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# Peripheral Nerve Stimulation for Occipital Neuralgia: A Parallel Approach

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**Background:** Occipital neuralgia (ON) is a common headache syndrome characterized by sharp, shooting pain affecting the posterior head in the distribution of the occipital nerve. It is associated with debilitating symptoms that can severely impact a patient's quality of life. We report the use of peripheral nerve stimulation (PNS) for ON with a nonconventional, parallel technique.

**Case Report:** A patient in their late 20s presented with persistent headaches and ON after a posterior occipitocervical fusion secondary to a C2 burst fracture because of a motor vehicle accident. Multiple modalities for pain treatment were tried without relief. Patient was considered a candidate for PNS. The patient first underwent a trial implantation. Using ultrasound and fluoroscopy, an 8-lead, Curonix stimulator lead was placed parallel to the nerve, entry from caudal to cranial. At follow-up, the patient reported nearly 100% pain relief. Patient proceeded with a 4-tined leads permanent PNS implant. Patient reported near absence of pain at 3-month, 6-month, and one-year follow-ups.

**Conclusions:** We demonstrate a unique approach of peripheral nerve implantation for the treatment of ON, specifically with the stimulator lead parallel vs commonly used perpendicular to the occipital nerve. This case demonstrates why a parallel technique may be a feasible method with better outcomes.

**Key words:** Occipital neuralgia, greater occipital nerve, lesser occipital nerve, peripheral nerve stimulation, activities of daily living

## BACKGROUND

Headache is one of the most common causes of disability worldwide (1). Occipital neuralgia (ON) is a common headache syndrome characterized by sharp, shooting pain affecting the posterior head in the distribution of the occipital nerve (2). It is associated with debilitating symptoms that can severely impact a patient's quality of life. The mechanisms of ON suggest that many possible compression points exist that may contribute to the symptoms (2). These compression points can be vascular, neurogenic, muscular, and osteogenic (2).

While conservative and pharmacologic therapies are typically considered first-line treatments, other treatment modalities have emerged over the last few decades. If a patient was nonresponsive to conservative therapies, more invasive treatments were considered, including nerve block of the occipital nerve with local anesthetic, followed by nerve ablation or stimulation (3). Implantable peripheral nerve stimulation (PNS) for ON was first introduced in the 1970s (4).

Despite the promising results, PNS for ON has been plagued by high complication rates, often resulting in

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surgical revision. Commonly reported complications include hardware erosion, infection, efficacy loss, and lead migration (5,6).

The purpose of this case report is to demonstrate a unique procedural technique, specifically placing the lead parallel to the occipital nerve and using ultrasound for accurate lead placement. Conventionally, the leads of the PNS are placed perpendicular to the nerve. Although reports have been made on different techniques, the parallel approach has not been reported (7). In this manuscript, we present a case report of a midline, parallel approach to PNS for ON that may reduce the complication of lead migration and increase the effectiveness of the nerve stimulator.

## Consent Form for Publication and Ethical Approval

Written informed consent was obtained from the patient along with accompanying images and stored in file for our records. An institutional review board is not required for this case report.

## CASE DESCRIPTION

A patient in their late 20s with a history of a posterior occipitocervical fusion presented with persistent, debilitating headaches. The patient required the occipitocervical fusion surgery due to a C2 burst fracture and ligamentous instability after a pedestrian vs motor vehicle accident, when they fell onto the ground after being run over by a car. The patient described the pain as aching and sharp, located at the upper neck to the top of his head bilaterally, radiating to the head, forehead, and upper thoracic region, worse with any head movement, rated 8-9 in severity on the Visual Analog Scale (VAS).

A clinical diagnosis of ON was made. The patient had trials of multiple modalities for pain relief, including medication management with tricyclic antidepressants, membrane stabilizers, opioids, ketamine, marijuana, physical therapy, acupuncture, and a series of greater (GON) and lesser occipital nerve (LON) blocks – all without lasting relief. After being nonresponsive to conservative management for over 6 months, the patient completed the psychological evaluation and was considered a candidate for PNS of the GON.

