studies was a slightly smaller cross-sectional area of the rectus capitus muscle in patients with nonspecific neck pain.¹⁶ Imaging should also be obtained before high-risk interventional procedures. A CT scan can be obtained if there is a high suspicion of osseous pathology. An MRI can visualize the cervical spine, segmental spinal nerves, and soft tissue. However, the specificity is not sufficient to be able to identify the source of cervical pain, with studies consistently finding age-dependent prevalence rates of degenerative changes exceeding 50% in asymptomatic individuals.¹⁴ The use of ultrasound is increasing, with signs suggesting occipital nerve entrapment including an enlarged, abnormal-appearing nerve. The normal cross-sectional area at C1–C2 levels is 2.0 ± 0.1 versus $4.1 \pm 2.6 \text{ mm}^2$ in symptomatic patients following entrapment. A role for ultrasound in identifying the possible cause of cervical pain is a growing area of investigation.¹⁷

A diagnostic block can be performed to confirm the diagnosis; however false positive rates are common and can be attributable to high placebo response rate and spread to different structures.^{10,11,18,19} Both CEH and ON may respond to an anesthetic block of the occipital nerves. Furthermore, blocking the third occipital nerve may inadvertently block the GON if a proximal approach is used, even with a volume as low as 0.3 mL.²⁰

DIFFERENTIAL DIAGNOSIS

In the differential diagnosis of CEH and ON, as with other headaches, organic disorders such as a space-occupying lesion in the posterior fossa cerebellaris and other tumors, fractures, cervical spondylosis, osteochondritis, (rheumatoid) arthritis of the cervical spinal column, sinus thrombosis, and Arnold–Chiari malformation should be excluded. Other headache disorders should also be considered, such as:

- **Migraine without aura:** Migraine without aura can be difficult to distinguish from CEH since their presentations overlap (Tables 4 and 5).

TABLE 4 CHD-3 migraine without aura.⁶

Migraine without aura	
A	At least five attacks fulfilling criteria B–D
B	Headache attacks lasting 4–72 h (untreated or unsuccessfully treated)
C	Headache has at least two of the following four characteristics: 1. Unilateral location 2. Pulsating quality 3. Moderate or severe pain intensity 4. Aggravation by or causing avoidance of routine physical activity (eg, walking or climbing stairs)
D	During headache at least one of the following: 1. Nausea and/or vomiting 2. Photophobia and phonophobia
E	Not better accounted for by another ICHD-3 diagnosis

TABLE 5 CEH versus migraine without aura.

	CEH	Migraine without aura
Location	Starts posterior	Starts frontal
Character	Moderate, nonexcruciating, and nonthrobbing	Throbbing–pulsating
Unilateral or bilateral	Unilateral, without shift. Can be bilateral	Unilateral with shift
Provocation through cervical manipulation or movement	Yes	No
Cervical range of motion	Limited	Full range of motion
Nausea/vomiting	Can be present, but mild	Can be present
Photo–phonophobia	Can be present, but mild	Can be present, but often severe

- Tension-type headache (TTH): Bilateral CEH can be differentiated from TTH since provocation through movement of or pressure on the cervical spinal column is not characteristic for TTH.
- Cluster headache: Cluster headache, one of the few chronic pain conditions that preferentially affects males, presents with excruciating attacks that can last from 20 min to 3 h. It can be associated with autonomic symptoms such as conjunctival injection, lacrimation, nasal congestion and/or rhinorrhea, eyelid edema, forehead and facial sweating, and miosis and/or ptosis. Patients report restlessness or agitation during an attack.
- Hemicrania continua: Hemicrania continua is a unilateral chronic daily headache that can fluctuate during the day. A hallmark of this headache is its response to indomethacin.
- Chronic paroxysmal hemicranias: Chronic paroxysmal hemicrania is characterized by a high frequency of severe unilateral headache attacks with a short duration (10–30 min). It also responds very well to indomethacin.
- Medication overuse headache (MOH): This should be considered if there are >15 days a month with headache and medication overuse for more than 3 months.
- Postherpetic neuralgia involving the C2 nerve root: History and examination of the scalp usually provides sufficient information for diagnosis, though rare presentations without rash (zoster sine herpete) can pose challenges.

The different headache disorders can be present simultaneous. Treatment should ideally be directed at each individual disorders, though there is considerable overlap between treatments.

Although there is overlap between the two conditions, CEH is a nociceptive referred pain condition, whereas ON is considered neuropathic.

TREATMENT

Conservative treatment

Conservative treatment is the first option before interventions are considered in both CEH and ON. Conservative treatment includes pain education and other forms of

self-care, medication, physical therapy (such as reducing secondary muscle tension and improving posture), the use of TENS, or a combination of the aforementioned treatments. On presentation, in a pain clinic, neurology, or neurosurgery department, most patients will have already tried various conservative treatments. Medication use should be sought out in detail, since patients can be overusing medications (which can worsen headaches), using the medication incorrectly, or may not have tried an effective medication due to fear of complications. Although medication overuse headache is usually linked to migraine, it may exacerbate other headache disorders. Opioids have little or no place in the treatment of a benign chronic headache disorder. Discontinuation of opioids should be strongly encouraged, with a weaning plan as necessary to avoid withdrawal and facilitate compliance.

TENS

TENS is an example of a noninvasive commonly used nerve stimulation technique. Farina et al. demonstrated in a nonrandomized study that TENS is an effective treatment method for CEH.²¹ A randomized study in patients with CEH showed a significant improvement in headache symptoms after 3 months of TENS therapy compared with the placebo group.²²

Interventional treatment CEH

When conservative treatment failed to provide satisfactory outcome, interventional pain treatments can be considered. A systematic review on interventional treatment strategies for the management of CEH included 23 studies on the following treatments: occipital nerve blocks (GON and LON blocks), intra-articular facet joint injections, lateral AA joint intra-articular injections, deep cervical plexus blocks, cervical epidural corticosteroid injections, radiofrequency treatment, and cryoneurolysis.²³ This review found several limitations including that most studies evaluated were not RCTs, contained heterogeneous inclusion criteria, and had small sample sizes. The interventional treatment options are discussed next.

Local injection

Local injection treatments have been used on different structures with different injectate medications, different frequencies, and different volumes. The use of botulinum toxin was not shown to be effective in a Cochrane review.²⁴ The use of injections, with or without steroids, in different anatomical targets seems to reduce pain, but only for a short duration.^{25–29} The targeted structures for local injections are discussed next.

Greater and lesser occipital nerve blocks

Both retrospective and prospective literature report a decrease in pain scores after GON blocks. Blocks can be performed based on landmarks or with ultrasound. The type of corticosteroids used differed between studies, as did the frequency of treatment and intervals between injections. One study concomitantly performed injections at the GON and C2/C3 facet joint with local anesthetics, repeating the procedure three times. They reported a decrease in pain for 2 months.²⁷ In a randomized controlled trial, 25 patients were assigned to receive injections of local anesthetics mixed with clonidine and fentanyl at the GON and LON, with 16 patients also receiving a facial block. The control group received an equivalent volume of saline. The authors reported a significant decrease in pain scores, analgesic consumption, and the frequency of headache after local injection of the GON and LON compared to the placebo group. The addition of facial nerve blocks resulted in a longer duration of action.²⁸ One study compared subcompartmental to classical GON injections of local anesthetic and corticosteroid using different volumes. The authors found subcompartmental injections resulted in longer pain relief and greater improvement of quality of life.²⁹ Another study approached the greater occipital nerve using ultrasound at the C2 segmental level. Local anesthetic and corticosteroid were injected in patients with ON (86%) and CEH (14%), with this technique resulting in a technically successful block in 86% of the 14 patients. At 4-week follow-up, the cohort experienced almost 50% pain relief.³⁰

Although ON blocks typically result in pain relief, the effect is temporary. ON blocks have been shown in studies to provide pain relief in a majority of patients with migraines, TTH, and cluster headaches (per a placebo-controlled trial),³¹ with studies generally finding no difference between blocks performed with local anesthetic alone versus local anesthetic with corticosteroid. It should be noted, however, that most studies performed blockade at sites superior to the typical location for greater occipital nerve entrapment at tendinous aponeurotic attachment of the trapezius at the superior nuchal line.³² There are however significant adverse effects with the use of repeated doses of steroids.³³ These should be taken into consideration when formulating a treatment plan. In addition, it is also challenging to conclude what contributes to the pain-relieving effect. Baek

et al. concluded that a 5 mL injection will also reach additional structures such as the suboccipital and third occipital nerves. Even the use of 1 mL injectate does not guarantee a selective block, making interpretation of the results challenging.^{34,35}

