PAIN MEDICINE CASE REPORTS

ISSN 2768-5152

Volume 5, Number 7, pp. 353-357

# TREATMENT OF POSTTHORACOTOMY INTERCOSTAL NEURALGIA WITH 60-DAY PERCUTANEOUS PNS: REPORT OF 2 CASES

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**Background:** Intercostal neuralgia is a debilitating condition that commonly occurs following thoracic surgeries. Presented here are 2 cases that highlight the potential of percutaneous peripheral nerve stimulation (PNS) targeting the intercostal nerves to provide immediate and sustained pain relief without permanent implantation.

**Case Report:** Two patients with chronic postthoracotomy intercostal neuralgia received up to 60 days of PNS with implanted percutaneous leads. Both patients reported 80%-90% reductions in pain intensity by the end of the 60-day PNS treatment. At last follow-up, 13-14 months after lead removal, both patients continued to report substantial levels of pain relief as well as cessation or significant reduction of opioid and non-opioid pain medications.

**Conclusion:** These cases suggest that 60-day percutaneous PNS may be applied to effectively treat nerve pain in the distribution of the intercostal nerves during the 60-day treatment and also may enable long-term sustained relief following the end of the PNS treatment period.

**Key words:** Intercostal neuralgia, post-thoracotomy pain, chronic pain, peripheral nerve stimulation, neuromodulation, case report

## INTRODUCTION

Intercostal neuralgia can cause debilitating chronic pain and occurs commonly after major thoracic surgeries (1,2). Post-thoracotomy pain syndrome (PTPS) has a reported prevalence of 30%-91%, with 3%-10% reporting severe and disabling pain (2-4). PTPS often includes neuropathic-type pain symptoms such as burning and stabbing sensations, dysesthesia, and allodynia in the distribution of the intercostal nerves (2). PTPS can be disruptive to quality of life including activities of daily living and sleep (2). Conventional treatment modalities have had mixed success, including nerve blocks, radiofrequency ablation, and pharmacological therapies like opioids, gabapentin, amitriptyline, and nonsteroidal antiinflammatory drugs (NSAIDs), but these therapies are often nonspecific to neuropathic pain or are insufficient leaving many patients without effective pain management (1,5).

Neurostimulation therapies like spinal cord stimulation (SCS), peripheral nerve stimulation (PNS), and peripheral nerve field stimulation (PNFS) have been used with mixed success to treat thoracic pain of neuropathic origin, including PTPS (6-12), post-herpetic neuralgia (10,13,14), and posttraumatic intercostal neuralgia (6). Those previous cases utilized permanently implanted stimulation systems to provide long-term pain relief, but permanent implantation is commonly associated with complications and revision surgeries due to loss of ef-

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Disclaimer: There was no external funding in the preparation of this manuscript.
Conflict of interest: Boston Scientific (speakers bureau), Ter Sera (consultant, speakers bureau), BDSI (speakers bureau), SPR Therapeutics (speakers bureau), Pfizer (advisory board)
Accepted: 2021-08-09, Published: 2021-09-30

ficacy, lead migration, or hardware failure (6,12,15-17). A novel percutaneous PNS system has demonstrated the potential for sustained relief of chronic pain following a temporary 60-day PNS treatment that does not require permanent implantation in studies for the treatment of post-amputation pain (18,19), oncologic pain (20), chronic shoulder pain (21-24), and chronic low back pain (25).

Presented here are 2 cases of chronic post-thoracotomy pain due to intercostal neuralgia that highlight the potential of percutaneous PNS targeting the intercostal nerves to provide immediate and sustained pain relief without permanent implantation of a neurostimulation device.

## CASE DESCRIPTION

### Case 1

The first patient was a 55-year-old male with a history of severe cardiovascular disease, bypass surgery, and multiple stents. He previously underwent resection of a carcinoid tumor of the left lower lobe of the lung in April 2018. Following resection, he continued to have severe chest wall pain for which opiates provided minimal assistance, including oxycodone, OxyContin, morphine, and hydromorphone. He was also currently taking gabapentin with minimal effect. The patient's primary care physician was concerned about the potential development of opioid dependence, so he was referred to pain management. The patient was diagnosed with intercostal neuralgia in December 2018. An initial nerve block with steroid was performed targeting the T9-T11 intercostal nerves and provided 100% benefit for one day but pain rapidly returned. The patient was lost to follow-up due to medical issues for a period of several months, then a second nerve block targeting the T9-T11 intercostal nerves was performed in May 2019 which provided 80% benefit for 5 days. He was maintained on opiates during this time including tapentadol extended-release and oxycodone for breakthrough pain. He noted opioid-induced constipation and was treated with naldemedine with good results. The patient completed a spinal cord stimulator trial (Boston Scientific, leads at T4-T6) in July 2019 and achieved very good coverage with multiple stimulation paradigms including using conventional paresthesia-based, burst, and high-rate stimulation, however the SCS trial did not provide sufficient pain relief to warrant implantation.

