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Peripheral Nerve Stimulation for the Treatment of Chronic Neuropathic Lower Extremity Pain: A Case Report

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Background: Peripheral nerve stimulation (PNS) may be an effective treatment for neuropathic pain syndromes of the extremities, even after conventional neuromodulation techniques have failed.

Case Report: A 71-year-old man with a history of postlaminectomy syndrome presented with chronic left-sided leg pain after receiving no relief after undergoing multiple neuromodulation modalities. The patient subsequently underwent a successful sciatic nerve PNS trial, followed by implantation, achieving 90% pain relief after 6 weeks.

Conclusion: We describe a case where PNS was successful in treating chronic neuropathic extremity pain after traditional neuromodulation therapies had failed. Further studies are warranted to assess the role of PNS within the treatment paradigm for refractory neuropathic pain.

Key words: Chronic pain, neuromodulation, peripheral nerve stimulation

BACKGROUND

Peripheral nerve stimulation (PNS) is a minimally invasive neuromodulation therapy that has become increasingly popular for the treatment of various pain conditions, including peripheral nerve injury pain syndromes, chronic low back pain, complex regional pain syndrome, and various headache disorders (1). Advancements in percutaneous implantation techniques using ultrasound guidance, device sizing, battery life, and safety have brought these treatments into mainstream usage (2).

Similar to a spinal cord stimulator (SCS), the proposed mechanism in which PNS is deemed to alleviate pain is based on the gate control theory formulated by Wall and Melzack in 1965 (3). However, the exact mechanism of the analgesic effect of PNS is largely unknown (1). Limited studies show evidence that PNS can provide at least modest improvements in peripheral neuropathic pain, although more research is needed to fully understand the specific role PNS should play within the treatment paradigm for chronic pain (4-6). This case demonstrates the use of PNS for chronic neuropathic pain in a patient where conventional spinal cord and dorsal root ganglion stimulation failed to provide durable relief.

CASE PRESENTATION

A 71-year-old man with a history of extensive cervical and lumbar spinal surgeries and postlaminectomy syndrome presented with chronic low back and left-sided leg pain. His most troubling pain was located at the left posterolateral calf, with occasional pain at the dorsal surface of his foot. The pain was described as constant, burning, and 7/10 in severity without a positional component. It worsened with activities such as walking.

Minimal pain improvement was achieved with a mul-

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timodal medication regimen including lidocaine patches daily, duloxetine 60 mg twice a day, memantine 10 mg twice a day, gabapentin 600 mg at night, and hydrocodone/acetaminophen 10 mg/325 mg 4 times a day, as needed. His most recent lumbar magnetic resonance imaging (MRI) was notable for L2-L4 posterior fusion hardware, high-grade canal stenosis at L1-L2, and severe L5-S1 left-sided neuroforaminal stenosis; a cervical MRI showed evidence of an anterior cervical discectomy and fusion at C4-C7, with presumed myelomalacia at C4-C5, and multilevel degenerative changes.

Prior to presentation at our institution, the patient underwent multiple interventional therapies, including an unsuccessful thoracic SCS trial. Following that, a cervical (C3-C6) SCS trial had been performed that reportedly provided relief of his left leg pain. The patient then underwent an unsuccessful cervical (C3-C6) SCS implant with percutaneous leads, followed by a cervical (C2-C5) paddle lead SCS implant, which caused new-onset neck pain without relief of his leg pain.

He was then referred to the Vanderbilt University Medical Center Interventional Pain Clinic for a left-sided L5 and S1 dorsal root ganglion (DRG) stimulator trial. During the procedure, the L5 electrode could not be advanced through the foramen, likely due to foraminal stenosis. A left-sided S1 DRG stimulator was successfully placed and provided 70% relief during the 7-day trial period; however, implantation of the S1 DRG stimulator provided no relief.

Given the failure with conventional neurostimulation modalities, as well as the peripheral characteristics of the patient's leg and foot concerns, a diagnostic left popliteal sciatic nerve block was performed. The block provided complete alleviation of his pain for 3 days. Following this, the patient underwent a PNS trial in which 2 tandem 8-contact electrodes were inserted under live ultrasound guidance using a 14G needle, with the most distal portion of the leads placed just proximal to the sciatic nerve bifurcation (Fig. 1). The patient reported excellent intraoperative paresthesia mapping, and upon completion of his 4-day PNS trial, he had 95% pain relief in his left leg and 80% relief at the dorsum of his foot. Subsequently, the patient underwent permanent implantation. A similar technique was used for electrode placement during the PNS implantation (Fig. 2). At the 6-week postoperative visit, the patient reported success with both tonic and paresthesia-free programming. He noted overall 90% relief of his leg and foot pain, along with significant functional improvements, including an increased ability to walk for prolonged periods.