Cervical facet joint injections

A retrospective study injecting the C1/C2 atlantoaxial and C2/C3 facet joint with a mixture of a local anesthetic and corticosteroid showed short-term pain relief in patients with CEH, but the authors also blocked the spinal rami, thereby making response and prevalence rates impossible to calculate.³⁶

Atlanto-occipital intra-articular injection

There is scant data evaluating atlanto-occipital joint injections. In one study evaluating 24 patients with non-traumatic suboccipital pain, tenderness overlying the occipital-spinal junction, and limited range of motion with lateral flexion and rotation, 20 patients experienced at least 50% pain relief immediately after the injection, with all continuing to report relief at 2 months.³⁷ An earlier randomized trial found that both intra-articular injections with local anesthetic and steroid provided similar relief to atlanto-occipital intra-articular pulsed RF through 6-month follow-up.³⁸ These results are in line with a recent consensus guideline.³⁹

Atlantoaxial intra-articular injection

This technique was described in a study in which 32 patients with CEH clinically attributable to the atlantoaxial joint were treated to a lateral AA joint injection via a posterior approach using triamcinolone. The authors reported a reduction in pain through 3-month follow-up, but not at 6 months.⁴⁰

Deep cervical plexus block

Goldberg et al. conducted a prospective study in 39 patients with CEH evaluating bilateral deep cervical blocks. At 3 months but not 6, the authors reported a significant reduction in pain scores.⁴¹ A single-blind randomized study comparing fluoroscopy with ultrasound-guided injections at the C2 and/or C3 transverse process in patients with CEH demonstrated a reduction in pain for up to 6 months, with no difference between groups. The side effects were also comparable in both groups.⁴²

Continuous cervical epidural block

One retrospective that included 37 patients with CEH evaluated lidocaine, dexamethasone, and saline infusions through epidural catheters placed between C6–7 and T1–2. The infusion rate was 5 mL/h for 3–4 weeks. Additionally, 5 mg triamcinolone was given weekly for 3–4 weeks. Based on pain relief and analgesic consumption, the treatment was effective for 6 months.⁴³ Another study evaluating a single-shot cervical epidural steroid injection showed beneficial results after 4 weeks.²⁶

Radiofrequency ablation

Radiofrequency ablation (RFA) creates a lesion through Wallerian degeneration that interrupts the nerve supply. There are four prospective studies including one randomized and controlled that evaluated the effect of RFA of the cervical facet joints. The controlled trial randomized 12 patients clinically diagnosed with CEH to either a radiofrequency neurotomy or sham procedure. Although patients were somewhat improved in the radiofrequency group at 3 months, at 6, 12, 18, and 24 months no difference between groups was found.^{44–47} A prospective study performed in 15 patients with CEH showed that radiofrequency treatment of the cervical facet joints resulted in improvement in pain, the number of headache attacks per week, and a decrease in analgesic intake up to 16.8 months after the intervention.⁴⁸ In an observational study conducted in 46 patients with CEH, 30 responded to double C3–4 medial branch blocks and proceeded to undergo RFA. At 12-month follow-up, more than 70% of the patients reported significant pain relief, a reduction in the number of headache-days per week, and a decrease in analgesic use.⁴⁹ A study on patients with CEH attributed to the C4–7 facet joints reported substantial pain relief for up to 6 months after RFA.⁵⁰ One study comparing the effectiveness of RFA of the cervical facet joints possibly followed by RF treatment of DRG versus infiltration of the GON found no difference in effectiveness at multiple follow-ups through 48 weeks.⁵¹ A retrospective analysis performed in 40 patients treated for CEH and/or ON with radiofrequency treatment of the C2 DRG and/or RFA of the TON found that 70% of patients experienced at least 80% pain relief at a mean 22.3-week follow-up.⁴⁵ A prospective study examining RFA of the TON reported a success rate of 88% (45 of 51 nerves in 49 patients), with benefits lasting a median 297 days.⁴⁶ Another case series conducted in 11 patients with osteoarthritis of the AA joint performed CT-guided RFA of the C2 DRG coupled with the injection of dexamethasone and local anesthetic, reporting benefit at a mean follow-up of 10.4 months.⁴⁷ A systematic review by Suer et al. evaluating cervical medial branch RFA included the studies by Stovner et al. and Haspeslagh et al., finding variable pain relief ranging between 30% and 50% with commensurate variability in duration of effect. Of note, two of the four studies in this review reported on the treatment in patients with whiplash-associated disorder.⁵² Another systematic review by Nagar et al. evaluating RFA and pulsed radiofrequency (PRF) that included the studies by Stovner et al., Haspeslagh et al., Gabrhelik et al., and Lord and colleagues, described limited evidence for RFA in CEH in the absence of high-quality evidence.⁵³ The largest systematic review by Grandhi et al. reported similar conclusions.⁵⁴

Pulsed radiofrequency treatment

As opposed to RFA, pulsed radiofrequency (PRF) treatment does not injure nerve architecture and is deemed to

be a safer option, especially for neuropathic pain wherein the etiology is nerve injury. Its mechanisms of action are hypothesized to be via creation of an electrical field, thereby disrupting pain transmission and potentiation, enhanced descending modulation, and alterations in gene expression. However, the exact mechanisms of action are still being elucidated. Although there are some studies evaluating the effect of PRF in patients with chronic headache, the literature is scarce. In a randomized trial performed in 30 patients with CEH, PRF treatment of the GON provided greater long-term pain control than local anesthetic and corticosteroid injection.⁵⁵ In another study, PRF performed within the C1–C2 joint resulted in >50% pain relief in roughly 50% of patients for up to 6 months. At 1 year, the success rate slightly decreased to 44.2%.⁵⁶ One retrospective study investigated the effect of PRF treatment of the C3–C5 medial branches bilaterally in 57 patients with CEH who responded to two diagnostic blocks. The authors reported dramatic (>75%) pain relief lasting up to 12 months.⁵⁷ Another retrospective study reported that PRF of the C2 DRG using the posterior approach resulted in ≥50% pain relief at 6 months in 40% of the patients.⁵⁸ A case–control study by Li et al. compared outcomes in 139 patients who underwent either PRF at the C2 DRG in combination with a cervical epidural steroid injection versus cervical epidural steroid injection alone. The combination group (PRF and injection) experienced lower VAS scores, frequency of pain attacks, and a greater ability to work. The duration of effect of PRF + ESI was also twice as long as of ESI alone.⁵⁹ The previously mentioned systematic reviews by Nagar et al. and Grandhi et al. concluded that there is poor evidence and very limited benefit regarding the use of PRF in CEH^{53,54}; this recommendation is highlighted by the poor quality of the clinical studies.

Cryoneurolysis

Cryoneurolysis is based on the application of an ice ball induced by low temperature forming through the injection of pressurized gas, usually nitrous or carbon dioxide, at the end of cryoprobe. This temperature is thought to induce Wallerian degeneration through axonotmesis, with subsequent analgesia lasting from several weeks to up to 5 months. With preservation of the cell body, the nerve retains its ability to regenerate. Side effects are generally minor and include local pain and dizziness. A double-blind comparative effectiveness study comparing cryoneurolysis of the GON to steroid injections in patients with CEH reported pain relief for the first several weeks in both groups but no significant differences between the groups. After 6 and 7 weeks, pain relief started to subside. At 18 weeks, however, 74% of the patients reported a much to moderately improved global status. Both pain and range of motion improved in approximately half of the 51 patients.⁶⁰ Flaws in this study

include unequal randomization (31 in cryoanalgesia vs. 21 in GON block group, with differences in baseline age and headache duration).

Surgery

Surgery is often considered a last resort; since this is an invasive treatment it carries greater risks on its own. Surgical neurolysis of the GON has been shown to provide significant pain relief through a mean 14.5-month follow-up, though 92% of 50 patients in one series had a recurrence of symptoms after 1 year, with seven requiring reoperation.⁶¹ Surgical decompression of the second cervical nerve root in 35 patients provided complete pain relief in 37% and improvement of pain scores in 51%.⁶² Because of the use of electrocoagulation it has been postulated therapeutic effect and duration may be enhanced through coagulation, similar to a radiofrequency lesion.⁶³ Bing et al. described endoscopic neurotomy of the C2-C3 medial branches in a single patient with refractory CEH.⁶⁴ Pain in the neck, occipital area, and on the top of the head almost disappeared, though the temporal and supraorbital areas remained painful.

