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Midline Minimally Invasive Placement of Spinal Cord Stimulators: A Technical Note

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ABSTRACT

Background: Spinal cord stimulators (SCSs) have conventionally been implanted through open approaches requiring extensive muscle dissection to perform laminectomies and permanently place the paddle lead. This approach could contribute to worsening the pain syndrome in patients who experience chronic pain. In an attempt to reduce operative times, minimize blood loss and postoperative pain, and ease the technical challenges of placing the paddle lead in the midline via a paramedian and off-midline incision, we designed a new minimally invasive surgery (MIS) technique to place the paddle lead using a tubular retractor system through a true midline approach.

Methods: We performed a retrospective review of all MIS paddle lead placements performed by the senior author between October 2010 and June 2013. Patient demographics; clinical indications for placement of paddle lead; location of paddle lead; and perioperative data including blood loss, length of surgery, and surgical and perioperative morbidity were recorded.

Results: Between October 2010 and June 2013, 78 patients had MIS placement of paddle lead SCSs. Patient ages ranged from 27 to 87 years old, with a mean age of 59. The most common levels for paddle lead placement were T8 and T9. No minor or major neurologic complications occurred in our patient population. No patient was readmitted after being discharged from the hospital and all surgeries were outpatient procedures. We had a migration rate comparable to open techniques and minimal blood loss.

Conclusion: Our technique is safe and effective and carries minimal surgical morbidity compared to standard open techniques for placement of SCSs.

INTRODUCTION

Spinal cord stimulators (SCSs) have been used for decades to treat chronic pain syndromes.[1-6] Stimulators were conventionally implanted through open approaches with extensive muscle dissection to perform 1- or 2-level laminectomies and permanently place the paddle lead. This approach could contribute to worsening the pain syndrome in patients who experience chronic pain and also increases medical

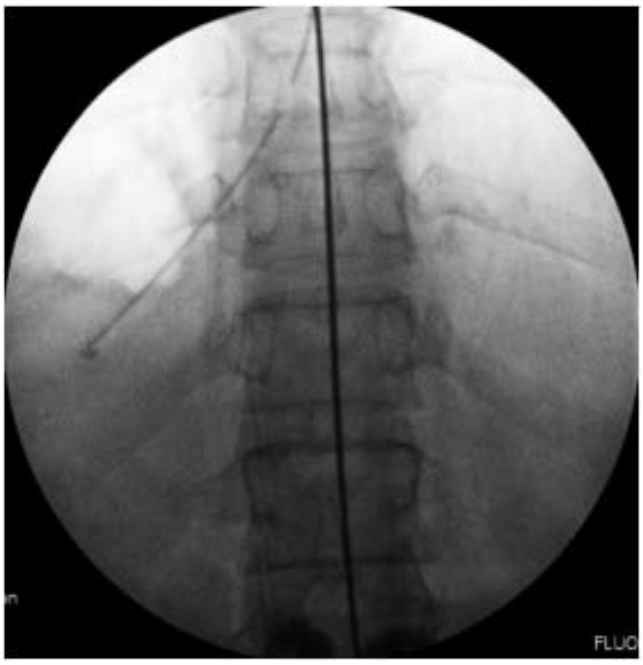

Figure 1. Anteroposterior fluoroscopy showing the midline of the thoracic spine used as a reference to mark the skin.