DISCUSSION

This study describes the successful treatment of neuropathic pain using PNS. In this case, PNS neuromodulation provided a more targeted pain coverage compared to conventional DRG and SCS in the setting of postlaminectomy syndrome. These results complement the previously limited studies demonstrating analgesic improvement with PNS in treating neuropathic pain of the extremities (4,5,7).

The use of DRG and SCS therapies for radicular pain in patients with postlaminectomy syndrome has been shown to be effective in several clinical studies (8-11). SCS modalities are traditionally attempted prior to PNS when conservative measures have failed. However, PNS has been gaining traction in its clinical use as an initial stand-alone therapy or as an adjuvant to alternative neuromodulation therapies when pain is localized to a single extremity (4). It should be noted that when comparing PNS to DRG or SCS, PNS has a more favorable safety profile because there is no instrumentation within the spinal canal, and procedural complications such as infection are often less detrimental (5-7). However, special considerations for PNS should include ergonomics of device placement, susceptibility of percutaneous leads to migration, and higher rates of skin erosion (12).

There is currently limited clinical data regarding the efficacy of PNS for neuropathic pain of the extremities. The most robust study was conducted by Deer et al (5) in 2016, a prospective randomized controlled trial demonstrating significant improvement with PNS in a blinded group of patients with neuropathic pain of the extremities or trunk. The treatment group reported a mean pain reduction of 27.2% after 3 months (5). Their study, however, does not compare PNS to DRG or SCS within the treatment algorithm. A second study, performed by van Gorp et al (13), was a multicenter randomized controlled trial that reported a 50% improvement in low-back pain for patients with postlaminectomy syndrome who were treated with peripheral nerve field stimulation as an add-on therapy to SCS. This study reflects the additional benefits of PNS for low-back pain treatment in patients whose initial SCS treatment was only effective in addressing their leg pain. Most recently, a case report by Ferreira-Dos-Santos et al (4) demonstrated the efficacy of PNS at the superficial fibular nerve after failure with a thoracic SCS for chronic L5-S1 radiculopathy pain, and Langford et al (14) described a patient who benefitted from sural nerve PNS after 2 failed SCS trials for L5-S1 radiculopathy pain.

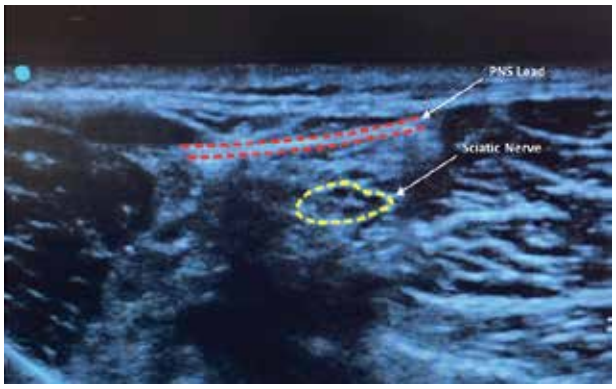

Fig. 1. Lead placement proximal to the sciatic nerve bifurcation using ultrasound guidance.

Fig. 2. Sciatic nerve leads visualized with fluoroscopy.

The patient in our case presented with postlaminectomy syndrome and burning pain complaints located in the posterolateral aspect of his leg and the dorsum of his foot, suggesting a neuropathic pain generator localized to the L5 or S1 nerve root. An initial attempt for pain coverage with a thoracic SCS trial was a reasonable therapy for this patient; however, this did not provide durable relief. The patient next underwent a cervical SCS trial and subsequent implantation without significant relief of his symptoms. Furthermore, although the patient's S1 DRG trial provided some relief, an L5 lead was unable to be placed; it is plausible that the S1 implant was inadequate in capturing the patient's main pain generator. Ultimately, after failure with multiple neuromodulation techniques, PNS at the distal bifurcation of the sciatic nerve provided this patient durable relief of his neuropathic extremity pain.

Given this patient's clinical course, there are multiple explanations as to why initial neuromodulation strategies were ineffective. Although SCS has consistently been shown to be effective for radicular pain in the extremities, PNS may improve pain coverage not captured by conventional spinal cord neuromodulation (5). This finding raises questions as to the exact mechanism of the analgesia of PNS, with recent studies indicating that PNS may activate higher central nervous system centers, beyond those of previously accepted mechanisms of peripheral and spinal inhibition (15).

A limitation in this case was that the patient did not undergo diagnostic electromyography. This tool might have been useful to exclude other conditions causing paresthesia, such as distal nerve entrapments or peripheral neuropathy. However, these diagnoses were deemed to be less likely given the patient's findings of severe neuroforaminal stenosis at L5-S1 on MRI and no evidence of peripheral nerve injury under ultrasound.

CONCLUSIONS

In conclusion, PNS may be considered as a treatment option for chronic neuropathic extremity pain in cases where traditional neuromodulation therapies have failed to provide relief. Further studies are warranted to assess the role of PNS within the treatment paradigm for refractory neuropathic pain, especially when patients may be candidates for various types of neuromodulation.

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