INTERVENTIONAL TREATMENT FOR ON

Greater occipital nerve block

Blocking the GON, with or without steroids, provides at least a temporary effect. In a small ($n=10$) retrospective study by Kuhn et al., the GON was infiltrated with corticosteroids after a positive test block with bupivacaine. The authors found pain relief for less than 1 week in 10% of patients, 1 week in 30%, 2 weeks in 30%, 1 month in 10%, and more than 2.5 months in 20% of patients.¹⁰ Hammond and Danta found a short-term effect (less than 1 week) in 64% of the patients after a single infiltration with local anesthetics; 36% of the patients had an effect lasting longer than 1 month.⁶⁵ Studies evaluating botulinum toxin type A are scarce. Kapural et al. retrospectively described six patients suffering severe ON who were treated with botulinum toxin type A occipital nerve blocks and reported pain relief averaging 16.3 weeks based on pain scores.⁶⁶ Taylor et al. treated six patients suffering from ON with botulinum toxin type A injections at the GON and LON. They found that only the sharp and shooting (neuropathic-type) pain decreased in intensity, with the dull and aching pain remaining the same.⁶⁷ A prospective study evaluating 44 patients with ON who were either a GON injection or a GON and LON injection with local anesthetic and dexamethasone

found 42 of the 44 patients experienced improvement after the procedure and at 6-month follow-up.⁶⁸

PRF

Although radiofrequency treatment seems to be effective in the treatment of ON, it is also associated with severe complications including worsening pain from neuroma and nerve injury, and the possibility of deafferentation phenomena.⁶⁹ Interest in PRF treatment, which does not typically result in injury to the nerve architecture, is therefore increasing. Navani et al. described a case report where ON was treated with PRF. The patient showed 70% pain relief after 4 months. A repeat treatment resulted in another 5 months pain relief.^{68,70} Choi et al. treated 10 patients who responded with short-term relief to two blocks with PRF. The technique was landmark based with a PRF duration of 4 min. The mean follow-up was 7.5 months. All patients experienced pain relief at 1 and 6 months without complications.⁷¹ A study by Huang et al. included 102 patients with a primary diagnosis of ON or migraine headache with occipital nerve tenderness and a positive, albeit short-term, response to diagnostic blocks. They performed a PRF treatment based on anatomical landmarks using stimulation to guide therapy. A majority of patients (63%) had both the GON and LON treated; 59.8% of the patients were treated with two or more PRF cycles. Four patients reported temporary worsening of the pain. One patient developed a new type of pain which resolved within 3 weeks. Fifty-one percent of the patients experienced $\geq 50\%$ pain relief lasting at least 3 months.⁷² Vanelderden et al. conducted a prospective study in 19 patients who had a positive response to a diagnostic block. After 6 months, pain had improved substantially in 52.5% of patients.⁷³ Cohen et al. performed a double-blind, multicenter comparative effectiveness study with 81 patients with ON or migraine with occipital nerve tenderness who had responded with short-term relief to diagnostic blocks. Half of the patients received treatment at both the GON and LON based on their pain pattern, tenderness to palpation, and response to diagnostic blocks. They compared local anesthetic injection and three cycles of PRF (42 patients) to local anesthetic and steroid injections (39 patients)+sham PRF. Pain reduction was superior in the PRF group at all time periods, with diminishing pain relief over time through 6-month follow-up.⁷⁴

Cooled RF ablation

There is a single case report evaluating cooled RFA in a 35-year-old female with bilateral ON who had previously failed PRF and conventional RFA. She experienced 75% pain reduction without complications at an

indeterminate follow-up period. More research is needed regarding this treatment.⁷⁵

Cryoneurolysis

Kastler et al. performed an observational study in six patients in whom seven cryoneurolysis procedures were done. At 1 week, all patients experienced >50% pain relief. At 3 months, five of seven cases had more than 50% pain relief, though in six of seven patients the pain eventually returned to baseline.⁷⁶

Occipital nerve stimulation

Occipital nerve stimulation (ONS) is sometimes used for ON that is refractory to conventional medical management and minimal interventional pain treatments. It is thought to involve modulation of peripheral and central nociceptive inputs. It is hypothesized that ONS may activate brain stem pain inhibitory centers as evidenced by an increase in regional cerebral blood flow.⁷⁷ The success of ONS is primarily determined by proper patient selection, which is discussed in detail by Slavin et al.⁷⁸ The first publication was a case series in 13 patients by Weiner et al., which showed >75% pain relief in two third of patients and >50% pain relief in one third at 1–6-year follow-up.⁷⁹ Kapural et al. described six patients with chronic, refractory occipital headaches who all experienced significant improvements in pain scores and functional capacity after implantation of a peripheral nerve stimulation system.⁴ Salmasi et al. published another case series in three patients, two of whom underwent bilateral ONS, after achieving significant but short-lasting benefit from diagnostic ON block.⁸⁰ All patients had a secondary diagnosis of migraine, with one also having CEH. At follow-up periods varying between 6 and 16 months, 2 of 3 patients achieved >50% pain relief, with both successful outcomes adjudicated at 6 months. The Neuromodulation Appropriateness Consensus Committee concluded that ONS should be considered in refractory ON.⁸¹ A systematic review and evidence-based guideline published by the Congress of Neurological Surgeons also suggested that ONS is a treatment option for patients with medically refractory ON based on nine studies.⁸²

Surgery

Considering the invasiveness and risk of complications, surgical procedures are considered only when the previous mentioned treatments have failed, and the patient continues to experience debilitating symptoms. Different surgical approaches have been used to treat ON such as intradural sectioning of the C1–C3 posterior rootlets, gangliotomy of C2, nerve decompression, and peripheral

neurectomy.^{62,83–86} Complications can occur, however, including anesthesia dolorosa, which is a dense zone of anesthesia, extreme hypersensitivity of the scalp, dysesthesia, neuroma formation, and vertigo, believed to be secondary at least in part to deafferentation.⁸⁵ An alternative procedure is partial posterior rhizotomy, in which the goal is to relieve pain without damaging proprioception and nonpain sensations. Dubuisson et al. conducted a case series consisting of 14 procedures in 11 patients with refractory ON who underwent partial posterior neurectomy. Follow-up periods ranged from 3 months to over 5 years, with several patients experiencing pain outside of the distribution of the occipital nerves. Seven patients experienced complete pain relief, three patients experienced >50% pain relief, and four patients had >50% pain relief in the occipital area but still reported pain in the periorbital and temporal regions. Aside from modest sensory changes, there were no neurological deficits attributable to the procedure.⁸⁵ Gille et al. described surgical neurolysis of the GON along with sectioning of the inferior oblique muscle leading to nerve release in 10 patients who experienced good relief with blockade of the C2 DRG. Seven patients were either satisfied or very satisfied, with >50% reduction in pain at 3-month follow-up, and >70% at follow-up.⁸⁷ Three patients exhibited anatomic anomalies during surgery.⁸⁸ In a retrospective chart review, Ducic et al. described performing neurolysis of either the GON, LON, and/or dorsal occipital nerve, with 80% of the patients experiencing >50% pain relief and 43% being pain-free at a mean 33-month follow-up.⁸⁹ In this series, the authors reported that CEH and older age were associated with negative outcome.

Complications

Cervical facet joint interventions performed using fluoroscopic guidance rarely results in serious complications.^{26,90} These risks are described in chapter 7. With repeated ON injections, both systemic side effects as well as local side effects (e.g., skin atrophy and hypopigmentation, hair loss) of steroids should be considered. Regarding PRF of the ON, no serious complications have been described. Minor complications include temporary worsening of the pain. In the study by Huang et al. one patient experienced a new type of pain that resolved after 3 weeks.⁷²

Surgery is associated with generic and procedure-specific complications including infection, bleeding, neuroma formation, and anesthesia dolorosa, which manifest as intense pain and complex regional pain syndrome-like symptoms. RFA of the occipital nerves may result in peripheral neuropathic pain secondary to nerve injury (e.g., neuroma formation or proliferation of sodium channels) or deafferentation phenomena. Surgical neurolysis was shown to induce incisional cellulitis in 2 of 206 patients treated.⁸⁹

ONS

Reported complications by Silberstein et al. are lead migration (18.7%), persistent pain or numbness at the IPG/lead site (21.5%), infection (6.5%), skin erosion (5.6%), and unintended stimulation effects (6.5%).⁹¹ He also found lead migration in 24% (of 51) and infection in 14% of patients.⁹¹ Joswig et al. reported lead migration (26%) and infection (4.7%) in a retrospective case series of 96 patients.⁹²

Evidence for interventional management

Table 6 summarized the evidence for interventional management of CEH and of ON. This evidence is summarized in the therapeutic algorithm (Figure 1).

