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A Retrospective Case Series of Difficult Percutaneous Dorsal Column Stimulator Epidural Lead Placement for Failed Back Surgery Syndrome

Robert J. Baranello, MD, Jeremy T. Walker, MD, and Christopher M. Sobey, MD

Background: Percutaneous dorsal column stimulator lead placement is a well-established procedure for a variety of neuropathic disease processes, including failed back surgery syndrome (FBSS). Although previous spine surgeries and patient-specific pathology can make lead placement difficult, there are very few studies or case reports documented in the literature describing these challenges and outcomes.

Case Report: A retrospective electronic medical record chart review was conducted of 6 patients with FBSS who failed more conservative interventional therapies and otherwise multimodal analgesia as deemed by both patient and practitioner.

Conclusion: Postsurgical changes in the epidural space, including fibrosis and scar tissue formation, made driving leads very challenging and compromised final lead placement as well as number of leads placed.

Key words: Neuromodulation, failed back surgery syndrome, dorsal column stimulation

BACKGROUND

Neuromodulation is a technique of targeted stimulus delivery, such as electrical stimulation, in order to elicit a desired neural response. There are both invasive and noninvasive techniques for neuromodulation; an example of the former is dorsal column stimulation (DCS). In most cases, percutaneous lead placement is a relatively straightforward procedure wherein electrodes are placed into the posterior epidural space, much like a continuous epidural catheter for perioperative pain management or labor analgesia. DCS is considered a safe and cost-effective technique for treatment of a variety of neuropathic pain disease processes (1-4). One of the major indications for DCS placement is failed back surgery syndrome (FBSS), a disorder of persistent pain with or without weakness, in which surgery did not provide relief.

It is a well-known phenomenon that prior laminectomy and fusion creates epidural adhesive fibrosis, resulting in a small potential space as well as scar tissue that affects both access to the epidural space as well as predictable driving of the electrode (5). Yet, a recent systematic review found that, based on the current available highest-level evidence, DCS provides better pain relief in the setting of FBSS as compared to medical management or repeat back surgery (6). Thus, there is irony in that the most well-established indication for DCS lead placement is also the one that can make the procedure more challenging when the entry site is in proximity to the prior surgical site. However, there is a dearth of literature on postsurgical factors affecting difficult percutaneous DCS lead placement, specifically in the setting of prior laminectomy or fusion. We present a series of 6 patients with FBSS (Table 1) who have failed more conservative

From: Department of Anesthesiology, Division of Pain Medicine, Vanderbilt University Medical Center, Nashville, TN

Corresponding Author: Robert J. Baranello, MD, E-mail: robert.j.baranello@vumc.org
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Table 1. Patient demographics.

Patient	Age	Gender	Prior Surgeries	Pain Location(s)	Lead Manufacturer	Final Lead Position	Trial Relief	Implant Relief
1	70	M	C3-T1 PSF C4-7 ACDF	Bilateral C8 radiculopathy	Medtronic 8-contact leads	Bilateral C6	60%	50%
2	66	F	T4-L5 PSF	Left > Right LBP with Left radiculopathy	St. Jude Octrode 8-contact leads	Bilateral T7	80%	60%
3	67	F	T9-S1 PSF	Bilateral lower extremities; polyneuropathy	Boston Scientific 16-contact Infinion CX	Left T10 Right T8	80%	100%
4	46	M	C5-6 ACDF C5-6 PSF L4-S1 PSF	Bilateral upper extremity neuropathic pain	Medtronic Vectris Octrode	Single lead, C2	75%	80%
5	76	F	T9-S1 PSF	Right > Left L5 radiculopathy	Medtronic Octrode	Bilateral T7	<50%	N/A
6	58	M	N/A	LBP with bilateral radiculopathy	Boston Scientific 16-contact Infinion CX	Aborted due to technical difficulty	N/A	N/A

interventional therapies and otherwise multimodal analgesia as deemed by both patient and practitioner.

CASE SERIES

In all cases, DCS lead placement was performed under fluoroscopy, using the standard percutaneous technique for lead placement with patients positioned, sedated satisfactorily, and prepared in a typical sterile fashion. Sterile drapes were then draped, and a timeout was performed. The epidural space was accessed with intermittent fluoroscopic guidance using the loss-of-resistance technique with 0.9% normal saline.

