Case Report

Peripheral nerve field stimulation successfully manages axial pain after posterior cervical spine surgery: case report

Hiroaki Owada[1], Masahiko Sumitani[2], Reo Inoue[1], Mariko Kawashima[3], Kazuhiko Ishii[3], Masahiro Shin[3], Kanji Uchida[1]

[1]Department of Anesthesiology and Pain Relief Center, The University of Tokyo Hospital, Tokyo, Japan; [2]Department of Pain and Palliative Medicine, The University of Tokyo Hospital, Tokyo, Japan; [3]Department of Neurosurgery, The University of Tokyo Hospital, Tokyo, Japan

Correspondence to: Masahiko Sumitani, MD, PhD. The University of Tokyo Hospital, 7-3-1 Hong, Bunkyo, Tokyo 113-0033, Japan.
Email: sumitanim-ane@h.u-tokyo.ac.jp.

Abstract: Axial neck and back pain after cervical spinal surgery is a common postoperative complication and can last for years. It is sometimes refractory to conventional treatments such as pharmacotherapy and spinal cord stimulation (SCS). Peripheral nerve field stimulation (PNFS) was recently introduced as an alternative treatment in the management of axial back pain into the occipital/craniofacial region and trunk in occipital neuralgia, post-herpetic neuralgia, and low back pain after lumbar spine surgery. However, PNFS has not been applied to axial neck pain. The patient suffered from occipital neuralgia and axial back pain after cervical spine surgery. In addition to PNFS of the greater occipital nerves for occipital neuralgia, we subcutaneously implanted two electrodes into the bilateral neck regions parallel with a sequential arrangement of the cervical spine. The electrodes were placed immediately above the trapezius muscles and electrical paresthesia was enhanced by posterior neck muscle twitches, fully covering the areas with axial neck pain. Both electrodes successfully achieved an almost 70% decrease in occipital and axial neck pain. Since axial neck pain after cervical spinal surgery often affects patients' health-related quality of life, neuromodulation in the form of PNFS may have the potential to become a novel alternative to conventional pain treatments for medically refractory axial neck pain.

Keywords: Peripheral nerve field stimulation (PNFS); axial pain after cervical spine surgery; occipital neuralgia; case report

Submitted Apr 17, 2020. Accepted for publication Jun 22, 2020.
doi: 10.21037/apm-20-978
View this article at: http://dx.doi.org/10.21037/apm-20-978

Introduction

After undergoing one or more spinal surgeries, patients are at a risk of developing persistent low back or neck pain, with or without radicular symptoms. The incidence of such post-spinal surgery back and neck pain is rather common, ranging 10–40% following lumbar spine surgery and 5–60% following cervical spine surgery (1,2).

Pertinent courses of care include pharmacological treatments, psychological interventions, physical and rehabilitation treatments, and neural blockades; however, post-spinal surgery pain is sometimes refractory to these treatments. Spinal cord stimulation (SCS) is an invasive but established procedure, noted as an alternative to traditional pain management. Randomized controlled trials have shown significantly higher analgesia, function, and patient satisfaction with the use of SCS than with the use of conventional medical management or repeat spine surgery in patients with post-lumbar spine surgery low back pain (3). However, in some cases, SCS becomes ineffective over time for post-lumbar spinal surgery back pain. Recently, peripheral nerve field stimulation (PNFS) has been considered for patients who either suffer from post-lumbar spinal surgery back pain or have failed other minimally invasive and conservative treatments. PFNS delivers electrical pulses via subcutaneous electrodes at the