The recommendations for the interventional treatment of CEH and ON are illustrated in Figures 1 and 2.

Algorithm

Technique GON injection

The greater occipital nerve originates from the medial aspect of the dorsal ramus of C2, where it branches out to become the largest pure sensory nerve in the body. It travels around the inferior oblique muscle, transverses it, and continues between the inferior oblique and the deep surface of semispinalis capitis. Here, it pierces the semispinalis capitis muscle interior and the trapezius at the aponeurosis, which are points for entrapment. From there it forms multiple superficial branches and innervates the posterior skull to the vertex.⁹⁴ Landmark-based injection of the greater occipital nerve has been described in various ways and with various measurement points. One approach is to draw an imaginary line between the occipital protuberance and the mastoid process. The GON is thought to be found at the medial one third of this line.⁹⁵ Another approach describes targeting a tender area marked by a variable caudal distance from the occipital protuberance (± 3 cm), about 1.5 cm lateral from the midline (1.5 cm). These distances may vary, and many practitioners use the maximal area of tenderness as a landmark or try to elicit radiating pain by tapping over a painful area.^{94,96} Careful consideration should be given to the occipital artery that is in close proximity to the greater occipital nerve as aspiration has low sensitivity. An alternative to the landmark-based technique is the use of ultrasound. This can be done at the level of C2, where the GON can be found on top of the obliquus capitis inferior muscle. Shim et al. compared landmark versus ultrasound-based approaches in 45 patients, find no difference in outcomes between groups.⁹⁷

Technique LON injection

The LON arises from the ventral rami of C2 and C3 in the cervical plexus. It travels around the spinal accessory nerve and upward along the posterior border of the sternocleidomastoid muscle before exiting through the deep fascia at the occiput. It innervates the integument of the scalp, the posterior third of the temporal fossa, and the neck posterior and superior to the auricle. Based on landmarks, it is amenable to blockade approximately 4–6 cm below the occipital protuberance, 6–7 cm from the midline⁹⁸ (see Figure 3).

With a landmark-based injection, the same line can be traced out as discussed earlier. The LON is found at approximately two third of the distance of this line, approximately midway between GON and the mastoid process. The same anatomical variation considerations for the GON exist for the LON, which is why the point of maximum tenderness can be used.

The LON can also be visualized using ultrasound, with its location being very superficial. It is located between the trapezius muscle and the sternocleidomastoid muscle, on top of the splenius capitis in the same view as the GON.

The technique for cervical medial branch block is described in chapter 7 of this series. (Pulsed) radiofrequency treatment of the cervical DRG is described in chapter 2.⁹⁹

Technique PRF treatment of the GON and LON

The target sites are located according to the external landmarks as described by Vital and Becser or via ultrasound, and can be confirmed by palpation and symptom elicitation (point of maximal tenderness).⁵ Once the targeted areas are identified, the skin located inferior and medial to the sites are anesthetized with a very low volume of local anesthetic (i.e., skin wheal) so as to avoid anesthetizing the target nerve which will be identified by electrostimulation. A radiofrequency cannula is then inserted at a cephalad and lateral (approximately 15°–25°) angle to the skin wheal so that the 10 mm active tip lands in the groove housing the point of maximal tenderness representing the greater occipital nerve or lesser occipital nerve, which is sometimes more superficial. The angle is chosen so that the active tip lies near parallel to the longitudinal trajectories of the nerves. Proximity to the GON and LON are confirmed with 50 Hz electrical stimulation, with concordant paresthesia, pressure or pain extending cephalad up the scalp in the distribution of the targeted nerve ideally achieved at <0.5 V. Subsequently, PRF treatment (45 V, 20 ms pulses in 1 s cycle, 2 Hz frequency) is performed for 2–4 min with a maximum temperature of 42°C. Both preclinical and clinical studies have shown better outcomes when more

TABLE 6 Summary of the most important literature on the interventional treatment of CEH and ON.

Author-date ref	Technique	Quality of evidence	Conclusion	Recommendation
Treatment of CEH				
Stovner et al. ⁴⁴	RF ablation of cervical facet joint or sham procedure	Randomized controlled trial	CEH improved in the RF group for 3 months, no difference between RF and sham at 6, 12, and 24 months	The procedure is probably not effective in CEH
Haspeslagh et al. ⁵¹	RF of the cervical facet joints and DRG versus local anesthetic infiltration of the GON and TENS	Randomized controlled trial	Patients improved in both groups. No difference between groups at 8, 16, 24, and 48 weeks	No evidence that RF of the cervical facet joints and upper dorsal root ganglia is better than local anesthetic infiltration of the GON followed by TENS
Gabrielik et al. ⁵⁵	PRF of the GON versus GON block with local anesthetic and steroid	Randomized controlled trial	Positive effect in both groups at 3 months. PRF effect remained through 9 months	PRF of GON may be beneficial in CEH
Nagar et al. ⁵³	RF ablation or PRF in CEH	Systematic review	Three nonrandomized trials showed RFA as an effective intervention. Three RCTs did not show an effect of RFA One nonrandomized trial showed PRF as an effective intervention. One RCT did not show any effect of PRF	There is limited evidence to support RF ablation for management of CHA as there are no high-quality RCTs and/or multiple consistent non-RCTs without methodological flaws. There is poor evidence to support PRF for CHA as there are no high-quality RCTs or non-RCTs
Grandhi et al. ⁵⁴	RF ablation or PRF in CEH	Systematic review	Some studies indicate benefit of RFA or PRF for a short duration of time	RFA and PRFA provide very limited benefit in the management of CHA
Suer et al. ⁵²	Radiofrequency ablation of the cervical facet joints in patients with CEH or WAD	Systematic review	Variability in pain relief between 30% and 50% with similar variability in duration of action	Based on this systematic review, efficacy of cervical facet RFA in treatment of chronic neck pain has Level II evidence
Treatment of ON				
Juškys et al. ⁶⁸	Local anesthetic and corticosteroid injection of GON or GON and LON	Prospective trial	Satisfactory results up to 6 months	Occipital nerve block provides a safe, simple and effective treatment of ON
Vanelderen et al. ⁷³	PRF of the ON	Prospective trial	Positive outcome after 6 months	PRF of GON and LON is a promising treatment for ON
Cohen et al. ⁷⁴	PRF versus steroid injections at GON or GON and LON in patients with ON or migraine	Double-blind sham-controlled trial	Pain relief was superior in PRF group. Pain relief diminished through 6 months	PRF should be considered for patients with ON and migraine + ON tenderness in those who experience short-acting relief with steroid
Sweet et al. ⁸²	Occipital nerve stimulation for ON	Systematic review	Nine studies, class III evidence	ONS is a treatment option for medically refractory ON

