Critical Evaluation of Results Following Laminectomy versus Percutaneous Lead Placement for Spinal Cord Stimulation

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ABSTRACT
OBJECTIVE: The purpose of this study was to compare the long-term efficacy of spinal cord stimulation (SCS) utilizing laminectomy versus percutaneous-styled electrodes.

METHODS: A chart analysis revealed 51 patients treated with SCS at Duke University Medical Center between December of 1992 and January of 1998. The majority of patients (59%) suffered from low back and radicular pain after multiple failed back surgeries. All 51 patients underwent an initial trial period of SCS using temporary electrodes. This was converted to a permanent system if trial stimulation reduced the patient's pain by more than 50%. Median long-term follow-up after permanent electrode placement was 31 months (range, 4-65 months). Severity of pain was determined pre- and postoperatively by a disinterested third party using a visual analog scale (VAS) in all patients who underwent permanent electrode placement. In addition, a modified outcome scale was used to compare the long-term efficacy of SCS with the efficacy reported in the literature following other treatment methods such as reoperation in patients with failed back surgery syndrome.

RESULTS: Twenty-one patients (41%) out of the 51 failed to achieve greater than 50% pain reduction during the trial period and the temporary electrodes were removed. Thirty (59%) of the 51 patients trialed underwent permanent electrode placement. Fifteen of the 30 patients (50%) had permanent electrodes placed percutaneously and 15 (50%) via laminectomy. Three of 8 patients (38%) who underwent thoracic laminectomy for permanent lead placement excellent outcomes, defined as pain-free or with little remaining pain at follow-up. The remaining five patients in this group (62%) had residual but significantly improved pain relative to their preoperative status. In the percutaneous group, 3 of 14 patients (21%) had excellent pain relief, 8 (57%) were significantly improved and 3 (21%) had poor outcomes, with little or no pain relief. Three of the four patients (75%) who underwent cervical laminectomy for lead placement had poor outcomes.

CONCLUSIONS: SCS is an effective treatment for chronic low back and lower extremity pain which is refractory to conservative therapy. These results suggest that the laminectomy-style electrode in the thoracic region achieves better long-term effectiveness than the percutaneous lead. In contrast, laminectomy for SCS in the cervical region is associated with poor results.

Index: back pain, Spinal Cord Stimulation

I. INTRODUCTION
Increasing numbers of patients are receiving percutaneously placed electrodes in order to reduce costs and to take advantage of minimally invasive techniques. Although percutaneous techniques are associated with several attractive advantages, there is currently no objective evidence evaluating which electrode systems have better long-term outcomes. Percutaneously placed electrodes may be associated with an increased incidence of migration [18, 28] despite the use of electrode anchoring techniques. In fact, several studies indicate that electrode migration may be the most common cause for failure to maintain long-term pain control with SCS [35, 18, 28]. Laminectomy-style electrodes are placed under direct vision, they have larger surface contact areas, and they may be secured directly to the dura to prevent migration. This potentially translates into improved results. The purpose of this study is to evaluate the long-term efficacy of spinal cord stimulation (SCS) using modern laminectomy versus percutaneous-styled electrodes. We reviewed our institutional experience with SCS using modern electrode systems over the past 5 years. Current follow-up was obtained on 30 patients who underwent permanent electrode placement by a disinterested third-party interview. Comparisons of outcome using modern percutaneous and laminectomy electrodes is presented.

II. METHODS
Fifty-one patients were identified who underwent SCS at Duke University Medical Center between December of 1993 and January of 1998. Thirty patients (59%) were male and 21 (41%) were female. All patients were referred for SCS from a multidisciplinary pain clinic having completed at least 6 months of conservative treatment with physiotherapy, pain medications and in some cases epidural injections. The various etiologies for the pain are shown in Table 1. The majority of patients (59%) were diagnosed with failed back surgery syndrome (FBSS), followed in number by complex regional pain syndrome (CRPS) I and II, and neuropathic pain syndromes. Patients in whom low back pain was the sole complaint were not treated with SCS.