In October 2019, a temporary percutaneous PNS system (SPRINT®, SPR Therapeutics, Cleveland, OH) was placed with percutaneous leads targeting the left T10 and T11 intercostal nerves. For each of the 2 target nerves, a stimulating probe was advanced under fluoroscopic guidance to within 0.5-0.7 cm of the target nerve (Fig. 1) and stimulation was delivered to confirm that the patient experienced comfortable paresthetic coverage of the painful region. Fine-wire coiled stimulating leads were then placed at the determined locations using a needle introducer, and the 2 wire leads were connected to a dual-channel external pulse generator mounted on the lower abdomen with an adhesive pad.

The patient reported immediate pain relief following lead placement which persisted throughout the 60 days of implantation. The T11 lead was accidentally dislodged 30 days into the therapy while changing the Tegaderm bandage over the exit site, and the lead was replaced within 5 days. In December 2019 both leads were removed, and at that time the patient reported an overall 80% improvement. During the course of the PNS treatment, daily tapentadol was reduced by 50%, and further opioid weaning continued over the course of the next several months. In May 2020, the patient reported continued 100% pain relief, complete cessation of tapentadol, and was taking 20 mg/day oxycodone. The patient has battled significant other medical issues including viral illness with prolonged recovery and abdominal surgery, but despite a myriad of other health issues, left chest wall pain remained at very low levels as of January 2021, 13 months after lead removal.

### Case 2

The second patient was a 77-year-old male with intercostal neuralgia following a thoracotomy for lung transplant due to pulmonary fibrosis. The patient was originally referred to pain management in May 2016. The patient previously tried Lidoderm patches and tramadol without effect. Trigger point injections provided only minimal relief. An intercostal nerve block with steroid was performed at T6-T8 (dexamethasone 10 mg split among all 3 levels) and the patient reported 50% benefit for one month. In April 2017, botulinum toxin A injection targeting the affected intercostal nerves was performed, providing over 50% relief. The treatment was repeated every 3 months for 2 years for a total of 7 different botulinum toxin A injections. While this intervention provided some relief, other options were sought to provide better and longer lasting relief.

A temporary percutaneous PNS system (SPRINT®, SPR

Therapeutics, Cleveland, OH) was placed in September 2019 targeting the T8 and T9 intercostal nerves under fluoroscopic guidance. The procedure was similar to the lead placement described for Case #1, with 2 fine wire percutaneous stimulating leads placed targeting the T8 and T9 nerves and connected to an externally mounted pulse generator. There were no lead dislodgements or fracture during the course of the treatment, and the leads were removed without complication after 58 days of implantation. At the time of lead removal, the patient reported 90% improvement in pain. At one month post-explant, pain was noted to be 80% improved, with reduction in Visual Analog Scale (VAS) 7/10 at baseline to 1/10 at follow-up. In April and June 2020, via appointments for telehealth, the patient still noted 90% improvement and was not on any pain medication. As of January 2021, 14 months after lead removal, the patient also remained dramatically improved and noted pain scores of 1/10 to 3/10.

## DISCUSSION

The 2 cases presented here report the successful use of a 60-day percutaneous PNS treatment for long-term relief of chronic neuropathic pain due to intercostal neuralgia. Intercostal neuralgia following thoracic surgery involves injury to a named peripheral nerve with neuropathic pain largely occurring in the distribution of that injured nerve, making it a prime candidate for treatment with PNS (26,27). However, only isolated reports exist for the use of PNS targeting the intercostal nerves for various thoracic pain conditions (13,14,28-30), none of which have reported sustained relief from a temporary PNS treatment in patients with PTPS.

In contrast to conventional lead placement approaches that aim to place PNS leads in close proximity to target nerves, the fine-wire coiled leads used in the present cases are intended to be placed remote (e.g., > 5 mm) from the target nerves. This report demonstrates the feasibility of placing leads percutaneously to deliver PNS remote from the intercostal nerves using fluoroscopic or ultrasound imaging to guide lead placement. Similar to studies using the temporary coiled PNS leads for nerve targets in the low back and extremities, ultrasound imaging may also be used to visualize soft tissue structures (e.g., pleura, muscles, neurovascular bundle) in addition to the key bony landmarks to place the leads in the intercostal muscles targeting the intercostal nerves.

