Technical Challenges in Lead Placement of Spinal Cord Stimulator for Treatment of Chronic Low Back Pain in Patients with Severe Scoliosis

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Introduction

A multiple of patients suffer with chronic low back pain secondary to post-laminectomy syndrome. Some such patients have concomitant severe thoracolumbar scoliosis. Spinal cord stimulation (SCS) is a recognized therapy for this condition after conservative treatments, such as physical therapy, medications, and further surgery, have not resolved their respective problems.

I first reported placement of SCS in a patient with severe dextroscoliosis. It was then noted that many patients with variations of either dextroscoliosis, levoscoliosis, kyphoscoliosis, or other variations all had some common factors including a desire to reduce their pain syndrome. This is an analysis of one-hundred thirty-six (136) patients over a twelve (12) year period of study.

Theoretically, the placement of SCS leads, trial or permanent, in patients with relatively normal anatomy can be challenging under normal circumstances; however, in patients with aberrant spinal anatomy, as with various types and severities of scoliosis, may present extraordinary challenges. It is commonly recommended to use a percutaneous paramedian insertion approach on the convex side of the scoliotic spine at the level of the apex vertebra, taking into consideration the necessary needle realignment.

Cases and Techniques

Patients recommended for SCS trial or permanent lead placement vary in age with the norm ranging from 50 to 70 years of age. These patients have a wide variation in social and medical background, although all suffer from post-laminectomy syndrome (also known as failed back syndrome or FBSS).

The patients experiencing chronic low back pain secondary to post-laminectomy syndrome generally presented with the pain which was described as continuous, spasmodic, and a throbbing dull ache that was present throughout the day and would become worse at night. The pain was aggravated by walking, work and exercise that varied in degree and type from patient to patient. The patient was relieved by sleep, rest and medication. The pain usually started in the low back region, radiated down to the buttock, and to the lateral aspect of the thigh into the posterior aspect of the calf region.

Abstract

Background and Aims: This paper details the technical challenges involved in placement of a spinal cord stimulator (SCS) for chronic low back pain in patients with severe scoliosis.

Objective: This article aims to suggest techniques which may assist in SCS lead placement in patients with severe scoliosis.

Design: Cumulative case reports with technical note.

Settings: These challenges commonly occur in an interventional pain management physician’s office or outpatient surgery setting.

Conclusion: While the technical challenges of lead placement of SCS may not be easy, witnessing such patient’s return to relatively normal lives is rewarding.

Keywords: Spinal cord stimulator, Scoliosis, Chronic back pain
citing "sciatica or an electric shock-like feeling." They also complained of intermittent bouts of paresthesia and numbness in the legs and feet region. Visual analog scale (VAS) in these patient, a standard measure of pain in the field of pain management, were at best 6-7 / 10 on a daily basis. The patients typically stated that they “wanted life back” and wished to decrease or discontinue their pain medications. Many of the patients just wanted the ability to walk a couple of blocks without pain.

The option of fluoroscopically-assisted placement of a percutaneous spinal cord stimulator trial was discussed with the patient with the intent to use dual octrode leads. Spinal cord stimulation (SCS) is an excellent therapy for patients with lumbar radiculopathy and axial low back pain (LBPP) with post lumbar laminectomy syndrome. SCS is an option for patients who wish not to have another lumbar surgery.

The patients were scheduled at an outpatient surgery center or office procedure room. The informed consent was signed. Preoperative antibiotics were given via IV infusion. Most of the patients were given sedation with 10 milligrams of oral diazepam forty (40) minutes to one hour prior to the procedure. The patient was placed in a prone position. The low back region was made aseptic using Betadine solution.

The placement of SCS, trial or permanent, in patients with relatively normal anatomy might be challenging under normal circumstances. In cases pertaining to a patient with aberrant spinal anatomy, as with various types and severities of scoliosis, this may present extraordinary challenges. It is usually recommended to use a percutaneous paramedian insertion approach on the convex side of the scoliotic spine at the level of the apex vertebra, taking into consideration the necessary needle realignment. In addition, information from anteroposterior and lateral radiography and magnetic resonance imaging (MRI) should be obtained and thoroughly reviewed preoperatively. Even though the shift of the dural sac provides a wider target zone for lead entry on the convex side, access into the epidural space for these patients was difficult because normal vertebral landmarks were not present for a Para median technique [1,2].

