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Temporary Peripheral Nerve Stimulation for the Treatment of Greater Occipital Neuralgia

Royce Copeland, DO, Angela Nwankwo, MD, and Emanuel Husu, MD

Background: Greater occipital neuralgia (GON), a cause of chronic headaches, can be debilitating and vastly affect one's quality of life. Recent strides in comprehending the pathophysiology of GON and the ongoing evolution of approaches to the condition's treatment have led to the pursuit of more effective interventions. Among these, temporary peripheral nerve stimulation (PNS) devices have surfaced as an avenue for management, presenting a minimally invasive yet highly efficient alternative in treating other chronic pain conditions. This study discusses a case of GON successfully managed with temporary (60-day) PNS.

Case Report: A 35-year-old man presented with a nearly 8-month history of intractable headaches without any inciting event along the left greater occipital nerve distribution. The patient underwent a series of 2 diagnostic GON blocks and experienced 90% pain relief. A 60-day PNS device was implanted to treat the patient's left-side GON, and during the 6-month period, the patient received 75% pain with no complications.

Conclusions: Temporary PNS is a promising treatment for painful mononeuropathies. Most PNS devices are implanted permanently to provide benefits, but this new development allows temporary stimulation devices to manage chronic pain. This case demonstrates another potential therapeutic option for pain management providers to alleviate pain in patients suffering from GON.

Key words: Peripheral nerve stimulation, occipital neuralgia, chronic headache, neuromodulation, pain medicine

BACKGROUND

Greater occipital neuralgia (GON) is a condition characterized by excruciating paroxysmal pain that originates from the occipital nerve and radiates to the vertex. The pain often stems from the greater occipital nerve, which arises from the dorsal primary ramus of C2, with variable contribution from C3 (1). This condition has posed a challenge in the pain management field, necessitating innovative and effective treatment strategies. A promising treatment modality for patients with chronic headaches that present with features of occipital neuralgia is occipital nerve stimulation via temporary peripheral nerve stimulation (PNS).

Traditionally, GON management has included oral medications, nerve blocks, and invasive surgical procedures (1). However, a significant proportion of patients, such as the one in the present case report, do not respond satisfactorily to these treatments and continue to endure relentless pain. Recent literature has highlighted the complexities and challenges in managing intractable occipital neuralgia (2). The limitations and potential risks associated with these approaches have led to a growing interest in neuromodulation techniques.

Among these treatments, PNS has garnered particular attention for its ability to modulate neural pathways and provide sustained pain relief. The application of PNS involves the targeted delivery of electrical stimulation

From: Department of Physical Medicine and Rehabilitation, Baylor College of Medicine, Houston, TX

Corresponding Author: Royce Copeland, DO, E-mail: royce.copeland@bcm.edu
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to peripheral nerves, interrupting or modulating pain signals (3). The evolving landscape of PNS technology has seen the emergence of the 60-day percutaneous PNS system, which offers a temporary, minimally invasive solution for chronic pain conditions.

In this developing environment, neuromodulation technologies, particularly peripheral nerve stimulation (PNS), have emerged as a promising avenue for treating painful mononeuropathies. Studies within the last 2 decades have demonstrated significant efficacy in implantable PNS devices' treatment of occipital neuralgia; however, physicians and patients often encounter high complications related to lead fractures, lead migration, and infections over time (4,6). More recently, temporary PNS technology has become available, with significant advantages over implantable PNS devices. This case report demonstrates a successful outcome of the use of temporary PNS as a GON treatment and adds to the body of literature on temporary PNS usage for managing various painful mononeuropathies.

CASE DESCRIPTION

A 35-year-old man with a medical history of hemochromatosis, depression, and insomnia was referred to a pain clinic for the management of daily, intractable, left-sided paroxysmal headaches. His existing medication regimen consisted of 20 mg of vilazodone daily, 400 mg of gabapentin 3 times a day, and 3 mg of eszopiclone at bedtime. The patient reported that the onset of the headaches occurred at the beginning of 2022 without any specific traumatic incident. The pain originated from the left posterior occiput, approximately 2 fingerbreadths inferior to and lateral from the external occipital protuberance, and extended toward the left parietal and temporal regions near the vertex. These episodes were described as sensations ranging from stabbings to electric shocks, each of which was accompanied by a pain severity rating of 10/10 on the visual analog scale (VAS). Despite the patient's use of oral neuropathic medications, his condition remained refractory.

In August 2022, the patient underwent a diagnostic block in his left greater occipital nerve. The procedure was guided by ultrasound and used a mixture of bupivacaine and triamcinolone. The patient reported complete pain relief, and the procedure was free from complications. Following this initial success, a second diagnostic nerve block was performed 2 months later under the same conditions, yielding 90% pain relief, according to the patient's reports. Encouraged by these outcomes, the physicians and patient decided to proceed with a 60-day temporary PNS for the left-sided GON.

Description of Technique

After sterile preparation was ensured, the patient was placed in the prone position, and a 15 Hz linear transducer was employed to locate the spinous process of the second cervical vertebra. Identification of the bifid C2 spinous process marked the subsequent step. There, the probe was positioned laterally at a 45-degree angulation, with the medial portion of the probe on the spinous process and the lateral portion on the cervical laminae. Internal landmarks were identified, including the C2 lamina, obliquus capitis inferior, and semispinalis capitis, with the greater occipital nerve found on the dorsal surface of the obliquus capitis inferior. Local anesthesia (1% lidocaine) was administered to ensure the patient's comfort. A percutaneous sleeve and stimulating probe lead introduction system were assembled and inserted from a lateral trajectory. This part of the process was closely monitored with ultrasound visualization. The probe tip was positioned adjacent to the greater occipital nerve, ensuring precise targeting. Verification of nerve target acquisition was confirmed by generating paresthesia in the area corresponding to the patient's pain. Once these parameters were established, the stimulating probe was carefully removed from the introducer needle. The percutaneous lead was then guided through the needle and positioned in close proximity to the nerve. Subsequently, the introducer needle was removed, and the exposed end of the percutaneous lead was connected to an external stimulator unit mounted to the skin. The patient tolerated the procedure well, and no intra-operative or postoperative complications were noted.