All patients were screened with a temporary electrode in order to establish satisfactory relief of pain before internalization of a permanent system. Thirty-eight trial stimulation periods (75%) were performed at Duke and
13 (25%) were performed elsewhere. For initial trial SCS in the thoracic region, a percutaneous catheter-type lead (Pisces Quadripolar electrode, Medtronic Corporation, Minneapolis, MN) was used in 41 patients and a laminectomy-type lead (Resume electrode, Medtronic Corporation, Minneapolis, MN) was used in 4 other patients. Use of the laminectomy-type leads in the latter was due to the large size of the patients. After screening 51 patients, 30 (59%) proceeded to undergo permanent implantation. All patients were followed for a minimum of 6 months. A total of 39 additional procedures were performed on these 30 patients because of electrode repositioning, electromechanical failures or wound infections.

Detailed methods for electrode placement have been published previously [16]. The Resume electrode is advanced through a small laminotomy under direct vision. Pisces Quadripolar electrodes are placed percutaneously through a Touhy needle. Pisces Quadripolar electrodes are directed under fluoroscopic guidance. Operations are performed under sterile conditions and patients are mildly sedated. Lidocaine is used for local anesthesia. Electrodes are positioned so as to elicit paresthesia in the anatomic distribution of the patient’s pain. Upper extremity symptoms were usually covered with the upper electrodes at or cephalad to C4 or C5, whereas lower-limb symptoms are covered with electrodes placed between T9 and T11.

Temporary leads were tested over a period ranging from 1 to 14 days. During this testing period, pain relief and improvements in activity levels were assessed. If trial stimulation reduced the patient’s pain by more than 50%, the system was internalized and connected to an implanted subcutaneous pulse generator (Irel II and III, Medtronic Corporation, Minneapolis, MN). Stimulation parameter settings ranged from 50 to 100 Hz, with 200 to 300 microsecond pulse widths, and amplitudes between 1.0 and 5.0 volts. Cycling modes were not used. Selection of specific electrode combinations was managed on an individual basis.

Twenty-one of 41 patients (51%) trialed with percutaneous electrodes underwent permanent implantation, and 3 of 4 patients (75%) trialed with laminectomy-styled electrodes underwent internalization. Laminectomy was routinely used for trial stimulation in the cervical region based upon advice from other experts in the field of stimulation [personal communication Bullit, North], however, this practice has now been modified. An additional 6 patients underwent laminectomy for replacement of lead systems that were previously implanted at other institutions. All 6 of these leads were in the thoracic region. Following permanent lead placement, patients were followed every three or six months for the first year and yearly thereafter.

Pre- and postoperative pain levels were based on the administration of a visual analog scale (VAS) [35, 12] with which the severity was rated from 0 to 10. The level of pain present preoperatively was assessed individually by the operating attending physician or resident during the routine preoperative work-up. Postoperatively, the level of pain was evaluated by the operating physician during the first follow-up exam. Thereafter, results were evaluated by telephone or in person by a disinterested third party physician who was not involved with the presurgical screening, the actual surgery, or postoperative care. A modified outcome scale (Table 2) was used to compare the long-term efficacy of SCS with other treatment methods reported in the literature such as reoperation in patients with failed back syndrome.

III. RESULTS

Twenty-one patients (41%) failed to improve more than 50% during the trial period and the temporary electrodes were removed. Thirty (59%) of the 51 patients trialed underwent permanent electrode placement. Fifteen of the 30 patients (50%) had permanent electrodes placed percutaneously and 15 (50%) via laminectomy. All 15 permanent percutaneous electrodes were placed in the thoracic region. Of the 15 permanent electrodes placed via laminectomy, 3 (20%) were in the cervical region and 12 (80%) were in the thoracic region.