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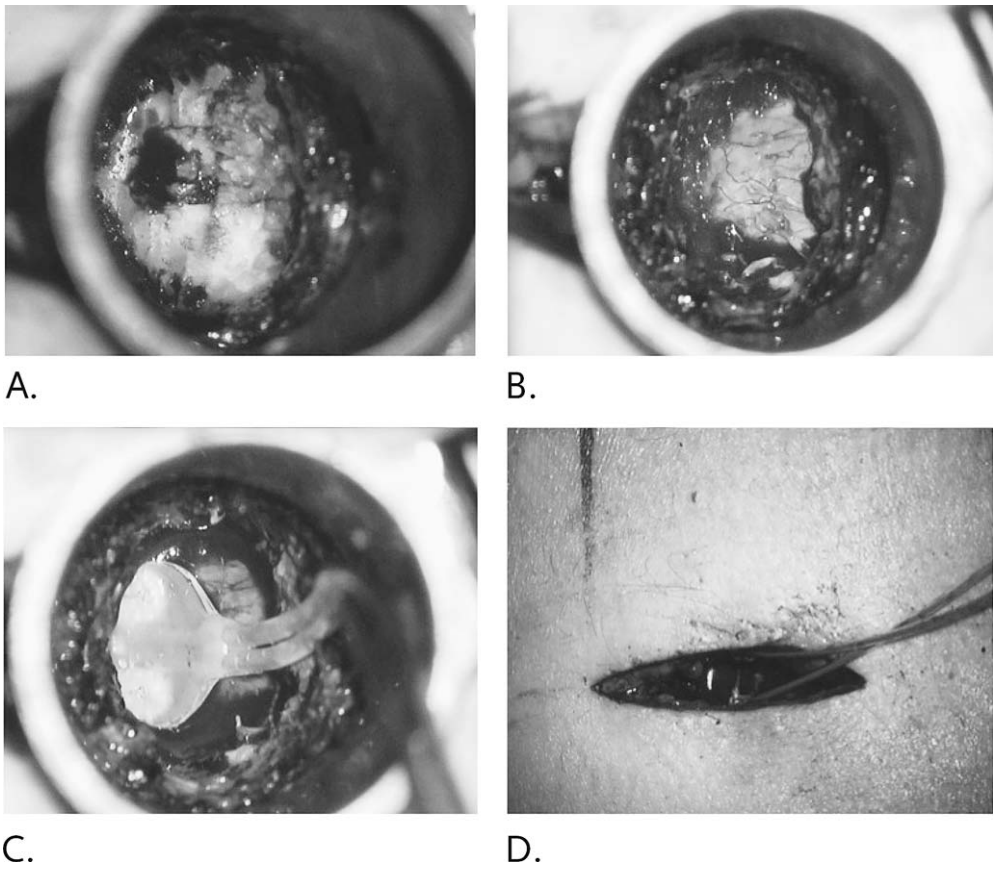


Figure 2. Sequence of surgical steps in the minimally invasive surgery midline placement of a spinal cord stimulator (SCS). A: Ligamentum flavum at the level of the caudal aspect of the superior lamina once the laminectomy has been performed. B: The ligamentum flavum has been removed and the epidural space is shown. C: The SCS paddle lead has been placed in the epidural space. D: The SCS lead cables are secured in the 3-cm wound over the midline before tunneling them to the buttocks incision for connection to the pulse generator.

costs when patients have to stay in the hospital for 1 or 2 days for pain management.[7]

Recently, multiple minimally invasive surgery (MIS) techniques have been described to place SCS paddle leads in the epidural space in an attempt to decrease the patient's postoperative pain and to reduce the length of the hospital stay.[7-11] These techniques have been performed using the conventional steps described for an MIS laminectomy: creating a window at the lateral aspect of the lamina and passing the paddle lead through the opening in an attempt to place it in a midline position. Because of the locations of the incision and the laminectomy, accurate midline positioning of the paddle lead is often difficult to achieve.[9,11]

In an attempt to reduce operative times, estimated blood loss, and postoperative pain from muscle dissection and to ease the technical challenges of placing the paddle lead in the midline via a paramedian and off-midline incision, we designed a new MIS technique to place the paddle lead using a tubular retractor system (METRx-MD; Medtronic) through a true midline approach. A prospective database of all patients who had paddle leads placed using the new technique was maintained. This article illustrates the technique and reviews the perioperative data of patients from 2010 to 2013 who underwent surgery with this technique.

METHODS

Patient Population

We performed a retrospective review of all MIS paddle lead placements performed by the senior author between October 2010 and June 2013. Patient demographics; clinical indications for placement of paddle lead; location of paddle lead; and perioperative data including blood loss, length of surgery, and surgical and perioperative morbidity were recorded.