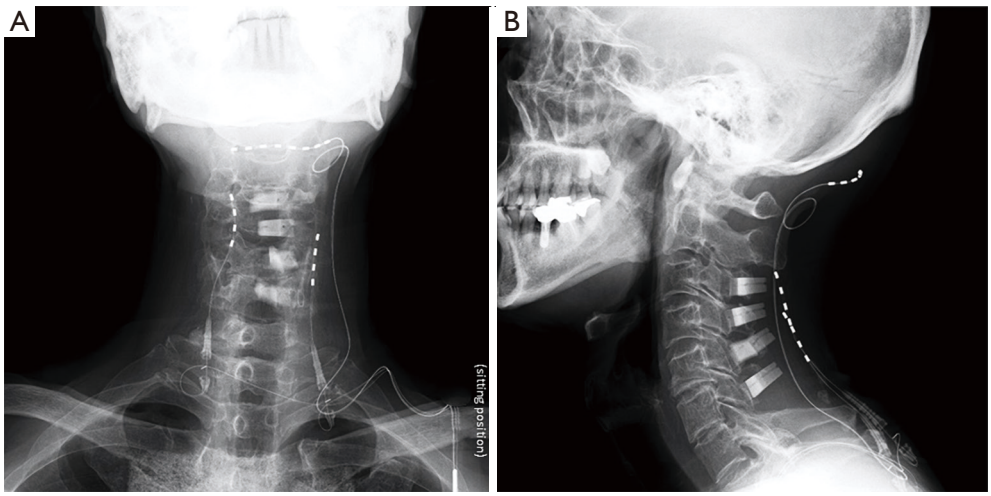

Figure 1 Peripheral nerve field stimulation procedure and lead placement. (A) A posterior-anterior fluoroscopic view of an 8-pole electrode in the occipital region and two 4-pole electrodes in the bilateral neck regions. (B) A lateral fluoroscopic view.

lumbar vertebral levels associated with back pain, either overlapping the pain with masking paresthesia or through the use of high frequency non-paresthesia neuromodulation. The general consensus on PFNS is positive with most published studies demonstrating a significant benefit, although sufficient evidence has not still been collected (4). Most PFNS procedures are applied to pain in occipital/craniofacial, thoracic, lumbosacral, abdominal, and groin/pelvic regions, but not to the cervical/neck region. We report the application of PFNS in a patient with post-cervical spinal surgery neck pain and occipital neuralgia and successful reduction of pain. We present the following article in accordance with the CARE checklist (available at http://dx.doi.org/10.21037/apm-20-978).

Case presentation

A 75-year-old man was diagnosed with cervical spondylosis and cervicogenic headache. He underwent cervical laminoplasty from C3 to C6 at another facility 2 years previously. However, his pain did not improve and gradually increased. Further, the neck pain expanded laterally and became worse. When he was referred to our outpatient clinic, he complained of occipital pain and neck pain. Bilateral occipital pain, worse on the right side, spread to the parietal region with accompanying allodynia. The neck pain was present across a wide area of the neck including the nuchal and lateral-ends of the upper trapezius muscle. The neck pain that developed after cervical spine surgery was described as a severe gnawing and dull pain, as if an iron plate was inserted in the neck. There were no neurological deficits and psychiatric disorders, according to physical and psychiatric examinations. Imaging studies on cervical spinal bones by the X-ray and magnetic resonance imaging did not reveal any clinically-relevant signs except for postoperative change, which can explain severe pain. He did not have any comorbidities except for hypertension and any relevant family histories. The severity of neck pain was increased in the sitting or standing position and decreased to a certain degree in the supine position. Therefore, the patient became bedridden. He thus suffered from post-cervical spinal surgery neck pain in addition to occipital neuralgia.

Since pharmacotherapy did not alleviate his occipital and neck pain, we performed PFNS for occipital and neck pain separately. Our clinical ethics committee approved all procedures in accordance with the ethical standards with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient. As well, written informed consent was obtained from the patient for publication of this study and any accompanying images. For the occipital pain, we subcutaneously horizontally inserted an 8-pole electrode (Octrode®, Abbott, USA) at the level of the skull base, identified based on the location of the pulses of the occipital arteries and the external occipital protuberance (*Figure 1A*). These electrodes targeted the bilateral greater occipital nerves and their electrical paresthesia spread from bilateral occipital regions to the parietal regions, which covered the areas affected by