In the 30 patients that underwent permanent implantation, mean age at the time of the initial procedure for SCS was 50.4 years (range, 24 to 74 years). Average duration of symptoms prior to surgery was 7.2 years (range, 8 months to 30 years). Patients had undergone an average of 2.7 prior surgical procedures for the relief of pain (range, 0-10 procedures). Sixteen (53%) were men and 14 (47%) women. There was no significant difference in demographics between patients who underwent percutaneous lead placement when compared to patients who underwent laminectomy (Table 3).

All 30 patients who underwent permanent implantation of spinal cord stimulators were available for long-term postoperative assessments in person or by telephone. Table 4 compares pre- and post-operative pain levels in all 30 patients who underwent permanent electrode placement as determined by administering a VAS [35]. Mean follow-up was 31 months (range, 4-65 months). Visual analog scores decreased an average of 4.6 for patients undergoing SCS placement via laminectomy in the thoracic region. Patients who underwent percutaneous placement of thoracic leads had an average decrease of 3.1. Table 5 illustrates the long-term results using a modified outcome scale (defined in Table 2).

Overall, eighty-three percent of the 30 patients who received permanent implants continued to report at least 50% relief of pain (with or without concurrent use of narcotics) at follow-up. Laminectomy-styled electrodes for SCS in the thoracic region were associated with a greater than 90% good or excellent outcome at long-term follow-up. No patients in this group had what was defined as a poor outcome. On the other hand, 2 of 3 patients (66%) who underwent SCS in the cervical region had poor outcomes. Percutaneous leads were placed in the thoracic region only and were associated with a good or excellent outcome in 54% of patients, fair in another 27% and poor in 21%.

Abrupt loss of pain relief occurred in 4 of 14 patients (29%) who had percutaneous leads, and gradual
loss in another 4 patients (total, 57%). All but one of these patients underwent electrode repositioning. Five of the 7 patients (71%) who underwent electrode repositioning never recovered significant analgesia. The one of 7 patients who did not elect to undergo revision had an outcome that changed from good to fair (see Table 2).

Nine patients (30%) with permanent implants under the age of 65 were actively working, compared to 8 (27%) preoperatively. Three patients were over the age of 65 and said they could work but were retired. In the thoracic laminectomy group, all three patients under the age of 65 who had been working preoperatively were back to work, and one other patient was retired and capable of working. Of the eight patients who were working preoperatively in the percutaneous group, 4 (50%) were back to work, 2 patients (25%) were retired, and 2 (25%) were unable to work as a result of continued pain. Due to the retrospective nature of this study, we were unable to accurately determine which patients were receiving disability compensation.

There was no mortality directly associated with surgery. There were no episodes of spinal cord compression or injury, bacterial meningitis, or life-threatening infection. One electrode required replacement because of fracturing and one patient required removal of the system due to infection at the generator site. Although the latter patient had excellent pain control, the result was graded as poor secondary to the return of pain following SCS removal. Two patients required replacement of the impulse generators due to mechanical failures. In both of these, the pain returned within a day of mechanical failure of the stimulating system and resolved with reinstitution of SCS. One of these patients subsequently developed a wound infection at the site of IPG replacement. This was treated successfully with IV antibiotics. Another patient is considering possible removal of the stimulator secondary to the feeling of increased temperature in the lead wires. However, he continues to have good pain relief 8 months following surgery with no revisions. Overall, nineteen patients required a total of 39 repositioning procedures. There were slightly more revisions required per patient in the percutaneously placed leads; 1.4 revisions per patient compared with 1.2 revisions per patient in the laminectomy group. This was not statistically significant. Ten of the 15 patients (67%) in the laminectomy group underwent a total of 18 revisions (range, 0 to 5), while 9 of the 15 patients (60%) in the percutaneous group underwent a total of 21 revisions (range, 0 to 6).

