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Lumbar Neuromodulation for Chronic Pain and Postural Stability in a Spinal Cord Injured Patient: A Case Report

Brock H. Marrs, MD, PhD[1,2], Wesley Youngblood, MD[3], and Preston C. Rippe, DO[1]

Background: Peripheral nerve stimulation (PNS) is an evolving therapy for treating chronic refractory pain; however, limited clinical evidence is available for the use of PNS for chronic low back pain in the spinal cord injured (SCI) patient.

Case Report: A patient, with an L1 complete SCI with a zone of partial preservation to S1 resulting in paraplegia and chronic low back pain, received bilateral L4 medial branch PNS. He had significant improvement of low back pain quantified by reductions in the Oswestry Disability Index and the Global Pain Scale, with additional benefits, including improved wheelchair sitting endurance and improved postural stability, at one-month and 2-month follow-up visits.

Conclusions: Despite limited evidence, our findings suggest lumbar medial branch PNS is a safe and viable option for treatment of chronic low back pain in the SCI population, with additional benefits of efferent fiber stimulation leading to improved postural stability and sitting tolerance.

Key words: Case report, peripheral nerve stimulation, chronic low back pain, spinal cord injury, neuromodulation

BACKGROUND

Spinal cord injury (SCI) is a condition characterized by damage to the spinal cord resulting in impaired voluntary motor control and sensory dysfunction, commonly leading to lifelong disability of varying severity (1,2). The annual incidence rate for SCI in the United States is approximately 54 new cases per million, predominately affecting men (3). SCI can be classified by mechanism, including traumatic or atraumatic; however, most cases are a result of trauma, tumor invasion, infection, or vascular disturbances (1). Gunshot-related SCIs account for approximately 5% of all SCIs in the United States, predominately affecting Black men between the ages of 20-30 years old, and are more likely to result in a complete American Spinal Injury Association Impairment Scale (AIS A) SCI (3-5).

SCIs are further classified by the severity of injury, as measured by the AIS (6). Complete injuries (AIS A) are defined as the complete loss of sensory and motor function below the level of injury and extending through the sacral segments S4-S5. In some cases, myotomes or dermatomes between the level of injury and the S4-S5 segment may retain some function. This is known as a zone of partial preservation (ZPP). These patients may be paraplegic or tetraplegic and are susceptible to losing the higher-order innervation of the lumbar paraspinals. SCIs that retain sensory function, motor function, or both at the S4-S5 segment are deemed incomplete injuries. Complications following an SCI, especially in AIS A injuries, can include neurogenic bladder with increased risk for urinary tract infection, neurogenic bowel, autonomic dysreflexia, orthostatic hypotension, pressure ulcers, deep venous thrombosis,

From: [1]University of Kentucky, Department of Physical Medicine and Rehabilitation, Lexington, KY; [2]University of Kentucky, Interventional Pain Management, Lexington, KY; [3]Premier Pain Treatment Institute, Loveland, OH

Corresponding Author: Brock H. Marrs, MD, PhD, E-mail: brock.marrs@uky.edu
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pulmonary embolism, pneumonia, and chronic pain syndromes (7-9).

In their guidelines, the American Spinal Injury Association reports an 80% prevalence of chronic pain after an SCI (10). Chronic pain can be categorized into mechanical/musculoskeletal and neuropathic pain. Musculoskeletal pain can occur in individuals with bony injuries due to trauma, spinal fracture/instability, muscle strain or spasms, overuse soft tissue injuries, or postsurgical pain (8). While shoulder pain is the most common site of musculoskeletal pain due to overuse from wheelchair propulsion, the SCI patient often experiences chronic low back pain due to altered biomechanics, postural instability, poor wheelchair seating, poor transfer mechanics, and/or muscle spasticity (8,10,11). Due to multifactorial etiologies of pain in SCI, standardized assessments may prove beneficial in evaluating low back pain. The Oswestry Disability Index (ODI), an assessment used to quantify patient-perception of degree of disability associated with low back pain, and the Global Pain Scale (GPS), an assessment used to quantify overall pain experience, can both be utilized to determine severity of pain (12,13).

A multidisciplinary approach to pain management, including medical, pharmacological, and psychological interventions, is necessary to meet the needs of the SCI patient (8). Interventional options for treating low back pain in these patients, as guided by the evidence-based guidelines according to the American Society of Pain and Neuroscience (ASPN), include steroid injections, trigger point injections, facet injections, ablations, intrathecal drug delivery, and neuromodulation (e.g., spinal cord stimulators, peripheral nerve stimulation (PNS), etc) (14).