Case #1

A 70-year-old man with remote history of C3-T1 posterior spinal fusion (PSF) and C4-7 anterior cervical discectomy and fusion (ACDF), as well as multiple revisions (Fig. 1), presented with new-onset upper extremity radiculopathy, neuropathic pain, and hand-grip weakness concerning for FBSS of the cervical spine. Electromyography (EMG) findings confirmed bilateral C8 radiculopathies. He had DCS placed 20 years prior for neck pain, which was subsequently removed 3 years later.

The trial was performed accessing the posterior epidural space via the paramedian approach bilaterally at T3-4. DCS leads were introduced into the epidural space bilaterally and advanced under live fluoroscopic guidance to the inferior aspect of the C6 vertebral body. The leads were unable to be advanced any further due to extensive scar tissue.

Following the 7-day trial period, the patient described > 60% pain reduction and the trial was deemed a success by patient and practitioner. He subsequently underwent permanent implantation of 2 Medtronic 75-cm 8-contact leads (Medtronic, Fridley, MN) with access at the T11/12 and T12/L1 interlaminar spaces and leads threaded to the middle of the C6 vertebral body. The patient confirmed "excellent" (> 90%) coverage of their painful condition in the bilateral upper extremities. On his 2-week follow-up visit, he reported > 50% pain relief and improved functionality.

Case #2

A 66-year-old woman with a history of multiple extensive back surgeries culminating in a posterior T4-L5 fusion presented to the clinic with chronic low-back pain and progressive left lower-extremity radicular pain worse in the L3-4 distribution, consistent with FBSS. Initially her pain was alleviated with nonsteroidal anti-inflammatory drugs and conservative therapy, including heat and a transcutaneous electrical nerve stimulation (TENS) unit. She tried acupuncture, physical therapy, and hydrotherapy with minimal relief. She also underwent epidural steroid injections and facet blocks without relief.

During the trial, the epidural space was accessed bilaterally via the paramedian approach at the T12-L1 interlaminar space. DCS leads were advanced to the superior aspect of the T7 vertebral body. Following a 7-day trial, the patient described > 80% pain reduction and the trial

