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Research Article

Epidural Anesthesia for Laminectomy Lead Placement in Spinal Cord Stimulation

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Abstract

Background: Spinal cord stimulation (SCS) is used to treat chronic pain and requires an alert patient to locate paresthesia for optimal lead positioning. Epidural anesthesia may be a suitable anesthetic but has not been evaluated in larger cohorts.

METHODS: We performed an open-label, prospective, observational, single-center study in 138 patients to evaluate the safety and efficacy of laminectomy lead placement under epidural anesthesia for neuropathic chronic pain treatment.

Results: There were statistically significant differences between intraoperative and postoperative (at 24 h) stimulation variables needed to produce paresthesias. Thus, the mean deviations of intra- and postoperative stimulation intensity (V) were 4.3 ± 1.5 and 3.2 ± 1.3, respectively ($P < 0.05$) with single-channel stimulation, and 4.6 ± 1.3 and 3.4 ± 1.1 ($P < 0.05$) with dual-channel simulation.

Conclusions: This is the first study of epidural anesthesia for SCS lead implant by laminectomy in a wide patient sample. The technique seems to be safe and effective.

ABBREVIATIONS

SCS: Spinal Cord Stimulation

INTRODUCTION

Thanks to technological progress and pathophysiological advances, techniques enhancing physiological mechanisms that facilitate or inhibit the nervous system have experienced a great surge in popularity during the last 40 years. As a result, nowadays spinal cord stimulation (SCS) is a common and effective procedure to treat chronic pain [1-3]. Depending on the type of lead, access to the spinal canal can be performed percutaneously or by surgical laminectomy [4-7]. Percutaneous cylindrical electrodes that only require neuraxial anesthesia and sedation, and therefore allow placement in the alert patient, are now in widespread use. Nonetheless, some authors feel that laminectomy access has several advantages, such as a wider surgical area with more testing and positioning possibilities, easy and accurate final lead anchoring, and minimization of traumatic dural and neural injuries [8,9]).

Our group proposes neuraxial epidural block as a suitable anesthetic technique for SCS lead placement with laminectomy.

MATERIALS AND METHODS

After obtaining the approval of the Research Ethics Board in our center and informed consent from the patients, we consecutively enrolled 138 patients with ASA physical status II-III and neuropathic pain syndrome in our study.

Patient selection and inclusion criteria

All patients had previous diagnosis of failed back surgery syndrome, a non-specific term encompassing persistent or recurrent chronic pain after lumbosacral spinal surgery, with radicular pain as the chief complaint.

We established two inclusion criteria. The first was radicular pain, as opposed to axial low back pain, as a primary symptom; eligible patients described their midline or axial low back pain as being less than, or equal to, their radiating hip, buttock, or lower extremity pain. The second criterion was an objective basis for pain beyond prior low back surgery, requiring one or more of the following: 1) recent abnormal diagnostic imaging results (e.g., myelogram demonstrating lumbar arachnoid fibrosis), 2) a neurological deficit consistent with the patient's pain and history,

and/or 3) a well-documented history of surgery for appropriate indications.

For patients to pass the trial we applied the generally accepted criteria of least 50% pain reduction (using standard self-reporting methods) along with stable or reduced analgesic use and changes in physical activity reflective of this relieved pain during the trial period. Patients who passed this trial received a permanent implant at exactly the same level, with half of the patients randomly assigned to receive a percutaneous electrode and the other half an insulated electrode implanted by laminectomy.

Exclusion criteria were patients who had taken acetylsalicylic acid within 6 days prior to surgery, a platelet count <150 x 109 / L, an international normalized ratio > 1.1, active neurological disease, cutaneous changes at the epidural puncture site and major psychiatric illness or abnormal illness.

Anesthetic technique

Patients were monitored during anesthesia and in the post anesthesia care unit following ASA standards and guidelines. Anesthesia was induced by inserting epidural catheters at the Th10-Th11, Th11-Th12 and Th12-L1 interspaces, using a midline and loss-of-resistance technique. We injected 8-10 ml of 0.375% ropivacaine, reaching the analgesic level for surgery by injecting a further 4-6 ml of the same anesthetic if required. The catheter was removed after an appropriate sensory level of blockade was obtained and before performing laminectomy.