IV. DISCUSSION

Variable electrode systems are utilized in different centers performing SCS. Likewise, reported rates of success vary widely in the literature. There are a number of theoretical advantages to each of the percutaneous and laminectomy designed electrode types. Percutaneously placed leads, on average, require shorter operative times and are thought to be associated with fewer operative complications. Percutaneous leads require less invasive surgery for placement, and they allow for the modification of positioning intraoperatively in order to attain paresthesia coverage in a specific location. On the other hand, laminectomy-styled can be anchored directly to the dura to minimize migration and they have insulated backing which protects against potentially uncomfortable recruitment of small fibers located dorsal to the electrodes, for example, in the ligamentum flavum. Moreover, the laminectomy-styled Resume electrode contains four contacts with a stimulation area of 12 mm², a much wider area of stimulation than the percutaneously placed Pisces Quadripolar electrode. The larger size of the Resume lead also acts to compress the CSF space and brings the electrodes into closer contact with the dorsal column of the spinal cord. Computer modeling suggests that stimulation is more effective under such circumstances [8]. This may account for what is thought to be a lower reported incidence of migration [7, 18, 28]. Laminectomy-styled electrodes may require fewer revisions in the long-term [18, 28, 35].

North et al. [32] evaluated the technical as well as clinical outcomes of percutaneous and laminectomy electrodes in 320 patients with chronic, intractable pain, who underwent implantation of temporary and/or permanent spinal cord stimulators between 1972 and 1990. Included in this retrospective evaluation were many of the older systems. One hundred and thirty-four of 171 patients with permanently implanted electrodes underwent percutaneous placement, while 37 patients underwent laminectomy. Seventy-five of 171 patients (44%) in the percutaneous group had single-channel systems. Although the remaining 96 patients (56%) had programmable devices, these were technically single-channel systems gated to multiple outputs. In their overall series of 298 permanently implanted devices in 249 patients, there were 226 percutaneous and 72 laminectomy electrodes; 131 were monopolar or bipolar, and 167 were arrays of four or eight contacts. The associated implanted electronics were single-channel, radiofrequency-coupled devices in 144 patients and multi-channel, programmable radiofrequency-coupled devices in 154. Kaplan-Meier survival statistics were calculated for the various electrode configurations used over the preceding two decades. The statistical endpoint for electrode survival was loss of stimulation paresthesias overlapping a patient’s usual distribution of pain - whether because of physical migration or malposition of the electrode. The highest failure rate was associated with dual, independently inserted percutaneous electrodes, connected to a single-channel, non-programmable device. A fixed bipolar laminectomy electrode, implanted as a single-stage procedure with single-channel electronics had the second highest failure rate [32]. Overall, multicontact electrode arrays of both percutaneous and laminectomy configurations were found to have significantly lower rates of failure over time. The percutaneous single-channel leads were significantly more prone to migration failure compared with multichannel leads (n = 90; hazard ratio =9.7; P = 0.025, by the Cox proportional hazard survival analysis).

Hassenbusche et al [7] retrospectively evaluated 26 patients who underwent SCS using percutaneously placed Pisces Quadripolar electrodes. After a mean follow-
up of 2.1 years, greater than 50% pain relief was achieved in 62% of SCS patients. This was compared to only 13% of 16 patients who received intrathecal narcotic infusions having similar levels of pain relief [7]. For the long-term intraspinal infusion of opioids, the overall success rate was clearly less than that seen with SCS. However, the most common problem encountered with SCS patients was in maintaining a stimulation pattern that matched the area of pain. Failure to maintain a bilateral or a midline area of stimulation was the most common reason for long-term failure. Although the numbers were not specified, it was noted that "there was a significant subset of patients who subsequently underwent a laminectomy for placement of a plate-type electrode." The authors also stated that "although this [laminectomy] is a more extensive operation, the long-term stability of these plate-type electrodes appears to be better."