Results

At the 2-month follow-up, in accordance with the manufacturer's guidelines, the patient was assessed for removal of the 60-day PNS. The patient reported a favorable tolerance to the treatment without any adverse effects. He had 80% pain relief and noted a marked improvement in his overall mood, reflecting the profound impact of pain relief on his quality of life. This positive trend continued at the 6-month follow-up, at which point the patient reported sustained 75% pain relief, further emphasizing the lasting benefits of this innovative approach.

DISCUSSION

Throughout the last several decades, neuromodulation technology has advanced vastly, showing that using PNS for painful mononeuropathies is associated with promising results. An analysis of the literature yields several long-term follow-up studies that have suggested that permanent occipital nerve stimulators can provide long-term benefits (5-7). Salmasi et al provided a case series of 3 patients who underwent 5 permanent PNS device implants and achieved an average of 55% pain relief for over 6 months without any complications (5). A narrative review of long-term outcomes associated with implantable occipital nerve stimulators for various chronic headaches revealed 17 studies that observed long-term sustained pain relief as defined by the study (a follow-up period that exceeded 24 months) (6). However, the authors highlight the significant heterogeneity in the term "positive response or sustained relief as defined by each study." Although there has been evidence of positive results associated with implantable occipital nerve stimulators, studies have shown high rates of AEs related to lead migration, revision surgery, infections, and allergies to surgical materials. Examples may be seen in Montenegro's narrative review, in which 313 of the 439 patients in the included studies (71%) experienced an adverse event (AE). (6) Another study also suggests that permanent implants may be associated with a high risk of complications. Another study also suggests that permanent implants may be associated with a high risk of complications. This possibility was demonstrated in a 2014 randomized controlled study, which examined the 12-month efficacy and safety of PNS of the occipital nerves (4). All 157 patients with implanted devices experienced an AE, with 111 of 157 (70.7%) enduring more than one. Of those AEs, 56 were hardware-related, 82 were biological, 45 were stimulation-related, and 26 were nondevice/procedure-related (4). Although the authors report two-thirds of patients reported excellent headache relief and improved quality of life, there is a high complication rate and a need to advance this technology to reduce AEs while maintaining the level of effectiveness.

New neuromodulation technology as applied to temporary PNS has expanded the possible locations in which to place stimulators, allowing for stimulation to occur without the need to traverse a joint. Temporary PNS allows patients to undergo a minimally invasive surgical procedure with no general anesthesia and under ultrasound guidance for percutaneous lead placement near the greater occipital nerve and the mounting of the external pulse generator to the skin. This device is completely removed in accordance with manufacturing guidelines after 60 days, and pain relief may potentially still be sustained. The mechanism of action of this new neuromodulation system is unknown; however, it is believed to generate proprioceptive afferent signals to restore the balance of peripheral inputs to the central nervous system and reverse maladaptive changes in central pain processing (8). Abd-Elsayed et al have proposed another theory of temporary PNS's treatment of chronic pain conditions: namely, that PNS inhibits alpha-delta and C fibers, which decreases pain signaling in the higher centers of the central nervous system while peripherally down-regulating inflammatory mediators and neurotransmitters associated with pain signaling (9).

Even though PNS's mechanism of action is still being postulated, many studies have observed good efficacy and safety profiles when using this same technology for other chronic pain syndromes, including medial branch nerves for facet joint-mediated back pain, femoral and sciatic nerves for post-amputation pain, and post-orthopedic surgical pain targeting the brachial plexus for rotator cuff repair (10-13). One other identifiable case in the literature used the temporary PNS system for GON and achieved complete relief of symptoms; however, the pain returned after the apparatus was removed at the 2-month mark. This finding suggests that the efficacies of this type of PNS system when used for this neuropathic condition may vary from our patient's results, which included 75% pain relief after 6 months (14). This report is significant for clinicians, since temporary PNS for the treatment of GON can be considered for individuals who have been failed by conservative measures but do not want to pursue more invasive interventions. Although the results of this case are promising, further studies are warranted to better understand the efficacy of temporary PNS for GON.

CONCLUSIONS

Overall, occipital neuralgia, especially GON, can be a debilitating condition, and when refractory to conservative and pharmacological treatments, it poses significant challenges for pain management. Temporary PNS is a low-risk, minimally invasive alternative to permanently implanted devices or peripheral nerve decompression surgery, which have been associated with high complication rates. While this case report provides a positive

outcome, additional studies are needed to establish the efficacy of the temporary PNS system for GON patients and the long-term treatment responses that ensue. This innovative approach is a step forward in managing this challenging condition, offering improved pain relief and quality of life for affected patients while minimizing the risk of complications.

Ethical Disclosure

The authors state that they have obtained appropriate institutional review board approval or have followed the principles outlined in the Declaration of Helsinki for all experimental investigations involving humans or animals. In addition, for investigations involving human patients, informed consent has been obtained from those involved.

Author Contributions

RC: Conceptualization, manuscript writing, interpretation, and literature review.

AN: Manuscript writing, interpretation, and literature review.

EH: Manuscript editing and interpretation.

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