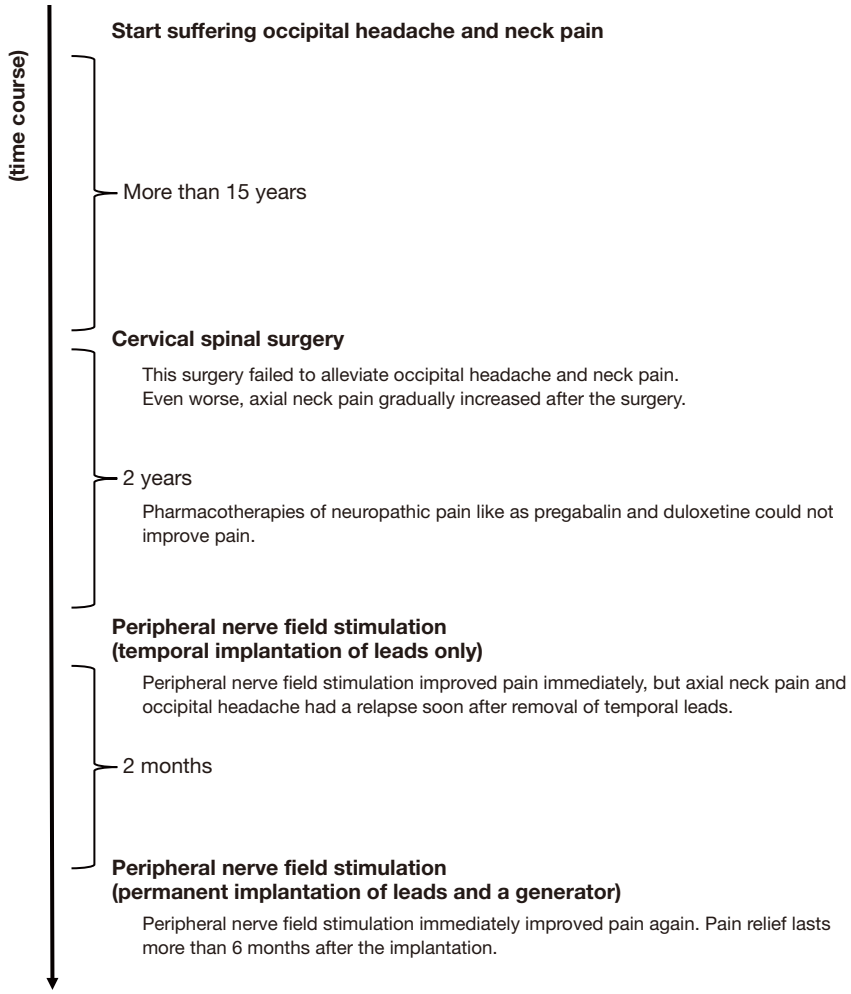

Figure 2 Time course of this case.

pain and allodynia. For the neck pain, we subcutaneously inserted two 4-pole electrodes (Quatrode®, Abbott, USA) into the subcutaneous layer immediately above the trapezius muscles, parallel to the vertebral spinous processes in a sequential arrangement (*Figure 1B*). Increasing the stimulus amplitudes of the electrodes, posterior neck muscle twitches were observed. Muscular twitches enhanced the patient's perception of the electrical paresthesia. Referencing these, we adjusted and determined the location of the electrodes for which electrical pulses could fully cover the areas affected by neck pain. We then implanted a 16-channel, rechargeable, constant-current pulse generator (Eon-mini®, Abbott, USA) in the left anterior chest (*Figure 2*). No postoperative complications were identified. Both electrodes in the occipital and neck regions successfully achieved almost a 70% decrease in pain. After hospital discharge, the analgesic effect of PFNS continued without any complications. PNFS achieved patient satisfaction.

Discussion

PNFS has been commonly applied to occipital/craniofacial areas. As was the case with this patient, PNFS has been employed to treat both greater and lesser occipital neuralgias and as a peripheral nerve target to treat primary headache disorders including cluster headache, tension headache, migraine, and trigeminal neuralgia (5,6). In one case report, PNFS were applied to the great auricular nerve for controlling pain in the craniofacial and neck areas (7). Moreover, in PNFS, leads are subcutaneously placed to stimulate the region of affected nerves and cutaneous afferents or the dermatomal distribution of the