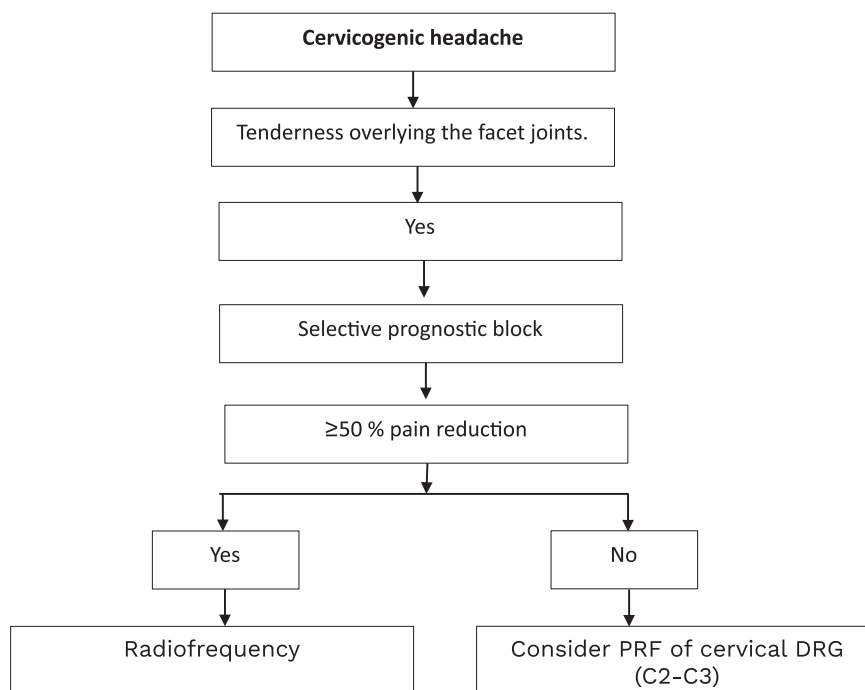


FIGURE 1 Algorithm for the treatment of cervicogenic headache.⁹³

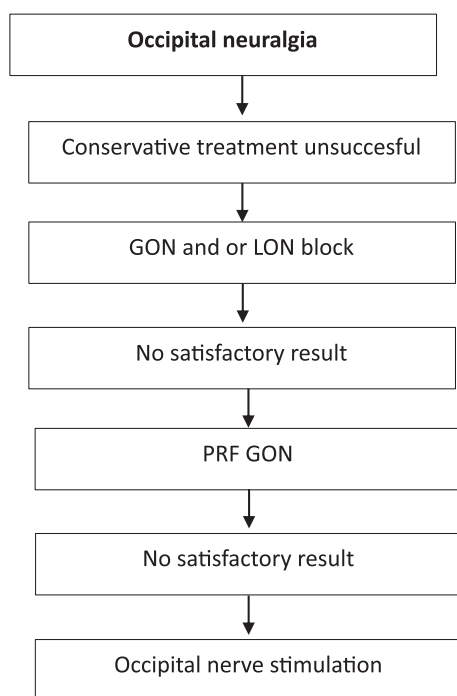


FIGURE 2 Algorithm for the treatment of occipital neuralgia.

than one cycle is performed, often with slight adjustment between 120 s cycles.^{72,100}

Technique ONS

The first stage of the procedure (the trial) is performed under mild sedation and local anesthesia to enable

monitoring patient feedback and ensuring optimal coverage of the painful areas. The patient is placed in a prone position. After disinfection, a curved needle is inserted at the upper lateral end of the neck and advanced toward the midline of the craniovertebral junction along the contour of the C1 arcus vertebralis under fluoroscopic guidance, crossing over the anatomic course of the nervus occipitalis major or minor. When position of the needle is deemed satisfactory, standard 4 or 8-contact electrodes are advanced through the needle, with the tip(s) of the electrodes situated in close proximity of the nervus occipitalis major or minor. Correct position of the electrode is verified by intraoperative test stimulation in the awake patient and fluoroscopy; saved images can be used to guide electrode position for the permanent implant in a patient who may be anesthetized. Once adequate coverage is achieved, the electrode is sutured in place with nonabsorbable sutures using two plastic anchors to minimize the possibility of displacement. In case of a successful trial, defined as at least 50% pain reduction, the patient undergoes the second part of the two-stage surgical procedure after 1–3 weeks under general anesthesia or deeper sedation. The first incision is made along the retroauricular area in a vertical direction. The soft tissues are dissected down to the fascia, and a small pocket is created above the fascia. The temporary electrode is removed, and the standard 4 or 8-contact electrode is then positioned in the same anatomic location as during the trial, which can be confirmed by comparison of trial and permanent implant radiographs. Once the electrode position is optimized, the needle is removed, and the electrode

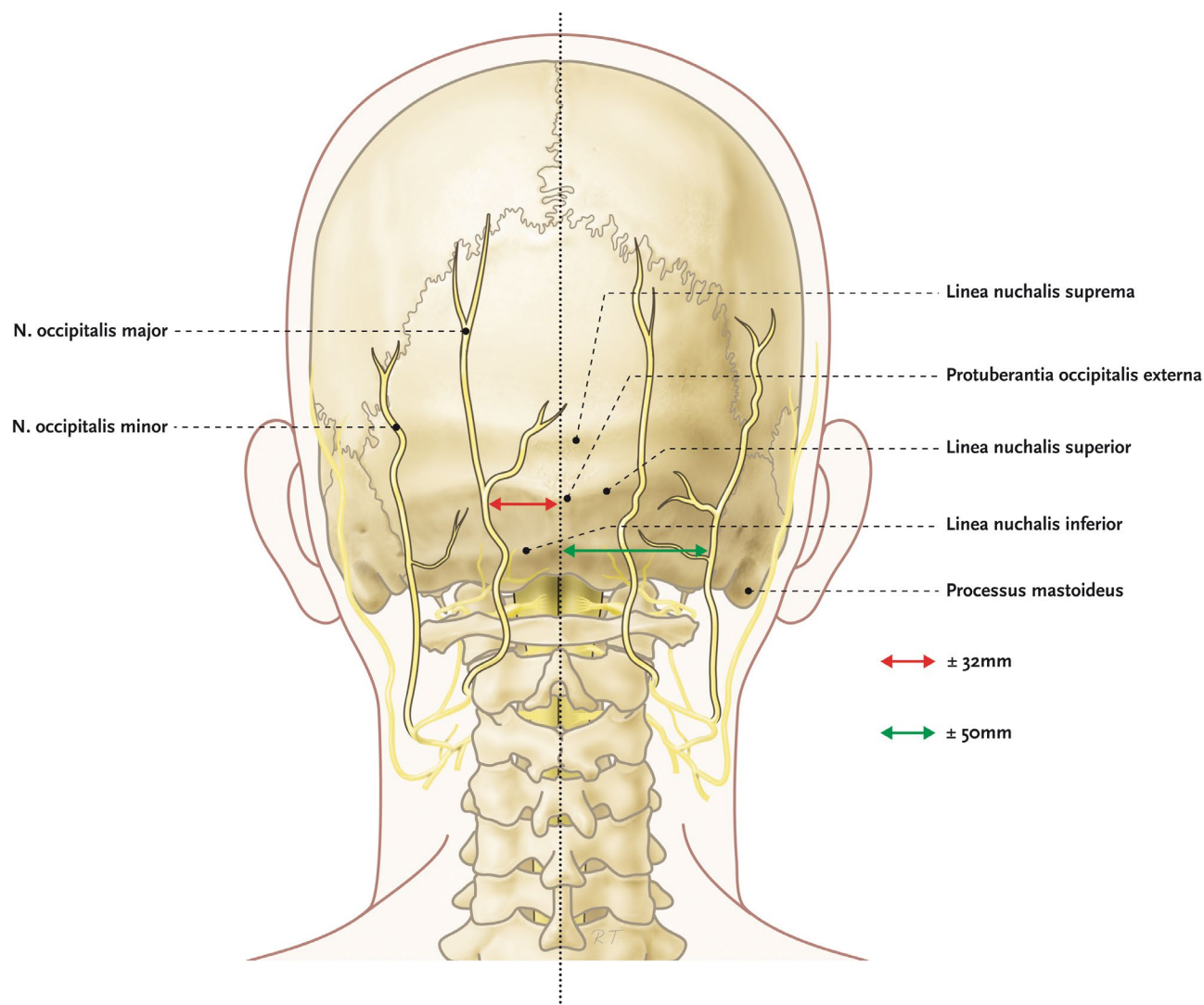


FIGURE 3 Anatomy of the head and superior spine and landmarks for injection of the ON.

is anchored to the occipital fascia with nonabsorbable sutures using a plastic anchor. Next, a subcutaneous pocket is created below the clavicle on the same side to accommodate the neurostimulator. Extension cables are advanced through a subcutaneous tunnel, establishing a connection between the electrode and the neurostimulator. At the end of the procedure all incisions are closed, cleaned, and covered with sterile dressings.¹⁰¹

AUTHORS CONTRIBUTIONS

Nicole Lefel performed the literature search and wrote the manuscript. Hans van Suijlekom assisted in the selection of the literature, revised, and adapted the manuscript. Van Zundert Jan revised the manuscript and is the final responsible for this manuscript. Cohen Steven revised and edited the manuscript.

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DATA AVAILABILITY STATEMENT

Data sharing is not applicable, as no new data were created or analyzed in this study.

PATIENTS CONSENT

No patient information was retrieved or analyzed; all information is derived from published literature. Therefore, no patient consent was needed.