A trial implantation was first performed. The patient was placed in the prone position, prepped, and draped in standard sterile fashion. With aid of ultrasound and fluoroscopy, the C2 spinous process was identified, then a 14G Coudé® needle was advanced from the upper thoracic area all the way to the C2 level and kept superficial to the obliquus capitis inferior muscle and close to the GON. The ultrasound, as well as the x-ray anteroposterior (AP) and lateral views, were also used to confirm that the stimulator leads were superficial to the metal screws that the patient had from the prior surgery. Out-of-plane approach was used as we tracked the tip of the needle from the insertion point all the way lateral to the GON and superficial to the oblique capitis inferior muscle. The "Curonix stimulator" is the PNS system we used for this case. An 8-contact, Curonix stimulator lead (Curonix Technologies Inc, Pompano, FL) was advanced through the needle, in plane parallel to the length of the nerve on each side (Fig. 1).

The contacts for both leads were programmed at cathode-cathode-anode-anode. For testing, amplitude was set at 2 mA, frequency of 80 Hz, and pulse width of 320 μs to establish a tonic response. The patient's pain distribution was captured with stimulation after making the appropriate adjustment. At one-week follow-up, patient reported nearLY 100% pain relief and improved generalized body pain and sleep. After 3 months, we proceeded with the permanent implantable.

PNS implantation was completed under monitored anesthesia care using intermittent boluses of fentanyl and midazolam. Patient was placed in the prone position where the occipital area, neck, and thoracic torso were prepped and draped. Ultrasound was used to identify the C2 spinous process, then the probe rotated so the lateral edge moved cranially to the transverse process of C1. The obliquus capitis inferior and semispinalis capitis muscles were identified, as well as the GON and C2 dorsal root ganglion between the 2 muscle layers (Fig. 2).

The skin and subcutaneous tissues overlying the needle trajectory were anesthetized with 1% lidocaine via a 1.5-inch, 25G needle. After local infiltration, a midline incision was made at the T1 level. Lateral to the spinous process just off the midline, the subcutaneous tissue was dissected until the fascia was visualized and palpated. A 13G blunt introducer was advanced with the aid of ultrasound and fluoroscopy in AP and lateral views through the incision; the tip was tracked with the ultrasound probe superficial to the iliocostalis part of the erector and rhomboid muscles in the upper thoracic area and then tracked to the C2 superficial to the obliquus capitis inferior muscle and close to the GON in plane parallel to the length of the nerve (Fig. 3).

Proper placement was verified with the aid of fluoroscopy in AP and lateral views. A 4-contact, tined Curonix stimulator lead (Curonix Technologies Inc, Pompano, FL) was advanced through the needle. Stimulation testing was performed targeting the patient's pain distribution, then, the introducer needles and the stylets were removed intact.

The same steps were repeated on the other side. Afterward, two 2.0 nonabsorbable sutures were placed circumferentially around the 2 leads. Another incision was made at the midthoracic area (T6-T7) on the left of the midline per patient request, after local infiltration of local anesthetics. Hemostasis was maintained with the aid of the electrocautery unit once the pocket for the generator was made. Then a tunneled blunt introducer was used to connect the leads from the anchor to the generator site subcutaneously. After stimulation and lead adjustment according to the patient's pain distribution, four 2.0 nonabsorbable sutures were placed around receiver coils as well as the generator site. Final verification of the leads, anchors, and the generator were visualized with the aid of fluoroscopy and ultrasound (Fig. 4). No complications were noted, and patient was transferred to the recovery room in stable condition.