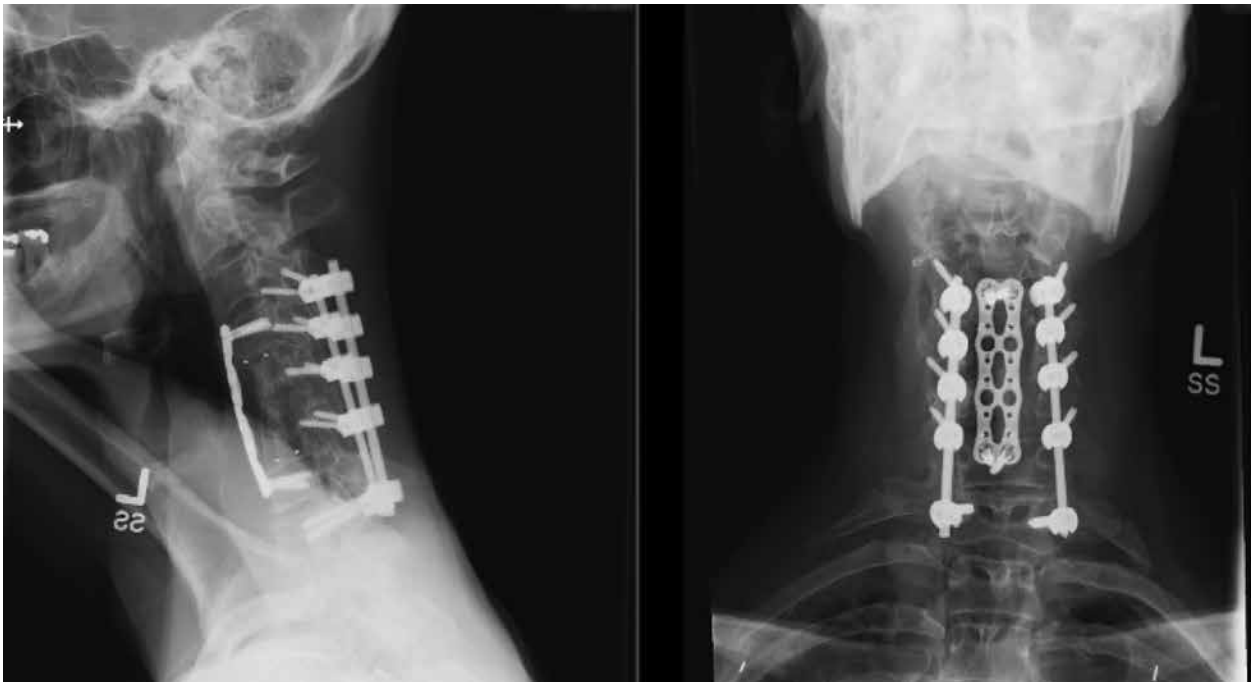

Fig. 1. Lateral and AP cervical x-rays of patient 1 demonstrating existing C4-7 ACDF and C3-T1 PSF with C4-6 laminectomies.

was deemed a success by patient and practitioner. She subsequently underwent permanent implantation of 2 Abbott Octrode 8-contact leads (Abbott, Lake Bluff, IL). The epidural space was accessed at the T12/L1 and L1/L2 interlaminar spaces and bilateral leads were advanced to the top of the T7 vertebral body (Fig. 2). The patient confirmed "excellent" (> 90%) coverage of their painful condition intraoperatively, and the implant procedure was completed. On her follow-up visit, she reported > 60% pain relief and improved functionality.

Case #3

A 67-year-old woman with a history of Parkinson's disease, atrial fibrillation, pulmonary embolism, and anticoagulated on apixaban presented to the clinic with a 5-year history of widespread pain complaints, including head, neck, shoulders, and lower back with occasional neuropathic pain in the bilateral lower extremities in the setting of prior T9-S1 PSF. A computed tomography (CT) scan confirmed prior bilateral T9-S1 pedicle screws and bridging rods, with a second set of rods extending from T12 through S1.

The trial was performed by accessing the posterior epidural space bilaterally at the T12-L1 interlaminar space and DCS leads were advanced with the left lead to the superior third of the T9 vertebral body and the right lead to the inferior third of the T8 vertebral body. Significant scar tissue was present due to previous extensive thoracolumbar fusion, which made threading the leads extremely difficult.

The patient described > 80% pain reduction following her 7-day trial and requested to proceed with a permanent implantation procedure. She subsequently underwent permanent implantation of 2 Boston Scientific 16-contact Infinion CX leads (Boston Scientific, Marlborough, MA). The epidural space was accessed bilaterally at the T12/L1 interlaminar space. During the implantation procedure, the left lead was advanced to the top third of T10 and the right contact advanced to the top of T8 (Fig. 3), unable to be advanced further due to epidural scarring. At her 2-month follow-up visit, she reported 100% pain relief.

Case #4

A 46-year-old man with a history of cervical vertebral fracture who underwent C5-6 ACDF and C5-6 PSF presented to the clinic with bilateral upper extremity neuropathic pain that he described as "dry ice." Cervical magnetic resonance imaging did not show any evidence of compressive lesions, and after failing a more