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REFERENCES

- Bogduk N. The anatomical basis for cervicogenic headache. *J Manip Physiol Ther.* 1992;15:67–70.
- Sjaastad O, Bakketeig LS. Prevalence of cervicogenic headache: Vaga study of headache epidemiology. *Acta Neurol Scand.* 2008;117:173–80.
- Koopman JS, Dieleman JP, Huygen FJ, de Mos M, Martin CG, Sturkenboom MC. Incidence of facial pain in the general population. *Pain.* 2009;147:122–7. <https://doi.org/10.1016/j.pain.2009.08.023>
- Kapur L, Mekhail N, Hayek SM, Stanton-Hicks M, Malak O. Occipital nerve electrical stimulation via the midline approach and subcutaneous surgical leads for treatment of severe occipital neuralgia: a pilot study. *Anesth Analg.* 2005;101:171–4.
- Bogduk N. Headaches and the cervical spine. *Cephalalgia.* 1984;4:7–8. <https://doi.org/10.1046/j.1468-2982.1984.0401006.x>
- Headache classification Committee of the International Headache Society (IHS) the international classification of headache disorders, 3rd edition. *Cephalalgia.* 2018;38:1. <https://doi.org/10.1177/0333102417738202>
- Sjaastad O, Fredriksen TA, Pfaffenrath V. Cervicogenic headache: diagnostic criteria. The Cervicogenic Headache International Study Group. *Headache.* 1998;38:442–5.
- Lord SM, Barnsley L, Wallis BJ, Bogduk N. Third occipital nerve headache: a prevalence study. *J Neurol Neurosurg Psychiatry.* 1994;57:1187. <https://doi.org/10.1136/jnnp.57.10.1187>
- Tubbs RS, Mortazavi MM, Loukas M, D'Antoni AV, Shoja MM, Chern JJ, et al. Anatomical study of the third occipital nerve and its potential role in occipital headache/neck pain following midline dissections of the craniocervical junction. *J Neurosurg Spine.* 2011;15:71–5. <https://doi.org/10.3171/2011.3.Spine10854>
- Kuhn WF, Kuhn SC, Gilberstadt H. Occipital neuralgias: clinical recognition of a complicated headache. A case series and literature review. *J Orofac Pain.* 1997;11:158–65.
- Govind J, Bogduk N. Sources of cervicogenic headache among the upper cervical synovial joints. *Pain Med.* 2022;23:1059–65. <https://doi.org/10.1093/pm/pnaa469>
- Anarte-Lazo E, Carvalho GF, Schwarz A, Luedtke K, Falla D. Differentiating migraine, cervicogenic headache and asymptomatic individuals based on physical examination findings: a systematic review and meta-analysis. *BMC Musculoskelet Disord.* 2021;22:755. <https://doi.org/10.1186/s12891-021-04595-w>
- Heller CA, Stanley P, Lewis-Jones B, Heller RF. Value of x ray examinations of the cervical spine. *Br Med J (Clin Res Ed).* 1983;287:1276–8.
- Schellhas KP, Smith MD, Gundry CR, Pollei SR. Cervical discogenic pain. Prospective correlation of magnetic resonance imaging and discography in asymptomatic subjects and pain sufferers. *Spine.* 1996;21:300–11.
- van Eerd M, Patijn J, Loeffen D, van Kleef M, Wildberger J. The diagnostic value of an x-ray-based scoring system for degeneration of the cervical spine: a reproducibility and validation study. *Pain Pract.* 2021;21:766–77. <https://doi.org/10.1111/papr.13013>
- Farrell SF, Smith AD, Hancock MJ, Webb AL, Sterling M. Cervical spine findings on MRI in people with neck pain compared with pain-free controls: a systematic review and meta-analysis. *J Magn Reson Imaging.* 2019;49:1638–54. <https://doi.org/10.1002/jmri.26567>
- Saranteas T, Kostroglou A, Efstathiou G, Giannoulis D, Moschovaki N, Mavrogenis AF, et al. Peripheral nerve blocks in the cervical region: from anatomy to ultrasound-guided techniques. *Dentomaxillofac Radiol.* 2020;49:20190400. <https://doi.org/10.1259/dmfr.20190400>
- Barnsley L, Lord S, Wallis B, Bogduk N. False-positive rates of cervical zygapophysial joint blocks. *Clin J Pain.* 1993;9:124–30.
- Schwarzer AC, Aprill CN, Derby R, Fortin J, Kine G, Bogduk N. The false-positive rate of uncontrolled diagnostic blocks of the lumbar zygapophysial joints. *Pain.* 1994;58:195–200.
- Wahezi SE, Silva K, Shaparin N, Lederman A, Emam M, Haramati N, et al. Currently recommended TON injectate volumes concomitantly block the GON: clinical implications for managing cervicogenic headache. *Pain Physician.* 2016;19:E1079–E1086.
- Farina S, Granella F, Malferrari G, Manzoni GC. Headache and cervical spine disorders: classification and treatment with transcutaneous electrical nerve stimulation. *Headache.* 1986;26:431–3.
- Sjaastad O, Fredriksen TA, Stolt-Nielsen A, Salvesen R, Jansen J, Pareja JA, et al. Cervicogenic headache: a clinical review with special emphasis on therapy. *Funct Neurol.* 1997;12:305–17.
- Goyal S, Kumar A, Mishra P, Goyal D. Efficacy of interventional treatment strategies for managing patients with cervicogenic headache: a systematic review. *Korean J Anesthesiol.* 2022;75:12–24. <https://doi.org/10.4097/kja.21328>
- Langevin P, Michael P, Peloso P, Lowcock J, Nolan M, Weber J, et al. Botulinum toxin for subacute/chronic neck pain. *Cochrane Database Syst Rev.* 2011;Cd008626. <https://doi.org/10.1002/14651858.CD008626.pub2>
- Martelletti P, van Suijlekom H. Cervicogenic headache: practical approaches to therapy. *CNS Drugs.* 2004;18:793–805. <https://doi.org/10.2165/00023210-200418120-00004>
- Martelletti P, Di Sabato F, Granata M, Alampi D, Apponi F, Borgonuovo P, et al. Epidural corticosteroid blockade in cervicogenic headache. *Eur Rev Med Pharmacol Sci.* 1998;2:31–6.
- Inan N, Ceyhan A, Inan L, Kavaklioglu O, Alptekin A, Unal N. C2/C3 nerve blocks and greater occipital nerve block in cervicogenic headache treatment. *Funct Neurol.* 2001;16:239–43.
- Naja ZM, El-Rajab M, Al-Tannir MA, Ziade FM, Tawfik OM. Occipital nerve blockade for cervicogenic headache: a double-blind randomized controlled clinical trial. *Pain Pract.* 2006;6:89–95.
- Lauretti GR, Corrêa SW, Mattos AL. Efficacy of the greater occipital nerve block for cervicogenic headache: comparing classical and subcompartmental techniques. *Pain Pract.* 2015;15:654–61. <https://doi.org/10.1111/papr.12228>
- Pingree MJ, Sole JS, O'Brien TG, Eldridge JS, Moeschler SM. Clinical efficacy of an ultrasound-guided greater occipital nerve block at the level of C2. *Reg Anesth Pain Med.* 2017;42:99–104. <https://doi.org/10.1097/aap.0000000000000513>
- Ambrosini A, Vandenheede M, Rossi P, Aloj F, Sauli E, Pierelli F, et al. Suboccipital injection with a mixture of rapid- and long-acting steroids in cluster headache: a double-blind placebo-controlled study. *Pain.* 2005;118:92–6. <https://doi.org/10.1016/j.pain.2005.07.015>
- Natsis K, Baraliakos X, Appell HJ, Tsikarakis P, Gigis I, Koebeke J. The course of the greater occipital nerve in the suboccipital region: a proposal for setting landmarks for local anesthesia in patients with occipital neuralgia. *Clin Anat.* 2006;19:332–6.
- Van Boxem K, Rijdsdijk M, Hans G, de Jong J, Kallewaard JW, Vissers K et al. Safe use of epidural corticosteroid injections: recommendations of the WIP Benelux Work Group. *Pain Pract.* 2019;19:61–92. <https://doi.org/10.1111/papr.12709>
- Baek IC, Park K, Kim TL, Jehoon OJ, Yang HM, Kim SH. Comparing the injectate spread and nerve involvement between different injectate volumes for ultrasound-guided