At one-month follow-up, the patient reported nearLY 100% pain relief from headaches that reflected positively on his mood and sleep. When present, the pain was rated 0-1 in severity on the VAS. All scheduled pain medications were stopped. Additionally, the patient had significant improvement in his activities of daily living. At 3-month follow-up, patient reported that the pain was nearly gone, which made great strides getting back into social life. At 6-month follow-up, patient continued to have resolution from headache syndrome and is back to working part time. They were pleased

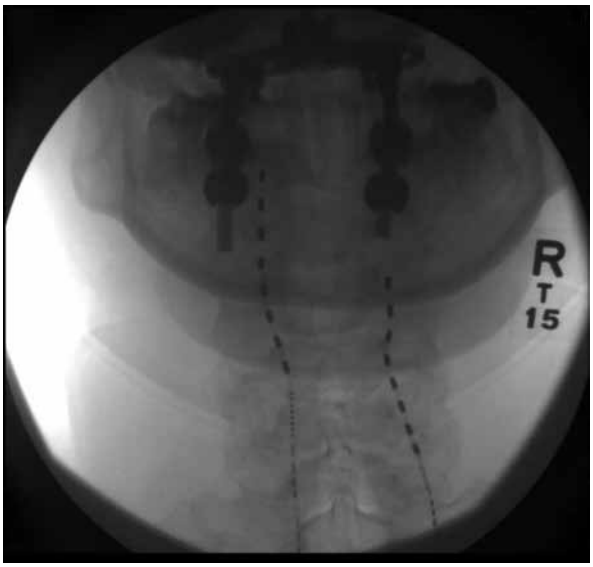


Fig. 1. Trial of PNS with 8-contact leads.
PNS, peripheral nerve stimulator

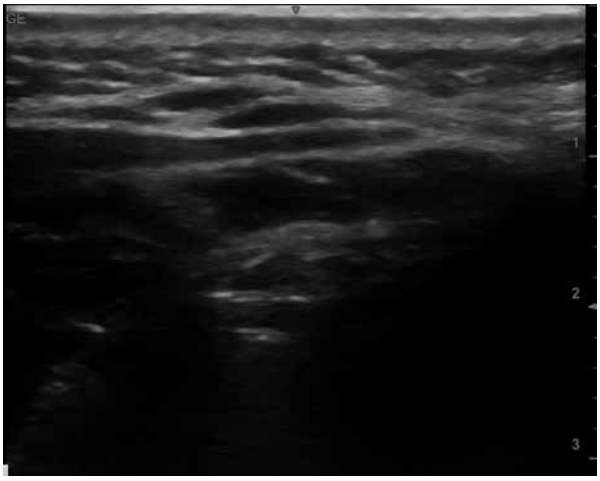

Fig. 2. Ultrasound image to guide placement of lead.
GON, greater occipital nerve.

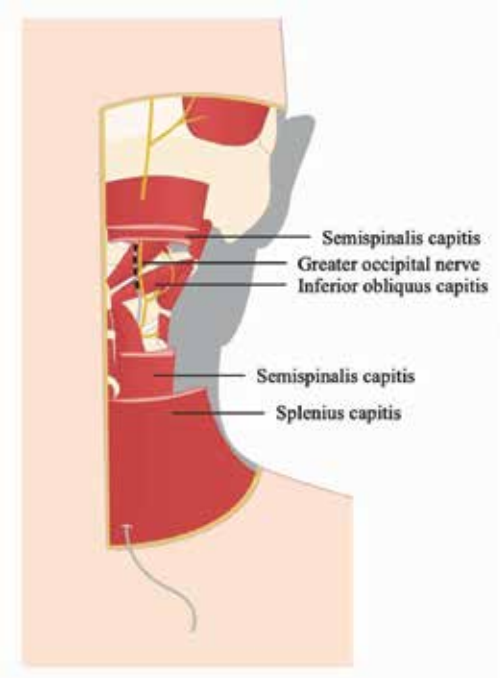


Fig. 3. The 4-contact lead placed parallel to the occipital nerve.

with their functional outcomes and participation in the community. At one-year follow-up, patient's quality of life has improved significantly. He was back to working full time, driving without issues, and also got married and had a kid. The patient continued to have less headache episodes, about once a month. He described his occasional headache as dull and intermittent, mainly in the upper neck region worse after a stressful day at work, almost immediately relieved with the PNS. Prior to the PNS, patient reported that he had at least several episodes a day, reported as a sharp radiating pain in the upper head bilaterally all the way to the top of the head. This sharp-quality pain has nearly gone away since the implantation.