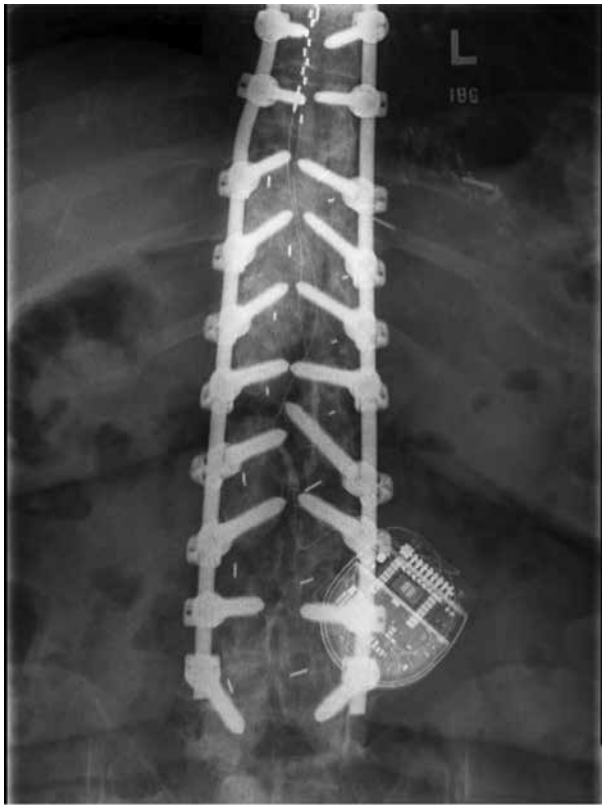

Fig. 2. AP thoracolumbar x-ray of patient 2 demonstrating T4-L5 PSF with percutaneous leads spanning at T7-9.

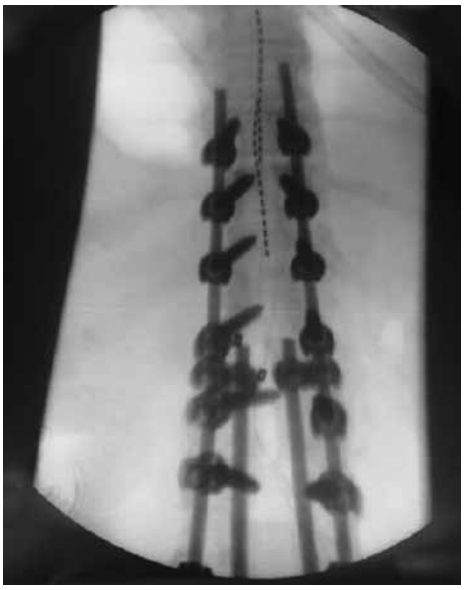

Fig. 3. AP thoracolumbar fluoroscopic image of patient 3 demonstrating T9-S1 PSF with percutaneous leads spanning at T7-9 on right and T9-11 on left.

conservative therapeutic approach, the patient opted to undergo a DCS trial.

During the trial the posterior epidural space was accessed at the T3/4 interlaminar space bilaterally; however, the lead was only able to be thread on the left side. A single DCS lead was advanced to the top of the C3 vertebral body using a left paramedian approach. The patient endorsed excellent bilateral paresthesia coverage, so the decision was made to place only a single lead.

After completing a 7-day trial, the patient described 75% pain reduction and the trial was deemed a success by patient and practitioner. The patient later returned for a permanent implant of a Medtronic Vectris octrode lead (Medtronic, Fridley, MN) and an Intellis implanted pulse generator (Medtronic, Fridley, MN). The epidural space was accessed with a 14-gauge Tuohy at the T2/3 interlaminar space. The single contact was advanced to the C2 vertebral body (Fig. 4) using a left paramedian approach. At his subsequent 2-month follow-up visit, he reported the best relief using tonic stimulation over non-paresthesia-based stimulation patterns. He preferred intermittent use of the device, reporting use for 30 minutes during his most severe episodes with 70% pain relief for several hours after.

Case #5

A 76-year-old woman with multiple sclerosis and FBSS who had a remote L1-5 fusion and developed kyphotic deformity at T12/L1 and high-grade central stenosis at L5/S1, and who subsequently underwent T9-S1 thoracolumbar fusion, presented to clinic 3 years later with bilateral L5 radiculopathy.

At the trial the epidural space was accessed bilaterally at the T11-T12 interlaminar space with DCS leads advanced to the superior aspect of the T6 vertebral body. She returned following a 5-day trial period reporting mild to moderate improvement, but not to her degree of expectations. Her leads were retracted under fluoroscopy to the superior aspect of the T7 vertebral body and the trial was extended for an additional 3 days. Unfortunately, the patient was unable to report > 50% improvement in low-back and right-leg pain.

Case #6

A 58-year-old man presented to the clinic with a history of diffuse idiopathic skeletal hyperostosis (DISH) syndrome and chronic lower back pain with bilateral L5 radiculopathies. His pain initially started following remote right L5-S1 microdiscectomy and had worsened

over the past decade. Pertinent imaging showed partial ankylosis of the posterior aspect of T12-L1, as well as progressive epidural fibrosis and posterolateral epidural thickening at L5-S1. He underwent many interventional procedures with varying degrees of relief.