- greater occipital nerve block at the C2 level: a cadaveric evaluation. *J Pain Res.* 2018;11:2033. <https://doi.org/10.2147/jpr.S172692>
35. Song Z, Zhao S, Ma J, Wu Z, Yang S. Fluoroscopy-guided blockade of the greater occipital nerve in cadavers: a comparison of spread and nerve involvement for different Injectate volumes. *Pain Res Manag.* 2020;2020:8925895. <https://doi.org/10.1155/2020/8925895>
 36. Zhou L, Hud-Shakoor Z, Hennessey C, Ashkenazi A. Upper cervical facet joint and spinal rami blocks for the treatment of cervicogenic headache. *Headache.* 2010;50:657–63. <https://doi.org/10.1111/j.1526-4610.2010.01623.x>
 37. Lee DG, Cho YW, Jang SH, Son SM, Kim GJ, Ahn SH. Effectiveness of intra-articular steroid injection for atlanto-occipital joint pain. *Pain Med.* 2015;16:1077–82. <https://doi.org/10.1111/pme.12474>
 38. Shin SM, Kwak SG, Lee DG, Chang MC. Clinical effectiveness of intra-articular pulsed radiofrequency compared to intra-articular corticosteroid injection for management of Atlanto-occipital joint pain: a prospective randomized controlled pilot study. *Spine (Phila Pa 1976).* 2018;43(11):741–6. <https://doi.org/10.1097/brs.0000000000002414>
 39. Hurley RW, Adams MCB, Barad M, Bhaskar A, Bhatia A, Chadwick A, et al. Consensus practice guidelines on interventions for cervical spine (facet) joint pain from a multispecialty international working group. *Reg Anesth Pain Med.* 2022;47:3–59. <https://doi.org/10.1136/rapm-2021-103031>
 40. Narouze SN, Casanova J, Mekhail N. The longitudinal effectiveness of lateral atlantoaxial intra-articular steroid injection in the treatment of cervicogenic headache. *Pain Med.* 2007;8:184–8.
 41. Goldberg ME, Schwartzman RJ, Domsy R, Sabia M, Torjman MC. Deep cervical plexus block for the treatment of cervicogenic headache. *Pain Physician.* 2008;11:849–54.
 42. Wan Q, Yang H, Li X, Lin C, Ke S, Wu S, et al. Ultrasound-guided versus fluoroscopy-guided deep cervical plexus block for the treatment of cervicogenic headache. *Biomed Res Int.* 2017;2017:4654803. <https://doi.org/10.1155/2017/4654803>
 43. He MW, Ni JX, Guo YN, Wang Q, Yang LQ, Liu JJ, et al. Continuous epidural block of the cervical vertebrae for cervicogenic headache. *Chin Med J.* 2009;122:427–30.
 44. Stovner LJ, Kolstad F, Helde G. Radiofrequency denervation of facet joints C2–C6 in cervicogenic headache: a randomized, double-blind, sham-controlled study. *Cephalalgia.* 2004;24:821–30. <https://doi.org/10.1111/j.1468-2982.2004.00773.x>
 45. Hamer JF, Purath TA. Response of cervicogenic headaches and occipital neuralgia to radiofrequency ablation of the C2 dorsal root ganglion and/or third occipital nerve. *Headache.* 2014;54:500–10. <https://doi.org/10.1111/head.12295>
 46. Govind J, King W, Bailey B, Bogduk N. Radiofrequency neurotomy for the treatment of third occipital headache. *J Neurol Neurosurg Psychiatry.* 2003;74:88–93.
 47. Chazen JL, Roytman M, Yoon ES, Mullen TK, Lebl DR. CT-guided C2 dorsal root ganglion radiofrequency ablation for the treatment of cervicogenic headache: case series and clinical outcomes. *AJNR Am J Neuroradiol.* 2022;43:575–8. <https://doi.org/10.3174/ajnr.A7471>
 48. van Suijlekom HA, van Kleef M, Barendse GA, Sluijter ME, Sjaastad O, Weber WE. Radiofrequency cervical zygapophyseal joint neurotomy for cervicogenic headache: a prospective study of 15 patients. *Funct Neurol.* 1998;13:297–303.
 49. Lee JB, Park JY, Park J, Lim DJ, Kim SD, Chung HS. Clinical efficacy of radiofrequency cervical zygapophyseal neurotomy in patients with chronic cervicogenic headache. *J Korean Med Sci.* 2007;22:326–9. <https://doi.org/10.3346/jkms.2007.22.2.326>
 50. Park SW, Park YS, Nam TK, Cho TG. The effect of radiofrequency neurotomy of lower cervical medial branches on cervicogenic headache. *J Korean Neurosurg Soc.* 2011;50:507–11. <https://doi.org/10.3340/jkns.2011.50.6.507>
 51. Haspeslagh SR, Van Suijlekom HA, Lamé IE, Kessels AG, van Kleef M, Weber WE. Randomised controlled trial of cervical radiofrequency lesions as a treatment for cervicogenic headache [ISRCTN07444684]. *BMC Anesthesiol.* 2006;6:1. <https://doi.org/10.1186/1471-2253-6-1>
 52. Suer M, Wahezi SE, Abd-Elseyed A, Sehgal N. Cervical facet joint pain and cervicogenic headache treated with radiofrequency ablation: a systematic review. *Pain Physician.* 2022;25:251–63.
 53. Nagar VR, Birthi P, Grider JS, Asopa A. Systematic review of radiofrequency ablation and pulsed radiofrequency for management of cervicogenic headache. *Pain Physician.* 2015;18:109–30.
 54. Grandhi RK, Kaye AD, Abd-Elseyed A. Systematic review of radiofrequency ablation and pulsed radiofrequency for management of cervicogenic headaches. *Curr Pain Headache Rep.* 2018;22:18. <https://doi.org/10.1007/s11916-018-0673-9>
 55. Gabrhelik T, Michalek P, Adamus M. Pulsed radiofrequency therapy versus greater occipital nerve block in the management of refractory cervicogenic headache—a pilot study. *Prague Med Rep.* 2011;112:279–87.
 56. Halim W, Chua NH, Vissers KC. Long-term pain relief in patients with cervicogenic headaches after pulsed radiofrequency application into the lateral atlantoaxial (C1–2) joint using an anterolateral approach. *Pain Pract.* 2010;10:267–71. <https://doi.org/10.1111/j.1533-2500.2010.00360.x>
 57. Park MS, Choi HJ, Yang JS, Jeon JP, Kang SH, Cho YJ. Clinical efficacy of pulsed radiofrequency treatment targeting the mid-cervical medial branches for intractable cervicogenic headache. *Clin J Pain.* 2021;37:206–10. <https://doi.org/10.1097/ajp.0000000000000911>
 58. Lee HJ, Cho HH, Nahm FS, Lee PB, Choi E. Pulsed radiofrequency ablation of the C2 dorsal root ganglion using a posterior approach for treating cervicogenic headache: a retrospective chart review. *Headache.* 2020;60:2463–72. <https://doi.org/10.1111/head.13759>
 59. Li SJ, Feng D. Pulsed radiofrequency of the C2 dorsal root ganglion and epidural steroid injections for cervicogenic headache. *Neurol Sci.* 2019;40:1173–81. <https://doi.org/10.1007/s10072-019-03782-x>
 60. Kvarstein G, Höglström H, Allen SM, Rosland JH. Cryoneurolysis for cervicogenic headache—a double blinded randomized controlled study. *Scand J Pain.* 2019;20:39–50. <https://doi.org/10.1515/sjpain-2019-0086>
 61. Bovim G, Fredriksen TA, Stolt-Nielsen A, Sjaastad O. Neurolysis of the greater occipital nerve in cervicogenic headache. A follow up study. *Headache.* 1992;32:175–9.
 62. Pikus HJ, Phillips JM. Outcome of surgical decompression of the second cervical root for cervicogenic headache. *Neurosurgery.* 1996;39:63–71.
 63. Stechison MT. Outcome of surgical decompression of the second cervical root for cervicogenic headache. *Neurosurgery.* 1997;40:1105–6.
 64. Bing N, Tao D, Wei S, Guang L, Hongwei Z. Percutaneous endoscopic C2–C3 medial branches neurotomy for cervicogenic headache. *World Neurosurg.* 2019;126:498–501. <https://doi.org/10.1016/j.wneu.2019.03.072>
 65. Hammond SR, Danta G. Occipital neuralgia. *Clin Exp Neurol.* 1978;15:258–70.
 66. Kapural L, Stillman M, Kapural M, McIntyre P, Guirgus M, Mekhail N. Botulinum toxin occipital nerve block for the treatment of severe occipital neuralgia: a case series. *Pain Pract.* 2007;7:337–40.
 67. Taylor M, Silva S, Cottrell C. Botulinum toxin type-a (BOTOX) in the treatment of occipital neuralgia: a pilot study. *Headache.* 2008;48:1476–81.
 68. Juškys R, Štuckas G. Effectiveness of treatment of occipital neuralgia using the nerve block technique: a prospective analysis of 44 patients. *Acta Med Litu.* 2018;25:53–60. <https://doi.org/10.6001/actamedica.v25i2.3757>