PNS is an evolving therapy for treating chronic pain, and there is evidence for the use of PNS to treat low back pain refractory to failed conservative and interventional treatments (ASPN guidelines report Level II Grade B) (14,15). Pain relief is thought to come through the modulation of medial branch afferent activity, resulting in improved interplay between Aβ fibers and C fibers, which can lead to decreased central sensitization and local nociceptive signaling (16). As a secondary effect of PNS in the lumbar spine, stimulation of the medial branch efferent fibers innervating the multifidus can promote multifidus activation, which can lead to improved postural stability and overall spine mechanics (17).

To date, there is sparse, if any, literature describing the use of PNS for chronic low back pain in the SCI patient. This population, especially, may benefit from the dual action of PNS in the lumbar spine, given the likelihood of compromised multifidus innervation. In this paper, we present a patient with an L1 AIS A SCI (complete) with ZPP at S1 resulting in paraplegia who underwent Sprint PNS (SPR® Therapeutics, Cleveland, OH) at the bilateral L4 medial branches. Informed consent was not obtained due to the retrospective nature of the chart review.

CASE PRESENTATION

A 29-year-old man with an L1 AIS A SCI with ZPP to S1 due to a gunshot wound resulting in paraplegia presented with chronic low back pain. His initial SCI was complicated by retained bullet fragments in the L2 vertebral body and L3 transverse process, neurogenic bladder, and neurogenic bowel. No surgical intervention was warranted from a neurosurgical perspective following the initial SCI. He completed a 3-week course of rehab at an acute inpatient rehabilitation center following discharge from the acute hospital after the initial injury. He was followed by the physical medicine and rehabilitation clinic for his SCI, with power-assist wheels ordered for a manual wheelchair (MWC) and bilateral knee-ankle-foot orthoses ordered for increased community ambulation, for which he ultimately completed an additional 2-week course of acute rehabilitation.

The patient's postacute rehab discharge course was complicated by left knee pain and worsening low back pain. He had one presentation to the emergency department specifically for his low back pain during which he was diagnosed with muscle spasms. His low back pain was refractory to acetaminophen 1,000 mg every 6 hours as needed, baclofen 10 mg 3 times daily, cyclobenzaprine 5 mg every 8 hours, tizanidine 4 mg every 8 hours, oxycodone 10 mg every 6 hours as needed, oxycodone-acetaminophen 5-325 mg every 4 hours as needed, duloxetine 60 mg daily, pregabalin 50 mg 3 times daily, and lidocaine patch 4% daily as needed.

Following evaluation in the Interventional Pain Clinic, the patient underwent placement of Sprint PNS (SPR® Therapeutics, Cleveland, OH) leads at the bilateral L4 medial branches. Prior to therapy, he recorded preprocedural ODI and GPS scores of 27/50 and 48/100, respectively. The leads were placed under fluoroscopic guidance with midplacement testing to ensure accuracy. Activation of the multifidi was noted during testing. The leads were kept in place for a therapy period of 60 days. There were no preprocedural or postprocedural complications. Following 30 days of therapy, he reported

a > 95% reduction in his bilateral low back pain while sitting in his MWC, with a reduction of ODI and GPS scores to 20/50 and 15/100, respectively. At the conclusion of the therapy period (60 days), the PNS leads were removed. At that time, he reported a > 90% reduction in his bilateral low back pain with a reduction of ODI and GPS scores to 9/50 and 12/100, respectively. In addition to pain reduction, he reported improved postural stability, tolerance to sitting, and extended sitting time while in his MWC.

CONCLUSIONS

Despite limited evidence in the literature, our findings suggest that lumbar medial branch PNS is a safe and viable option for the treatment of chronic low back pain in the SCI population. Further, stimulation of the efferent fibers within the medial branches can lead to improved postural stability and sitting tolerance. Our findings are supported by dramatic reductions in ODI and GPS scores (66% and 75%, respectively) at 2 months. Improved stability, reduced pain, and increased sitting tolerance can positively impact activities of daily living, transfer safety, independence, and overall quality of life.

Limitations to this case include the lack of long-term follow-up given the timing of stimulator placement. Further studies would prove beneficial in further describing the role of lumbar medial branch PNS in the SCI population. Additionally, given the impact of lumbar medial branch PNS on both the medial branch and multifidus, comparative studies of medial branch nerve stimulation vs independent multifidus stimulation can further delineate the impact of lumbar paraspinal activation in chronic low back pain in SCI.

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