The trial was attempted initially with epidural access at T12-L1, using a bilateral approach with a 14-gauge Tuohy needle. The proceduralist was unable to access the space due to extensive bony overgrowth. Epidural access was then successful at the L1-2 interspace; however, the DCS lead was unable to be advanced past the L1 vertebral level due to mechanical obstruction. Multiple attempts to reposition were unsuccessful and access was attempted at the T11-12 space as well, with inability to acquire loss of resistance despite patient repositioning and approach alterations. Eventually, an attempt to access the T11-12 space using a left paramedian approach resulted in inadvertent dural puncture with leakage of cerebrospinal fluid (CSF). At that point the procedure was aborted due to inability to access the epidural space at 3 different spinal levels. This was thought to be secondary to the patient's extensive osteophytic overgrowth, consistent with his diagnosis of diffuse idiopathic skeletal hyperostosis (DISH) syndrome. An epidural blood patch via a midline approach was then performed given continued evidence of CSF leak from inadvertent puncture. Following the attempt, the decision was made to refer the patient to neurosurgery for paddle lead implantation (Fig. 5). The patient underwent a T10 laminectomy and placement of a Boston Scientific paddle electrode system (Boston Scientific, Marlborough, MA).

Three months following his procedure, he reported 70% improvement in overall pain. He endorsed some residual right-sided leg pain that continued to be optimized with changes to DCS settings. Overall, he was very pleased, and his functional status had greatly improved.

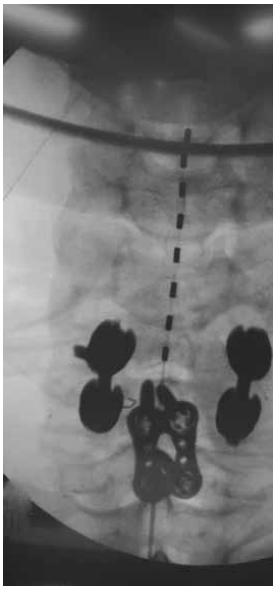

Fig. 4. AP cervical fluoroscopic image of patient 4 demonstrating C5-6 ACDF, C5-6 PSF and single midline percutaneous lead spanning C2-4.

DISCUSSION

Patients who have already had back surgery (either laminectomy, fusion, or both) present with a difficult field through which to percutaneously place DCS leads (5). Therefore, it is important to perform a full history and physical examination, as well as to review all relevant imaging and documentation of surgical reports to confirm the level of a patient's prior surgeries. It is recommended that, prior to any DCS lead placement, the patient be evaluated by their proceduralist and potential challenges associated with the procedure discussed with the patient to ensure there is clear understanding of expectations and possible complications (7).

A case report by Choi et al (8) described an example of complications because of percutaneous DCS lead placement in a patient with prior fusion and laminectomy. The patient had a history of L3-S1 anterior and T9-S1 posterior spinal fusion with T12-L5 laminectomies and suffered dural puncture during SCS trial after 3 failed attempts. Each attempt was associated with painful paresthesia in the bilateral lower extremities. They go on to describe their success with creative use of the transforaminal space as an access point for epidural blood patch placement for symptomatic postdural puncture headache. This case report emphasizes what we also found with our patients in cases #5 and #6, as epidural access proved difficult due to the postsurgical changes in the epidural space that can interfere with the loss-of-resistance technique by disrupting the integrity of the ligamentum flavum.

Anatomical divergences such as facet hypertrophy, osteophytes, overgrowth, or compromised interlaminar spaces are some of the more common reasons that DCS electrode placement is difficult.