In the greater majority of patients having scoliosis and pain secondary to post-laminectomy syndrome, a percutaneous trial spinal cord stimulator uses this technique: Using fluoroscopic guidance, the pedicles of the vertebra being used as the epidural entry point are lined up such that the spinous process is absolute midline. In the usual 70-80 kg patient, there is a mark with indelible ink to where the entry point of the skin is usually made. The point of entry from the skin is usually 15-20 degrees paramedian to 2 vertebral segments below the epidural entry point. I feel that regardless of the spine curving to the left or to the right, after entering the epidural space, the site of initial entry does not matter, so long as the epidural entry is as close to midline as possible. There are two techniques to guide the leads to their desired destination at or near midline of the T8-T9 region. The first technique used is maneuvering the tight turns of the scoliotic spine using the stylet to drive the leads to the desired region. The second technique used is to use the epidural needle itself to direct/drive the lead to the desired endpoint. This technique was designed by Kenneth Alo, MD. It involves directing the bevel of the epidural needle up, down, and sideways such in a way as to be able to manipulate the cephalad movement of the lead. It is my recommendation to use both techniques in patients with scoliotic spine. If neither technique works due to the severity of the curvature of the spine, remove the stylet and put more of a bend to the distal tip of the style; use sterile water or saline to lubricate the stylet back into the lead, then drive the lead to the desired endpoint. Once the leads are in the desired location with adequate paresthesia over the painful region, the needle and stylet are removed, and the leads are traditionally taped in place with bio-occlusive dressing. The patient is given three to five days during this trial period to test the analgesia produced by the spinal cord stimulator. The patient is encouraged to walk, perform normal household activities, and perform minimal exercise such as walking, going shopping, and other activities which previously produced severe pain. The patient is then asked the percentage of pain relief produced from the spinal cord stimulator, the actual visual analog scale (VAS) in which the patient had during stimulation, and the amount of functionality produced by the trial stimulator. If the patient shows 50% pain relief or higher and increased level of functioning, such as increased distance the patient is capable of walking without having pain, ability to go shopping without suffering from pain, and/or able to walk without assistance, which would mean that the patient had passed the trial stimulation stage of the SCS and is therefore able to advance to permanent implant of the spinal cord stimulator.

For the cases of the permanent placement, the spinal cord stimulator is placed in a somewhat similar manner to the trial SCS. Once the pedicles of the vertebra being used as the entry point into the epidural space are identified and the skin is marked using a marking pen. Then, a 5 to 10-centimeter line is marked vertically from that point. Skin and subcutaneous dissection is performed in a similar manner to that which is used in most SCS implant procedures. The epidural needle is introduced from the wound in a similar manner to the trial SCS procedure. Upon access into the desired epidural point of entry, using loss of resistance technique, a dummy lead is inserted. Then, the needle is withdrawn and an Epiducer is introduced into the epidural space. The Epiducer allows for the placement of S-type paddle leads. The paddle leads allow for a greater surface area of spinal cord stimulation. This allows for a greater area of paresthesia, hence pain relief. I found that there is less movement of the lead or lead migration using paddle leads. Anchoring of the leads and tunneling of the leads, and placement of the generator is done in a traditional fashion of an SCS implant.

Providing instructions to the patient is vital after the procedure. It is important to emphasize that the patient not engage in any sporting activity or high-impact recreational activity. There is to be no squatting, no yoga, nor any massages are to be performed around the implant. This is to ensure that the leads eventually adhere to the posterior epidural region and prevent lead migration, displacement or dislodgement.

In one patient in particular, the placement of a trial spinal cord stimulator was done in the following manner: An imaginary 10-centimeter line was drawn from the midline of the T12 to L1 region. The line was angled 30-degrees of midline of where L2 should have been (Figures 1 and 2). Once the epidural space was accessed at T12-L1 region using an intralaminar technique (Figure 3), the curvature of the spine from the scoliosis was severe enough to produce a challenge to drive the leads superiorly into the midline region to the T8-T9 region (Figure 4). The leads were driven as to follow the curvature of the spine as close to the midline.
as possible. The patient complained of right-sided anterior abdominal paresthesia upon initial stimulation. The stylet was replaced with a more rigid one and leads were then redirected even more lateral left of midline. The patient stated that he had excellent paresthesia coverage over the painful region of the low back from his post-laminectomy syndrome after subsequent stimulation. VAS was 1-2 / 10 during stimulation. In addition, the patient had 75% to 80% reduction in pain. The patient could walk a greater distance and greater length of time without pain and he could go shopping for 30 minutes without using a walking assistance device, such as a cane. It was noted that his physiologic midline was different from his anatomic midline. Some patients with severe scoliosis have moderate spinal stenosis which can present potential challenges to epidural lead placement and threading. Difficulty in performing epidural lead placement may result in neural injury, spinal hematoma, post-dural puncture headache, or infection.