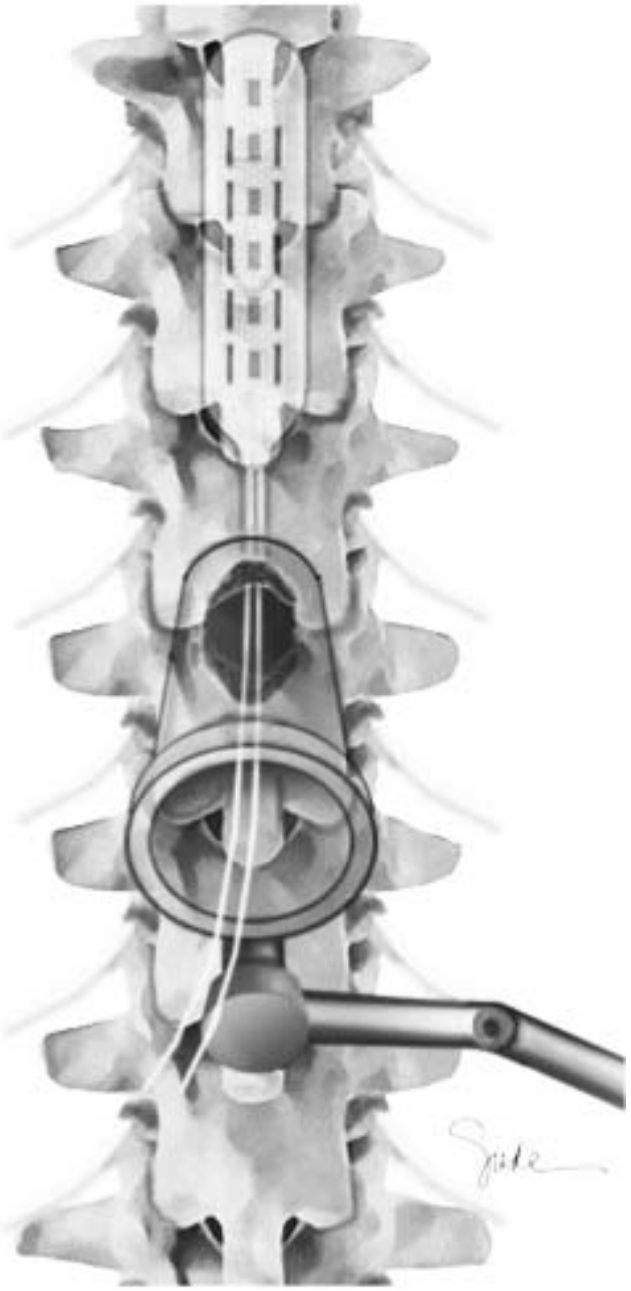


Figure 3. Anteroposterior illustration showing the paddle lead in the midline. With the laminectomy performed in the midline, the paddle lead is easily guided into the epidural space.

Surgical Technique

All patients had successful trials (>50% pain relief) of SCSs performed by their pain specialists prior to being referred for placement of permanent paddle lead via laminectomy. Informed consent was obtained in all cases. The study was approved by our institutional review board.

We placed all paddle leads with patients under general anesthesia and in a prone position on either a