## DISCUSSION

PNS is a promising treatment modality for refractory ON. This case demonstrates that PNS can significantly reduce pain and increase quality of life in a patient with refractory ON following posterior occipitocervical fusion surgery.

Prior to the advent of stimulator systems, physicians used other treatment modalities for refractory cases of ON, including nerve blocks, radiofrequency neuromodulation, and cryoneurolysis (8). The benefits of these interventions, however, are usually short lived. Spinal cord stimulator (SCS) systems are thought to provide longer-term benefits, but these devices have their own limitations (9,10). Lead migration and erosion have been reported as common complications more with SCS than with peripheral nerve devices (7,11,12). Furthermore, tunneling through the neck area is challenging, especially with SCS. Therefore, many partitioners prefer the use of PNS implantation with short, thin leads, and no internal pulse generator when compared to SCS (3).

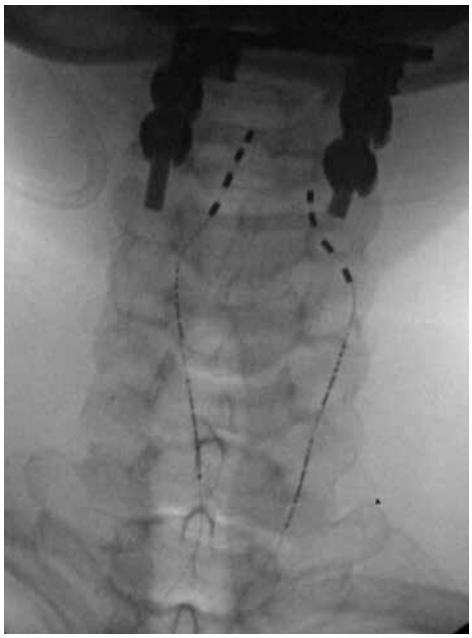

Fig. 4. Postoperative x-ray image of stimulation permanent leads parallel to the occipital nerve with 4-contact leads.

A prospective study (13) on 157 patients with chronic migraine treated with PNS reported a low incidence of adverse events and recommended more practice of PNS implantation among skilled physicians.

The emergence of minimally invasive percutaneous approaches has led to more widespread use of PNS. Multiple options exist for percutaneous placement of leads, which are stimulated directly with an implantable pulse generator that requires an implanted battery or a stimulator that is powered by an external power source/impulse generator (14). The PNS "Curonix" (Curonix Technologies Inc, Pompano, FL) was used for our patient, which is composed of the implanted neurostimulator and an external nonimplanted wireless transmitter.

The parallel approach used in our case provided several advantages compared to the traditional perpendicular approach. When the leads are parallel to the nerve length, it increases the chance of contacting a greater distribution of the nerve targeting more pain supply, hence the effectiveness of the nerve stimulator as it allows more electrical contact between the leads and the nerve. Four contacts interact with the nerve compared to one or two contacts in the perpendicular approach. So even if there is a little migration, there would be more contacts in relation to the nerve when parallel vs perpendicular approach, which makes it a novel approach. In addition, during the trial, we used 8 leads to maximize the area of stimulation, but in the permanent one, 4 contact leads were only sufficient for achieving the same response. Furthermore, when PNS is placed parallel to the length of the nerve, this may cause less migration and more lead stability, especially in high-mobility joints like the neck area.

The incision/entry point was placed below the hairline at the T1-T2 level, which potentially can decrease the risk of infection in addition to being more cosmetically appealing.