The line was angled 30-degrees from midline of where L2 should have been (Figure 2). Once the epidural space was accessed at the T12-L1 region, using an intralaminar technique (Figure 3), the curvature of the line from the scoliosis was severe enough to produce a challenge to driving the leads superiorly into the midline region to the T8-T9 region (Figure 4). The leads were driven as to follow the curvature of the spine as close to the midline as possible. The patient complained of right-sided anterior abdominal paresthesia upon initial stimulation. The stylet was replaced with a more rigid one and leads were then redirected even more lateral left of midline. The patient stated that he had excellent paresthesia coverage over the painful region of the low back from his post-laminectomy syndrome after subsequent stimulation. VAS was 1-2 / 10 during stimulation. The patient had 75% to 80% reduction in pain. He could ambulate without the use of a cane and could go shopping for up to 30 minutes. It was noted that his physiologic midline was different from his anatomic midline [1] (Figure 5).

Some patients with severe scoliosis have moderate spinal stenosis which can also present potential challenges to epidural lead placement and threading [3].
Difficulty in performing epidural lead placement may result in neural injury, spinal hematoma, post-dural puncture, headache, or infection.

Discussion

Defined as lateral curvature of the spine of > 10-degrees, the degree of lateral curvature is determined by the Cobb angle. The Cobb angle is measured between the most tilted vertebral bodies in the coronal plane. A line is drawn parallel to the superior endplate of the cephalad vertebrae with the greatest angulation. A perpendicular line is drawn from each of these lines which create the Cobb angle. In addition to the lateral curvature in idiopathic scoliosis, there is also rotation of the vertebral bodies. Anatomically, the spinous processes point towards the midline (concave side) and the vertebral bodies rotate towards the convex side of the curve [4].

A strong linear relationship exists between the Cobb angle and vertebral rotation in both thoracic and lumbar curves in untreated patients and maximum rotation occurs at the apex of the scoliotic curve. Depending upon the degree of lateral curvature (Cobb angle), idiopathic scoliosis is classified as mild (11-25 degrees), moderate (25-50 degrees), or severe (> 50 degrees) [5].

Scoliosis is not a disease, but rather it is a term used to describe any abnormal sideways curvature of the spine. Viewed from the back, a typical spine is straight. When scoliosis occurs, the spine can curve in one of three ways:

- The spine curves to the side as a single curve to the left (shaped like the letter C) called *levoscoliosis*.
- The spine curves to the side as a single curve to the right (shaped like a backward letter C) called *dextroscoliosis*.
- The spine has two curves (shaped like the letter S) [4].

There are two methods of a trial SCS in patients with scoliosis. First method involves performing a percutaneous trial SCS using trial leads. Second method involves performing a percutaneous trial SCS using permanent octrode or S-type paddle leads delivered via Epiducer, burying the leads subcutaneously using a percutaneous connector to the programmer/generator. The benefit of the latter option is that the leads do not have to be removed after the trial period. Therefore, there is no requirement of repeating epidural access and lead placement in which trial lead placement was exceptionally difficult. Various methods may be used to control low back pain in scoliotic patients. Pain medications are more often used but have risks including but not limited to nausea and vomiting, and overdose/death. Radiofrequency/rhizotomy of nerves of the facet joints can reduce low back pain but not the radiculopathy. Intrathecal pumps are another valid choice to reduce pain syndrome but have risks associated to and including meningitis, respiratory depression, and death. SCS should always be attempted prior to intrathecal pump placement.

Conclusion

The treatment of chronic pain remains challenging as reported by Steven Falowski, MD. Spinal cord stimulation has been performed for over thirty (30) years, and slow but steady progress with this technology has been made. As the equipment and stimulation parameters are improved, the selection criteria will be better defined and parameters slowly expanded. More importantly, experience in the technique and the equipment have made SCS a much more reliable and safe modality. Like all the modalities performed for chronic pain management, its results are favorable. It is important to remember that the goal of neuro-stimulation is to reduce pain rather than to eliminate pain. It has been shown to have a 50% improvement in pain relief. Very few other invasive modalities can claim this success rate with a few years of follow up [5].

This study was conducted on 136 patients, 111 of which a permanent stimulator was implanted and 25 of which received a trial only. Approximately 20 of these patients had severe scoliosis and I never used a single lead placement in these cases.

Based on the author’s anecdotal evidence, over 90% of the SCS patients with scoliosis stated they had good (50% or higher) pain relief. The rate of success improves if the same physician performs the trial and permanent implant.

The severity of abnormal curvatures of the spine might overwhelm and intimidate some physicians, not considering a spinal cord stimulator, but patience and knowledge of the spinal anatomy are essential. The stimulation of the dorsal column tract of the physiologic midline of these patients ensured paresthesia’s over the painful areas of the low back and lower extremities. Driving the leads either by double-rotation of the needle or increasing the curve of the stylet aided in proper lead placement. Patients with various degrees of scoliosis deserve consideration for SCS just as much as patients with normal spinal anatomy [1].

Upon last review, SCS implanted patients were contacted two years’ post-implant. The majority reported decrease of pain on average of 70%, 50% decrease in pain medication intake, and approximately 30% of those patients were capable of returning to gainful employment.

References