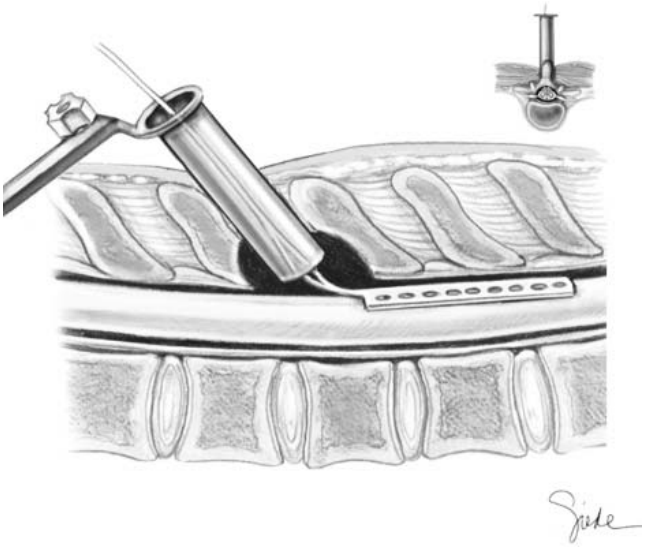
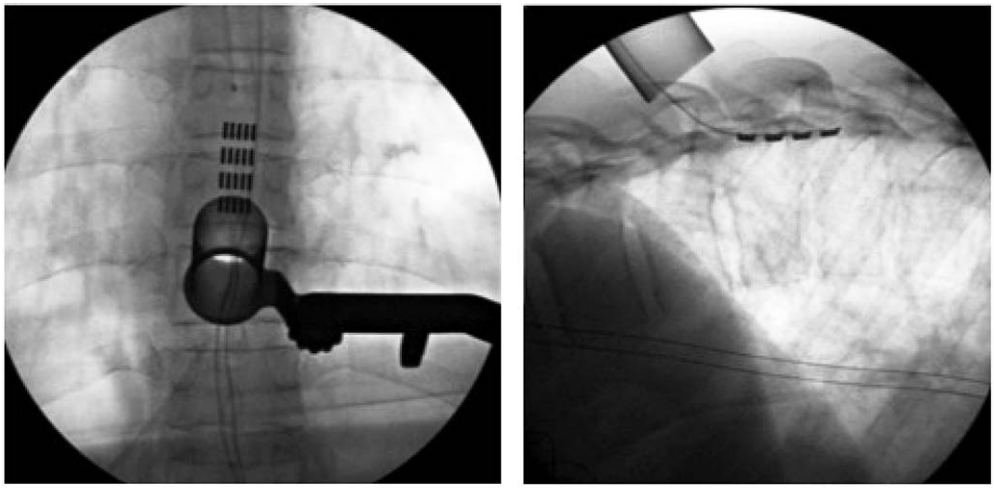


Figure 4. Illustration showing the laminectomy/removal of spinous processes at the thoracic spine. The ligamentum flavum has been removed and the paddle lead placed in the epidural space. The angle of the METRx-MD tube follows the angle of the spinous processes and the tube facilitates the placement of the spinal cord stimulator paddle lead in the epidural space. The inset image shows the location of the tube retractor in the midline where the lead will be placed.

Wilson frame or Jackson table. In all patients, we used intraoperative somatosensory evoked potentials (SSEPs) and free-running electromyograms (EMGs) that were also employed to confirm adequate coverage of lower extremities after epidural placement of the paddle lead. The paddle lead was placed at the predetermined spinal level at which the patients had the best response during their percutaneous trial. All leads were placed in the thoracic spinal level.

The thoracolumbar and buttocks regions were prepped and draped in all cases using sterile technique. A midline thoracic incision and a transverse buttocks incision were used for placement of the paddle lead and pulse generator, respectively. The thoracic incision was made 1 spinal segment level below the level at which the paddle lead was placed. The incision for the pulse generator was generally placed over the upper buttocks area and below the waistline. We used fluoroscopic guidance to localize the spine level for placement of the paddle lead to ensure that our incision was exactly in the midline (ie, over the spinous processes) and to assemble the tubular retractor system in the midline (Figure 1). The METRx-MD tubular retractor system was placed between the superior part of the caudal spinous process and the inferior part of the rostral spinous process. We used anteroposterior fluoroscopy to confirm midline positioning of the tubular



A. B.

Figure 5. A: Anteroposterior fluoroscopy showing the midline location of the tubular retractor system and the placement of the spinal cord stimulator (SCS) paddle lead in the midline. B: Lateral fluoroscopy showing the tubular retractor between the 2 adjacent spinous processes and the paddle lead in the epidural space. The position of the tubular retractor system is 1 vertebral level below the desired position of the SCS paddle lead and is oblique.