In a multicenter study on the treatment of nonmalignant chronic pain, Broggi et al. [2] permanently implanted SCS electrodes in 283 patients. This group reported more than 50% reduction of pain in 87% of patients after 3 months of follow-up. However, these good results gradually declined over time. Seventy-five percent of patients still had more than 50% pain reduction at 6 months, which declined to 60% at 1 year, and 43% of the 132 patients evaluated at 2 years. Only 6 of 45 patients evaluated (13%) at 5 years still used the stimulator due to decreased effectiveness of the unit. This group implanted unipolar leads in 92 patients (52.9%), multipolar Pisces Quadripolar (Medtronic) leads in 166 (45.7%) and Resume" (Medtronic) plaque type leads in 5 (1.4%) patients. The gradual decline in results may have been related to the large number of leads placed percutaneously. There was no analysis of outcome based on electrode type. However, the most frequently reported complication occurring in this group of patients was lead displacement. In 4 out of 5 patients who underwent cervical implantation, the migration recurred and a Resume lead was then implanted.

The importance of electrode positioning in relation to the spinal cord during SCS was illustrated by Holshheimer et al [8] using a computer model. This group evaluated the effects of the antero-posterior and medio-lateral positions of the spinal cord in the dural sac on the perception threshold and paresthesia coverage in SCS. The distributions of the dorsal CSF layer thickness, measured from transverse MR scans of normal subjects at various spinal levels were used to calculate the distributions of threshold voltages for the stimulation of spinal nerve fibers by a computer model. Calculated theoretical threshold distributions were then shown to fit well to the corresponding distributions of perception threshold measured in patients with a Resume electrode. They concluded that the thickness of the dorsal CSF layer is the main factor determining the perception threshold and paresthesia coverage in SCS: an increasing CSF layer thickness raises the threshold and reduces the coverage, and vice versa [8]. It was also concluded that a lateral asymmetry of less than 1 mm results in a significant reduction of perception threshold and may result in unilateral paresthesia [8]. This may translate into decreased pain relief in patients with bilateral symptoms, or those with a significant component of their pain located in the low back region. In an MRI study by this same group [9] assessing the normal position of the spinal cord in the spinal canal, it was shown that in about 40% of subjects the spinal cord midline and the vertebral midline were 1-2 mm apart at all levels investigated. These results and it’s calculated effect on paresthesia distribution is in accordance with Barolat et al [1] who reported that the percentage of paresthesia felt symmetrically when the stimulating contacts were perfectly located at the radiological midline was only 27%.

Overall, 25 of 30 patients (83%) in this series had greater than 50% pain reduction including those concurrently using narcotics, and 20 of 30 patients (67%) without the use of narcotics (Table 5). Similar outcomes were obtained by measuring a pre- and postoperative standard VAS (Table 4). These results are impressive given the patient population, which had failed to improve with medical management and after an average of 2.3 prior surgical treatments. Alternative treatments had in most cases been exhausted. Our outcome was as good or better than most other carefully reported series of patients with chronic, benign, pain treated with SCS. This may be related to patient selection. The majority of patients in our study suffered from failed back surgery syndrome. This is the most common indication for SCS implantation in the United States [25]. Disinterested third-party long-term follow-up has demonstrated that spinal cord stimulation has an impressive rate of success in this subgroup of patients with chronic, intractable pain when compared to outcomes following most other neurological procedures [24, 31]. Northing et al [31] recently reported preliminary results of a prospective, randomized comparison of SCS and reoperation in patients with failed back surgery syndrome. Results for the first 27 patients reaching the 6-month crossover point demonstrated a statistically significant (p = 0.018) advantage for SCS over reoperation.