Additionally, patients with scoliosis, plica mediana dorsalis – a band of connective tissue that divides the epidural space at the dorsal midline, or scar tissue from prior surgeries may present challenges to lead placement. One case report demonstrated successful lead placement in a patient with fusion of the thoracolumbar spine with obliteration of the interlaminar spaces sec-

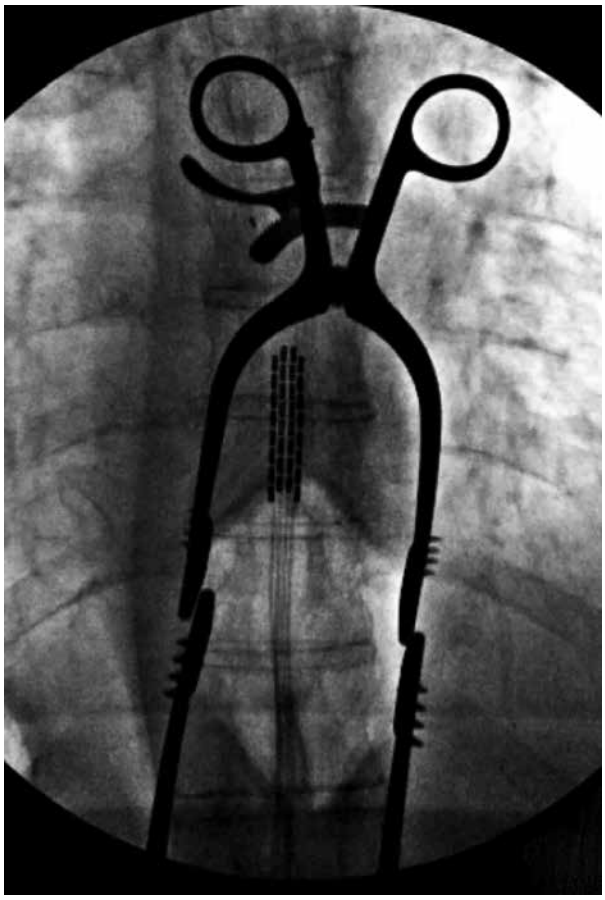

Fig. 5. AP thoracolumbar X-ray of patient 6 showing intraoperative paddle lead placement with lead spanning T9-10.

ondary to ankylosing spondylitis. The patient presented with complex regional pain syndrome of the lower extremity and 2 thoracic epidural leads were successfully placed percutaneously through the sacral hiatus (9). Similar to Case #2, interestingly, having a history of percutaneous cylindrical electrode placement did not affect the success of subsequent placements. However, the number of previous placements was independently associated with operation time. Factors that did not affect operation time or success included smoking and body mass index (10).

Another recent case report described a unique, but broadly applicable complication that led to difficult percutaneous placement of DCS leads. The patient underwent 4 lumbar surgeries secondary to complications of bony overgrowth from bone-morphogenic protein, a growth factor for cellular proliferation of bone, which ultimately led to FBSS. They went on to describe restorative function with neuromodulation therapy via neurosurgical lead placement in a bone-morphogenic protein-induced postoperative complication (11). This complication can easily be extrapolated to bony overgrowth, osteophyte formation, or reactive fibrosis encountered in FBSS.

Peripheral neuralgias of prominent subcutaneous sensory nerves in the low back appear to be primary pain generators or mediators of LBP in many cases of FBSS. The superior and middle cluneal nerves are 2 purely sensory nerves that have been identified as primary pain-generators in low-back pain and FBSS (12). One case series presented 13 patients with persistent or recurrent thoracolumbar FBSS, of whom 12 noted superior cluneal nerve entrapment as a primary pain generator (13). Using diagnostic injections, they identified that postoperative fibrosis and encapsulation of pedicle screws used for instrumented fusion led to peripheral neuralgias of the superior and/or middle cluneal nerves, as well as distal subcutaneous branches of the dorsal primary rami. Another patient with epidural lipomatosis, an abnormal overgrowth of adipose tissue in extradural space, was documented to have undergone DCS lead placement (14). However, they experienced very high impedance in the epidural space during the trial. The patient ultimately required neurosurgical intervention and underwent placement of laminotomy lead with good coverage.

CONCLUSION

We aimed to present a series of patients who underwent attempted percutaneous DCS lead placement in the setting of an established diagnosis of FBSS. In many of our cases, leads were placed percutaneously through prior surgical beds with severely distorted anatomy and virtually ablated interlaminar spaces. Likewise, postsurgical changes in the epidural space, including fibrosis and scar tissue formation, made driving DCS leads very challenging and caused compromises in final lead placement as well as number of leads placed.

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