retractor system in relation to the spinous processes. Under an operating microscope, the interspinous ligament and the soft tissue adjacent to the caudal spinous process and bilateral lamina were removed using a Bovie cautery pen. Some cases required us to drill into the inferior edge of the rostral spinous process to bring the METRx-MD tube down between the 2 adjacent spinous processes. The dissection was carried down at each side of the spinous process and about 1 cm laterally on both sides of the lamina. At this point, a large enough midline laminectomy was performed to allow passage of the paddle lead in the epidural space. The ligamentum flavum was removed using lower-profile golden-tip Kerrison forceps. A Woodson instrument was used to ensure the epidural plane was free from adhesions before sliding the paddle lead into the epidural space (Figures 2 through 4). Fluoroscopic confirmation was obtained in all cases (Figure 5) after placement of the paddle lead. In the case of epidural adhesions, a malleable dural scar dissector was used to break down the scar tissues in the epidural space prior to placing the paddle lead. After confirmation of good positioning by fluoroscopy, the METRx-MD tube was removed with caution and the paddle lead contacts were tested by electrophysiologic neuromonitoring to confirm appropriate coverage using both EMG and SSEP responses. If good responses were obtained, the lead extensions were secured either to the thoracolumbar fascia and/or to the inferior lamina to prevent migration. After the lead was secured, the cables were tunneled subcutaneously, connected to the battery, and tested for impedance abnormalities prior to final subcutaneous insertion (Figure 6).

RESULTS

Between October 2010 and June 2013, 78 patients had MIS placement of paddle lead SCSs. Patient ages ranged from 27 to 87 years old. Mean age at the time of the surgery was 59 years old. All the surgeries were performed as outpatient procedures. The most common levels at which paddle leads were placed were T8 and T9. The Table shows the preoperative diagnoses and indications for placement of paddle leads in the patients.

Mean body mass index (BMI) was 31.5, ranging from 16.5 to 59.0. Mean estimated blood loss was 22.7 mL. Length of surgery was 97 minutes on average. The rate of revision surgery for migration of the paddle lead was 18% (14 of 78 patients). The migration group had a mean BMI of 35.0, and 3 of the 14 patients reported falls with immediate SCS malfunction after the fall. A mean time of 53.8 days passed between the first surgery and the revision procedure. All the revision surgeries were performed with an open approach. One patient had to undergo removal of the entire SCS because of infection. This patient had a BMI of 59.0; the infection started over the battery site and spread up to the paddle lead incision site.

No minor or major neurologic complications occurred in our patient population. No patient was readmitted after being discharged from the hospital. We are now analyzing the patient-reported outcomes