The distribution of symptoms and not just the etiology has been shown to be an important determinant of pain relief [Burt 77, Krain 89, Kumar 91, Law 87, Nash 72, North Ewend 91, North Fowl 92, Urban 78, Sweek 73]. Based on this, patients in whom low back pain was the sole complaint were not treated with SCS. Achieving overlap of the low back pain and stimulation paresthesias has been shown to be more technically difficult in these patients [North Kidd 95], in contrast to patients with primarily leg pain [Kumar 91, Meilm 89, Ray 82, Sweek 74]. North et al. [31] emphasizes the clinical importance of achieving close correspondence of stimulation paresthesias with the topography of each patient’s pain. This group has shown that there is a statistically significant direct relationship between the overlap of stimulation-induced paresthesias and pain relief from SCS [31]. Electrode position has been shown to be critical to achieving satisfactory overlap of pain by stimulation paresthesias [Law 82]. Another potential reason for our good results may be related to the fact that all of the patients in this study had modern electrode and generator systems implanted. The superiority of programmable multichannel devices over the earlier monopolar systems has previously been demonstrated [31].
Our policy of electrode repositioning may contribute to our improved outcome. The 30 patients who underwent permanent electrode placement had an average of 1.3 revisions per patient during the 31 months mean follow-up period. This revision rate is higher than most other centers performing SCS [references]. We have an aggressive policy of electrode repositioning if the overlap of paresthesias does not match the region of pain, or if pain relief achieved in the initial postoperative period is not maintained. When SCS that was initially successful fails abruptly, we feel the most likely cause is movement of the electrode. Gradual failure following an initial successful period of SCS can be due to a variety of causes. Fibrosis of the electrode tip [14, 15, 34, 37] may insulate the dorsum of the spinal cord from electrical stimulation. Movement of the electrode is still a possibility. On the other hand, a change in the relationship of the electrode and spinal cord may be the result of either true electrode migration (physical movement of the electrode in the spinal canal), or movement of the spinal cord itself. In both of these cases, we have a standard protocol of repositioning the electrode in the operating room.

It must be pointed out that multiple potential biases in this series. The retrospective nature makes it possible that a significant selection bias occurred between the percutaneous and laminectomy-styled electrode groups of patients. The fact that these patients were not randomized to one group or the other makes it inherently difficult to interpret final outcomes. However, it is unlikely that this would bias favorable results in the direction of the laminectomy-styled leads, given that thinner patients with less morbid medical conditions are more likely to undergo percutaneous lead placement. Another potential bias is the fact that the preoperative VAS was administered by the operating surgeon. This may have the effect of making our overall outcome for all groups of patients look better. However, it is unlikely to have introduced a bias in comparing different outcomes between the laminectomy percutaneous leads.

V. SUMMARY AND CONCLUSIONS

Spinal cord stimulation has been proven as one of the safest and most useful, minimally invasive procedure for the treatment of chronic pain. Recent technical advances in multichannel systems with electrode systems have led to improved clinical results and fewer complications. This study evaluated the long-term clinical outcome of 30 patients who had undergone permanent SCS utilizing modern, multi-channel, percutaneous or laminectomy-styled electrodes. The goal of this study was to evaluate which type of electrode system performed better in the long-term. These data suggest that laminectomy-styled electrodes can be expected to achieve more than 90% good or excellent results and another approximately 8% fair when placed in the thoracic region. Although patients were not prospectively randomized to each of the two treatment arms, laminectomy-styled electrodes appear to be associated with improved long-term effectiveness over those placed percutaneously. Percutaneous leads placed in the thoracic region are associated with more than 60% good or excellent results and another 25% fair. Although performed in a very limited number of patients, SCS in the cervical region appears to be associated with primarily poor results. These data are currently being used as rational to perform a randomized, controlled study.
### Table 1.
**Etiology of Pain in 51 Patients Trialed for SCS**

<table>
<thead>
<tr>
<th>Etiology</th>
<th>Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FBSS</td>
<td>30 (59)</td>
</tr>
<tr>
<td>Causalgia I and II</td>
<td>8 (16)</td>
</tr>
<tr>
<td>Neuropathic</td>
<td>5 (10)</td>
</tr>
<tr>
<td>Stroke</td>
<td>2 (4)</td>
</tr>
<tr>
<td>Other</td>
<td>6 (11)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>51 (100)</strong></td>
</tr>
</tbody>
</table>