The location of the nerve between the muscles at C2 is more consistent compared to the commonly used occipital area. As the nerve terminal branches are subcutaneous and have more anatomical variability and

superficial location, there may be a higher chance of failure, infection, and lead erosion in the occipital area compared to the deeper consistent location at the C2 approach. The stimulator in our case comes with the implanted neurostimulator and the receiver, which is an external, nonimplanted transmitter that provides programming options customized to the patient (described in detail in Case Description). The neurostimulator incision was done below the hairline at the T1-T2 level, and the receiver at the midthoracic area, making it easier for the patient to use. One challenge of the midline parallel approach is the technique to track the needle from the T1 to C2 area (15). However, given the potential advantages, widespread ultrasound availability, and the decreased risk of complications, the parallel approach may be more worthwhile to use (15).

## CONCLUSIONS

This case further supports the parallel technique as a safe and stable method for enhancing neurostimulation without providing additional risks. The long-term efficacy and complication rate of the parallel approach need to be studied in larger cohorts.

### Acknowledgment

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## REFERENCES

1. GBD 2017 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: A systematic analysis for the Global Burden of Disease Study 2017. *Lancet* 2018; 392:1789-1858.
2. Vanelderen P, Lataster A, Levy R, Mekhail N, van Kleef M, Van Zundert J. 8. Occipital neuralgia. *Pain Pract* 2010; 10:137-144.
3. Salmasi V, Olatoye OO, Terkawi AS, Hah JM, Ottestad E, Pingree M. Peripheral nerve stimulation for occipital neuralgia. *Pain Med* 2020; 21(suppl 1):S13-S17.
4. Slavin KV, Isagulyan ED, Gomez C, Yin D. Occipital nerve stimulation. *Neurosurg Clin N Am* 2019; 30:211-217.
5. Oh MY, Ortega J, Bellotte JB, Whiting DM, Alo K. Peripheral nerve stimulation for the treatment of occipital neuralgia and transformed migraine using a c1-2-3 subcutaneous paddle style electrode: A technical report. *Neuromodulation* 2004; 7:103-112.
6. Liu AJ, Ji HJ, Jiao YC, Zhang ZW. Peripheral nerve stimulation for occipital neuralgia. *Chin Med J (Engl)* 2015; 128:2553-2554.
7. Pittelkow T, Pagani-Estévez G, Landry B, Pingree M, Eldrige J. Occipital neuromodulation: A surgical technique with reduced complications. *Pain Physician* 2016; 19:E1005-E1012.
8. Kastler A, Attye A, Maindet C, et al. Greater occipital nerve cryoneurolysis in the management of intractable occipital neuralgia. *J Neuroradiol* 2018; 45:386-390.
9. Garcia-Ortega R, Edwards T, Moir L, Aziz TZ, Green AL, FitzGerald JJ. Burst occipital nerve stimulation for chronic migraine and chronic cluster headache. *Neuromodulation* 2019; 22:638-644.
10. Keifer OP Jr, Diaz A, Campbell M, Bezchlibnyk YB, Boulis NM. Occipital nerve stimulation for the treatment of refractory occipital neuralgia: A case series. *World Neurosurg* 2017; 105:599-604.
11. Amit A, Sharma M, Deogaonkar M. Peripheral nerve stimulation by 'sandwich' paddle leads: Technical note. *Acta Neurochir (Wien)* 2014; 156:1987-1989.
12. Abhinav K, Park ND, Prakash SK, Love-Jones S, Patel NK. Novel use of narrow paddle electrodes for occipital nerve stimulation--technical note. *Neuromodulation* 2013; 16:607-609.
13. Sharan A, Hub B, Narouze S, et al. Analysis of adverse events in the management of chronic migraine by peripheral nerve stimulation. *Neuromodulation* 2015; 18:305-312.
14. Strand N, D'Souza RS, Hagedorn JM, et al. Evidence-Based clinical guidelines from the American Society of Pain and Neuroscience for the use of implantable peripheral nerve stimulation in the treatment of chronic pain. *J Pain Res* 2022; 15:2483-2504.
15. Kapural 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; 101:171-174.