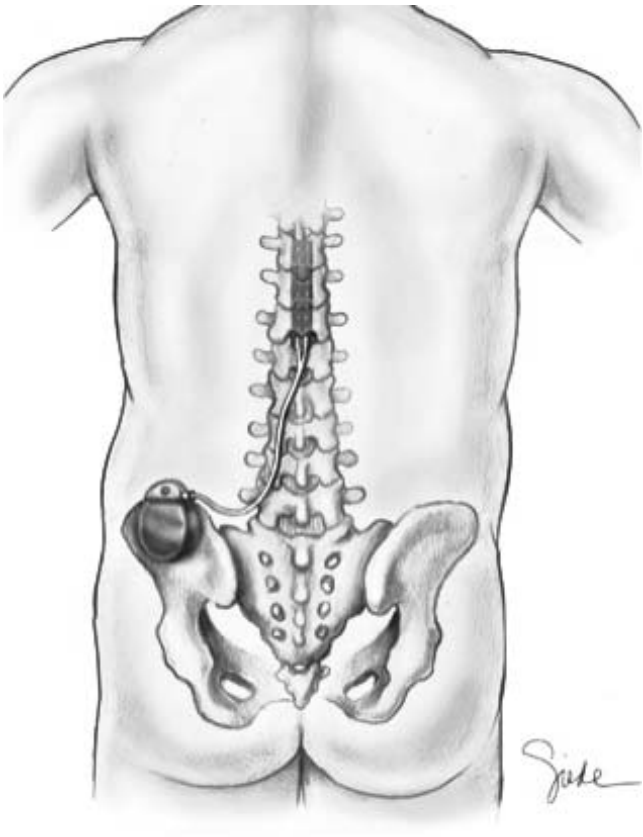


Figure 6. Illustration of the spinal cord stimulator (SCSs) system once it has been implanted. We prefer to position the battery on the superior aspect of the buttocks, inferior to the waistline, where the device is associated with fewer complaints from patients.

up to 1 year after placement of the spinal cord stimulator.

DISCUSSION

Placement of an SCS either percutaneously or via laminectomy is one treatment option for patients to manage chronic pain.[1-3,5] Because patients with chronic pain have a somewhat heightened response to painful stimuli, invasive treatments must not worsen their chronic pain state. Hence, MIS techniques are appropriate for these patients because they provide reduced morbidity compared to open spinal surgery techniques.[12] Less tissue is dissected, reducing blood loss and immediate postsurgical pain.[7,12] MIS techniques are safe, reproducible, and effective.

We describe a novel MIS technique for placement of paddle lead SCSs that is not only equally as effective as the standard open technique but is also economical because the surgery can be performed on an outpatient basis without added hospital costs. Our technique is unique in that it follows the basic principles of the open approaches in which the midline is the reference guide to place the SCS lead but eases the placement of paddle leads and carries minimal soft-tissue manipulation and resection, reflected in the scarce blood loss for the surgeries (22.7 mL average in our series). Our technique provides an advantage over the conventional techniques for patients with high BMI who require longer open incisions to allow access to the spinal lamina. Our technique also reduces the chance of neurologic complications and lack of appropriate bilateral pain coverage (0% in our series) that may be seen in other MIS approaches in which a paramedian incision is used.[9,11,13]

This midline approach requires minimal bone removal; the size of the laminectomy is tailored to the size of the lead that is passed through the small bone window created, allowing minimal room for lateral migration because the bone edges of the lamina keep the lead in the midline. The paddle migration rate of our technique (18%) was no different than the reported migration rates for other SCS placement techniques.[4,13-16] All of the migrations we witnessed were a result of dorsal migration of the paddle leads likely related to poor anchoring and

Table. Primary Diagnosis and Spinal Cord Stimulator Paddle Lead Placement

Primary Diagnosis	Number of Patients	Spinal Level of Paddle Lead Placement						
		T6	T7	T8	T9	T10	T11	T12
Failed back syndrome	70	3	11	42	59	46	14	0
Neuropathic leg pain	4	0	0	1	3	2	3	1
Lumbosacral spondylosis	1	0	0	1	1	0	0	0
Complex regional pain syndrome	1	0	0	0	1	1	0	0
Malposition, spinal cord electrodes (Patient had removal surgery and placement surgery together.)	1	0	0	0	0	1	1	0
Degenerative scoliosis	1	0	0	1	1	1	0	0

early excessive mobilization of the patients (especially flexion movement) and/or patient falls. To overcome this migration issue, we started using a different anchoring technique. Currently, we anchor the lead extensions from the paddle lead to the inferior lamina via a 2-mm tack-up hole created in the lamina through which we pass a 0-0 Vicryl stitch to suture the lead extension to the laminar bone. With the introduction of this anchoring variant, we have had a zero lead migration rate. We hope to be able to report the functional outcomes of the patients treated with this technique in the future.

CONCLUSION

In this article we describe a novel MIS technique for placement of paddle lead SCSs via laminectomy. No patient suffered any neurologic complication, we had a migration rate comparable to open techniques and minimal blood loss, and all patients were discharged the same day after surgery. The technique is safe and effective and carries minimal surgical morbidity compared to standard open techniques for placement of SCSs. Functional outcomes and the cost effectiveness of the technique are the subjects of our future studies.

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