### Table 2.
**Four Tier Long-Term Outcome Scale**

- Excellent - pain free or very little remaining pain, off narcotics
- Good - residual pain evident, but significantly improved (> 50%) and off narcotics
- Fair - residual pain evident, but significantly improved (> 50%), using narcotics
- Poor - less than 50% pain relief and using narcotics

### Table 3.
**Biographical Information**

<table>
<thead>
<tr>
<th>Lead Type</th>
<th>Mean Age (range)</th>
<th>FBSS</th>
<th>Causalgia</th>
<th>Neuropathic</th>
<th>Stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laminectomy Thoracic</td>
<td>50 (39-69)</td>
<td>6 (50)</td>
<td>3 (25)</td>
<td>3 (25)</td>
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<tr>
<td>Cervical</td>
<td>40 (34-46)</td>
<td>1 (33)</td>
<td>1 (33)</td>
<td>0 (0)</td>
<td>1 (33)</td>
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<tr>
<td>Total</td>
<td>34 (34-69)</td>
<td>7 (47)</td>
<td>4 (27)</td>
<td>3 (20)</td>
<td>1 (7)</td>
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<tr>
<td>Percutaneous Thoracic</td>
<td>53 (24-74)</td>
<td>9 (60)</td>
<td>2 (13)</td>
<td>1 (7)</td>
<td>1 (7)</td>
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</table>

### Table 4.
**Evaluation of Long-term Outcome Using a Visual Analog Scale (VAS) in Patients Undergoing SCS**

<table>
<thead>
<tr>
<th>Lead Type</th>
<th>Mean Follow-up (months)</th>
<th>Total Patients</th>
<th>Preoperative VAS (range)</th>
<th>Postoperative VAS (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laminectomy TL</td>
<td>8.6</td>
<td>12</td>
<td>8.4 (7-10)</td>
<td>3.8 (3-7)</td>
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<tr>
<td>Cervical</td>
<td>7.5</td>
<td>3</td>
<td>8.3 (7-9)</td>
<td>8.7 (7-10)</td>
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<tr>
<td>Total</td>
<td>8.4</td>
<td>15</td>
<td>8.4 (7-10)</td>
<td>4.8 (3-10)</td>
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<tr>
<td>Percutaneous TL</td>
<td>10.3</td>
<td>15</td>
<td>8.5 (6-10)</td>
<td>5.4 (0-10)</td>
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<td>Cervical</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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</table>

### Table 5.
**Evaluation of Long-term Outcome Using a Modified Outcome Scale in Patients Undergoing SCS**

<table>
<thead>
<tr>
<th>Lead Type</th>
<th>Mean Follow-up (mo.)</th>
<th>Total Patients</th>
<th>Excellent (%)</th>
<th>Good (%)</th>
<th>Fair (%)</th>
<th>Poor (%)</th>
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<tbody>
<tr>
<td>Laminectomy TL</td>
<td>8.6</td>
<td>12</td>
<td>6 (50)</td>
<td>5 (42)</td>
<td>1 (8)</td>
<td>0 (0)</td>
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<tr>
<td>Cervical</td>
<td>7.5</td>
<td>3</td>
<td>0 (0)</td>
<td>1 (33)</td>
<td>0 (0)</td>
<td>2 (66)</td>
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<tr>
<td>Total</td>
<td>8.4</td>
<td>15</td>
<td>6 (40)</td>
<td>6 (40)</td>
<td>1 (7)</td>
<td>2 (13)</td>
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<tr>
<td>Percutaneous TL</td>
<td>10.3</td>
<td>15</td>
<td>4 (27)</td>
<td>4 (27)</td>
<td>4 (27)</td>
<td>3 (20)</td>
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<td>Cervical</td>
<td>N/A</td>
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REFERENCES