Both patients achieved substantial (≥ 50% (31)) relief of their average and worst pain by the end of the 60-day PNS treatment. Notably, pain relief improved further and was sustained following removal of the percutaneous leads and, at last follow-up 15-16 months after the start of PNS treatment (i.e., 13-14 months after lead removal), both patients continued to report substantial pain relief. This long-term sustained relief is consistent with prior studies of temporary PNS in low back pain and chronic pain following amputation, in which a majority of patients receiving 60 days of PNS reported significant relief throughout up to 12 months of follow-up without a permanently implanted stimulation system (18,19,32,33). It has been proposed that the long-term sustained pain relief produced by up to 60 days of treatment with a percutaneous PNS system and leads designed for remote placement results from

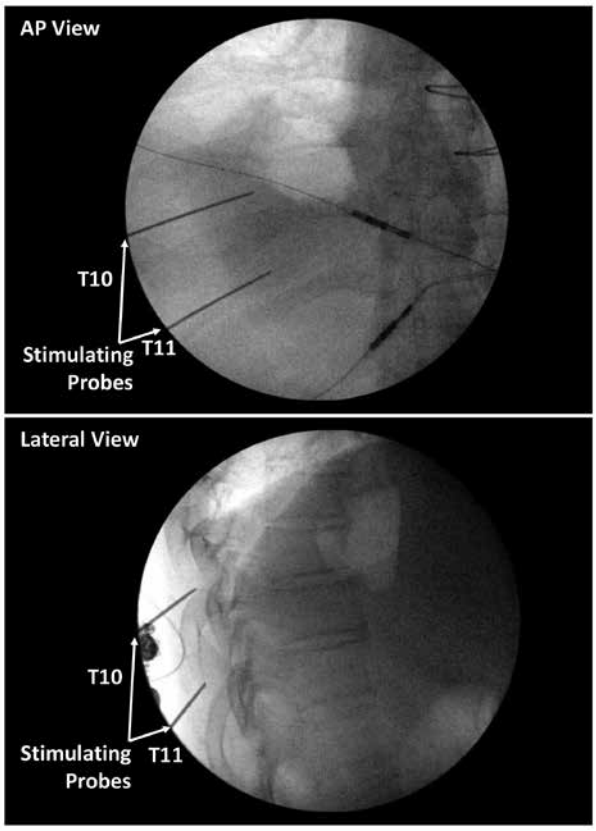


Fig. 1. Anteroposterior (AP) and lateral fluoroscopic images of stimulating probe placement. In Case 1, stimulating probes were placed to within 0.5-0.7 cm of the T10 and T11 intercostal nerves to evaluate stimulation prior to placing fine wire PNS leads for the 60-day PNS treatment. A similar approach was taken in Case 2 targeting the T8 and T9 intercostal nerves.

reconditioning of maladaptive cortical plasticity driven by robust nonnociceptive input from the region of pain, helping to unwind the state of central sensitization that perpetuates chronic pain following an injury or nerve trauma (34). The prolonged relief reported in the present cases supports that a central mechanism is likely to be involved in the long-term outcomes produced following stimulation of the intercostal nerves for the treatment of intercostal neuralgia.

Notably, Patient 1 had previously failed an SCS trial in which the epidural stimulation provided adequate paresthesia coverage of his region pain but did not provide pain relief. The subsequent successful treatment of his pain with percutaneous PNS suggests that prior failed neurostimulation trials or therapies are not necessarily predictive of the results with PNS, and that there may be therapeutic advantages to stimulating peripherally rather than epidurally for focal pain conditions such as intercostal neuralgia.

In addition to near-complete resolution of their neuropathic pain at last follow-up, both patients reported significant reductions in medication usage during both the PNS treatment and follow-up. Patient 1 weaned off one narcotic altogether and his average daily MME was reduced by over 60% to a low dose (i.e., ≤ 30 MME daily (35,36)), while Patient 2 weaned off all pain medications. These results are consistent with reports in studies of patients with chronic low back pain, postamputation pain, and acute postoperative pain, in which up to 60 days of percutaneous PNS was associated with reduced opioid usage (25,33,37-40). Given that intercostal neuralgia is commonly treated with opioid and non-opioid medications as first- or second-line therapies (41), the present cases provide initial evidence that a temporary PNS treatment may be used earlier in the treatment continuum to manage intercostal neuralgia pain and thereby reduce opioid and nonopioid medication usage, while avoiding the need for a permanently implanted system and the associated risks of complications.

## CONCLUSIONS

The 2 cases presented here suggest that 60-day percutaneous PNS can be applied to effectively treat nerve pain in the distribution of the intercostal nerves. Leads placed under fluoroscopic or ultrasound guidance targeting one or more intercostal nerves at the thoracic level may deliver comfortable stimulation that not only provides substantial levels of pain relief during the 60-day treatment, but also may enable long-term sustained relief following the end of the PNS treatment period.

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