nerves, which converge back at the spinal cord. SCS has primarily been used for widespread leg and buttock pain, and SCS cannot adequately covered and diminished axial back pain. SCS has failed to address pain in key regions such as the occipital/craniofacial area and trunk. As an alternative to SCS, PNFS has become popular for trunk pain following postherpetic neuralgia and low back pain in post-lumbar spinal surgery syndrome, in addition to occipital/craniofacial pain following occipital neuralgia and other headache disorders. Axial pain after posterior cervical spine surgery seems to be one of the common postoperative complications that lasts for years, although the incidence varies markedly from 5.2% to 61.5% (2). The pain distribution includes the bilateral nuchal, periscapular, and shoulder regions, with the nuchal region being predominantly affected. When using SCS to manage post-cervical spine surgery axial pain, a supply route of the electrode accessing the epidural space is not usually secured. If the electrode(s) could enter the cervical epidural space, it is usually difficult for SCS electrical pulses to cover the areas of bilateral axial neck pain and diminish the pain. Considering these, we performed PNFS to manage post-cervical spine surgery axial pain and successfully alleviated the axial back pain. In particular, electrical paresthesia induced by PNFS could cover the relatively-wide bilateral neck areas, which over-stride several territories of cervical nerve roots, and alleviate pain distributing such relatively-wide neck areas. This was the novel finding different from pain confined to the innervation territory of one (or two) lesioned peripheral nerve (5-7).

The underlying mechanisms of post-cervical spine surgery axial pain are still not understood. Some preventive approaches have been suggested, but none of them have been established. Most imaging findings after cervical spine surgeries are not correlated with the incidence and severity of the axial back pain, but posterior neck muscle atrophy is suggested to be related to axial back pain (2). Although the analgesic mechanisms of PNFS remain unclear, direct electrical stimulation of the posterior neck muscles through the electrode implanted above the muscular fascia might lead to pain alleviation. Muscular twitches induced by the electrode stimulation would help define the site of stimulation and determine the location of electrode implantation, similar to SCS (8). Since post-cervical spine surgery axial back pain often affects patients' health-related quality of life, neuromodulation in the form of PNFS has the potential to become a novel alternative to conventional pain treatment strategies for medically refractory axial neck pain. To confirm this, we should conquer following points: one is, this was the single case report. Further investigation is warranted with a larger sample and any other comparator treatments. And the other is, observational periods of this case was very short. Sustained pain relief of PFNS over long periods without tolerance should be monitored.

Acknowledgments

Funding: This study was funded by JSPS KAKENHI Grant Number (19H03749).

Footnote

Reporting Checklist: The authors have completed the CARE reporting checklist. Available at http://dx.doi.org/10.21037/apm-20-978

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/apm-20-978). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient.

References

1. Waguespack A, Schofferman J, Slosar P, et al. Etiology of long-term failures of lumbar spine surgery. Pain Med 2002;3:18-22.

2. Wang SJ, Jiang SD, Jiang LS, et al. Axial pain after posterior cervical spine surgery: a systematic review. Eur Spine J 2011;20:185-94.
3. Kumar K, Taylor RS, Jacques L, et al. Spinal cord stimulation versus conventional medical management for neuropathic pain: a multicentre randomised controlled trial in patients with failed back surgery syndrome. Pain 2007;132:179-88.
4. Verrills P, Vivian D, Mitchell B, et al. Peripheral nerve field stimulation for chronic pain: 100 cases and review of the literature. Pain Med 2011;12:1395-405.
5. Bartsch T, Paemeleire K, Goadsby PJ. Neurostimulation approaches to primary headache disorders. Curr Opin Neurol 2009;22:262-8.
6. Broggi G, Messina G, Franzini A. Cluster headache and TACs: rationale for central and peripheral neuromodulation. Neurol Sci 2009;30 Suppl 1:S75-9.
7. Simpson BA, Nannapaneni R. Trigemino-Cervical Neuropathic Pain Relieved by Serially Repeated Peripheral Nerve Field Stimulation Without Tolerance: Case Report. Neuromodulation 2017;20:383-5.
8. Murg M, Binder H, Dimitrijevic MR. Epidural electric stimulation of posterior structures of the human lumbar spinal cord: 1. muscle twitches - a functional method to define the site of stimulation. Spinal Cord 2000;38:394-402.

Cite this article as: Owada H, Sumitani M, Inoue R, Kawashima M, Ishii K, Shin M, Uchida K. Peripheral nerve field stimulation successfully manages axial pain after posterior cervical spine surgery: case report. Ann Palliat Med 2021;10(5):5792-5796. doi: 10.21037/apm-20-978