69. Finiels PJ, Batifol D. The treatment of occipital neuralgia: review of 111 cases. *Neurochirurgie*. 2016;62:233–40. <https://doi.org/10.1016/j.neuchi.2016.04.004>
70. Navani A, Mahajan G, Kreis P, Fishman SM. A case of pulsed radiofrequency lesioning for occipital neuralgia. *Pain Med*. 2006;7:453–6.
71. Choi HJ, Oh IH, Choi SK, Lim YJ. Clinical outcomes of pulsed radiofrequency neuromodulation for the treatment of occipital neuralgia. *J Korean Neurosurg Soc*. 2012;51:281–5. <https://doi.org/10.3340/jkns.2012.51.5.281>
72. Huang JH, Galvagno SM Jr, Hameed M, Wilkinson I, Erdek MA, Patel A, et al. Occipital nerve pulsed radiofrequency treatment: a multi-center study evaluating predictors of outcome. *Pain Med*. 2012;13:489–97. <https://doi.org/10.1111/j.1526-4637.2012.01348.x>
73. Vanelderen P, Rouwette T, De Vooght P, Puylaert M, Heylen R, Vissers K, et al. Pulsed radiofrequency for the treatment of occipital neuralgia: a prospective study with 6 months of follow-up. *Reg Anesth Pain Med*. 2010;35:148–51.
74. Cohen SP, Peterlin BL, Fulton L, Neely ET, Kurihara C, Gupta A, et al. Randomized, double-blind, comparative-effectiveness study comparing pulsed radiofrequency to steroid injections for occipital neuralgia or migraine with occipital nerve tenderness. *Pain*. 2015;156:2585–94. <https://doi.org/10.1097/j.pain.0000000000000373>
75. Vu T, Chhatre A. Cooled radiofrequency ablation for bilateral greater occipital neuralgia. *Case Rep Neurol Med*. 2014;2014:257373. <https://doi.org/10.1155/2014/257373>
76. Kastler A, Attyé A, Maindet C, Nicot B, Gay E, Kastler B, et al. Greater occipital nerve cryoneurolysis in the management of intractable occipital neuralgia. *J Neuroradiol*. 2018;45:386–90. <https://doi.org/10.1016/j.neurad.2017.11.002>
77. Antony AB, Mazzola AJ, Dhaliwal GS, Hunter CW. Neurostimulation for the treatment of chronic head and facial pain: a literature review. *Pain Physician*. 2019;22:447–77.
78. Slavin KV, Isagulyan ED, Gomez C, Yin D. Occipital nerve stimulation. *Neurosurg Clin N Am*. 2019;30:211–7. <https://doi.org/10.1016/j.nec.2018.12.004>
79. Weiner R, Reed K. Peripheral neurostimulation for control of intractable occipital neuralgia. *Neuromodulation*. 1999;2:217–22.
80. Salmasi V, Olatoye OO, Terkawi AS, Hah JM, Ottestad E, Pingree M. Peripheral nerve stimulation for occipital neuralgia. *Pain Med*. 2020;21:S13–s17. <https://doi.org/10.1093/pm/pnaa083>
81. Deer TR, Mekhail N, Provenzano D, Pope J, Krames E, Leong M, et al. The appropriate use of neurostimulation of the spinal cord and peripheral nervous system for the treatment of chronic pain and ischemic diseases: the neuromodulation appropriateness consensus committee. *Neuromodulation*. 2014;17:515. <https://doi.org/10.1111/ner.12208>
82. Sweet JA, Mitchell LS, Narouze S, Sharan AD, Falowski SM, Schwalb JM, et al. Occipital nerve stimulation for the treatment of patients with medically refractory occipital neuralgia: congress of neurological surgeons systematic review and evidence-based guideline. *Neurosurgery*. 2015;77:332–41. <https://doi.org/10.1227/neu.0000000000000872>
83. Poletti CE. Proposed operation for occipital neuralgia: C-2 and C-3 root decompression. Case report. *Neurosurgery*. 1983;12:221–4. <https://doi.org/10.1227/00006123-198302000-00017>
84. Pisapia JM, Bhowmick DA, Farber RE, Zager EL. Salvage C2 ganglionectomy after C2 nerve root decompression provides similar pain relief as a single surgical procedure for intractable occipital neuralgia. *World Neurosurg*. 2012;77:362–9. <https://doi.org/10.1016/j.wneu.2011.06.062>
85. Dubuisson D. Treatment of occipital neuralgia by partial posterior rhizotomy at C1-3. *J Neurosurg*. 1995;82:581–6.
86. Jose A, Nagori SA, Chattopadhyay PK, Roychoudhury A. Greater occipital nerve decompression for occipital neuralgia. *J Craniofac Surg*. 2018;29:e518–e521. <https://doi.org/10.1097/scs.00000000000004549>
87. Gille O, Lavignolle B, Vital JM. Surgical treatment of greater occipital neuralgia by neurolysis of the greater occipital nerve and sectioning of the inferior oblique muscle. *Spine (Phila Pa 1976)*. 2004;29(7):828–32.
88. Gillespie G, MacKenzie P. Epiduroscopy-a review. *Scott Med J*. 2004;49:79–81.
89. Ducic I, Hartmann EC, Larson EE. Indications and outcomes for surgical treatment of patients with chronic migraine headaches caused by occipital neuralgia. *Plast Reconstr Surg*. 2009;123:1453–61. <https://doi.org/10.1097/PRS.0b013e3181a0720e>
90. Manchikanti L, Malla Y, Wargo BW, Cash KA, Pampati V, Fellows B. Complications of fluoroscopically directed facet joint nerve blocks: a prospective evaluation of 7,500 episodes with 43,000 nerve blocks. *Pain Physician*. 2012;15:E143–E150.
91. Silberstein SD, Dodick DW, Saper J, Huh B, Slavin KV, Sharan A, et al. Safety and efficacy of peripheral nerve stimulation of the occipital nerves for the management of chronic migraine: results from a randomized, multicenter, double-blinded, controlled study. *Cephalalgia*. 2012;32:1165–79. <https://doi.org/10.1177/0333102412462642>
92. Joswig H, Abdallat M, Karapetyan V, MacDougall KW, Cooper PE, Parrent AG. Long-term experience with occipital and supra-orbital nerve stimulation for the various headache disorders—a retrospective institutional case series of 96 patients. *World Neurosurg*. 2021;151:e472–e483. <https://doi.org/10.1016/j.wneu.2021.04.070>
93. van Suijlekom H, Van Zundert J, Narouze S, van Kleef M, Mekhail N. 6. Cervicogenic headache. *Pain Pract*. 2010;10:124.
94. Choi I, Jeon SR. Neuralgias of the head: occipital neuralgia. *J Korean Med Sci*. 2016;31:479–88. <https://doi.org/10.3346/jkms.2016.31.4.479>
95. Blumenfeld A, Ashkenazi A, Napchan U, Bender SD, Klein BC, Berliner R, et al. Expert consensus recommendations for the performance of peripheral nerve blocks for headaches—a narrative review. *Headache*. 2013;53:437–46. <https://doi.org/10.1111/head.12053>
96. Loukas M, El-Sedfy A, Tubbs RS, Louis RG Jr, Wartmann CH, Curry B, et al. Identification of greater occipital nerve landmarks for the treatment of occipital neuralgia. *Folia Morphol (Warsz)*. 2006;65:337–42.
97. Shim JH, Ko SY, Bang MR, Jeon WJ, Cho SY, Yeom JH, et al. Ultrasound-guided greater occipital nerve block for patients with occipital headache and short term follow up. *Korean J Anesthesiol*. 2011;61:50–4. <https://doi.org/10.4097/kjae.2011.61.1.50>
98. Barmherzig R, Kingston W. Occipital neuralgia and cervicogenic headache: diagnosis and management. *Curr Neurol Neurosci Rep*. 2019;19:20. <https://doi.org/10.1007/s11910-019-0937-8>
99. Peene L, Cohen SP, Brouwer B, James R, Wolff A, van Boxem K, et al. 2. Cervical radicular pain. *Pain Pract*. 2023;23:800–17. <https://doi.org/10.1111/papr.13252>
100. Tanaka N, Yamaga M, Tateyama S, Uno T, Tsuneyoshi I, Takasaki M. The effect of pulsed radiofrequency current on mechanical allodynia induced with resiniferatoxin in rats. *Anesth Analg*. 2010;111:784–90.
101. Vanelderen P, Lataster A, Levy R, Mekhail N, van Kleef M, van Zundert J. 8. Occipital neuralgia. *Pain Pract*. 2010;10:137–44. <https://doi.org/10.1111/j.1533-2500.2009.00355.x>

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