Lead implant procedure

Minimum laminotomy was performed in Th9-Th10 or Th10-Th11, inserting an octapolar lead (mod. 3998 Specify, Medtronic Inc., Minneapolis, MN) in the epidural space in a total of 38 patients, and a flat lead of 16 poles (mod. 39565 Specify 5-6-5, Medtronic Inc., Minneapolis, MN) in the other 81 cases. The electrodes were advanced one or two vertebral levels cephalad under fluoroscopic control. Lead position was either midline or slightly lateral, as verified by radiographic and clinical intraoperative patient testing. Intraoperative testing was performed with a dual-channel paresthesia analyzer (DualScreen, model 3628, Medtronic Inc., Minneapolis, MN), each channel comprising 4 of the 8 electrodes.

The final position of the SCS lead was the vertebral level that provided the patient with pain coverage (state back pain if the pain is axial, do not state back pain if the pain is radicular in location) at the lowest amplitude. The electrodes were connected to electrical or rechargeable pulse generators from the same manufacturer.

To define patient comfort level during the surgical procedure, we used the visual analog scale pain score (VAS; 0 = no pain, 10 = worst pain ever) and the Richmond anxiety-sedation scale [10] [agitated (+2 to +4), restless (+1), alert and calm (0) and sedation (-1 to -5)]. Patients were instructed in use of VAS before the operation.

Statistical methods

All variables were controlled for normal distribution using the Kolmogorov-Smirnov test. Normally distributed variables were expressed as mean values and standard deviation. Student's t–test (SPSSR v. 13, Chicago, IL) was used to compare variables.

RESULTS AND DISCUSSION

This study was conducted in a total of 138 patients, recruited from June 1, 2010 to January 1, 2020. Patients underwent psychological screening before lead implantation. After excluding 19 cases in which either epidural puncture could not be performed or the anesthetic block was not satisfactory, the final sample size was 119 patients (Table 1). Technical failure was defined as two failed attempts by expert anesthesiologists or inability to advance the epidural catheter one or two vertebral levels. General anesthesia was used in patients when the epidural could not be placed.

The different variables of epidural puncture are shown in Table 2. Our results (all VAS pain scores <2) indicate that all patients reported a good level of comfort during the surgical procedure. No patients described the procedure as painful or unpleasant. Almost all patients reported feeling either calm or slightly restless; 94 had scores of 0 on the Richmond scale, 20 had scores of +1, while only 5 felt agitated with scores of +3. These latter cases requiring anxiolytics or stronger sedatives to complete the procedure.

The mean (SD) total intraoperative time was 123.5 (20) min. We found statistically significant differences between intraoperative and postoperative (at 24 h) stimulation variables needed to produce paresthesias. Thus, the mean deviations of intra- and postoperative stimulation intensity (V) were 4.3 ± 1.5 and 3.2 ± 1.3, respectively (P <0.05) with single-channel stimulation, and 4.6 ± 1.3 and 3.4 ± 1.1 (P <0.05) with dual-channel simulation.

Discussion

During the last decade SCS has been shown to be an effective treatment technique for patients with chronic neuropathic pain resistant to alternative treatments [11-14].

Our study demonstrates that epidural anesthesia is a suitable

Table 1: General patient characteristics.

Number (n)	119
Age (yrs.)	47.3 (9.5)
Sex (male/female)	52/67
ASA-PS	
II	94 (79%)
III	25 (21%)
Duration of symptoms (yrs.)	6.6 (3.2)
No. of previous surgeries	2.7 (1.3)
Level of previous surgeries	
L5-S1	46 (39%)
L4-L5	38 (32%)
L3-L4	25 (21%)
L2-L3	10 (8%)

Values are shown as number of patients (%) or mean (SD)
ASA-PS: American Society of Anesthesiologists physical status.

Table 2: Characteristics of the Anesthetic Procedure.	
Technical difficulty (based on number of attempts)	
Low (1-2 attempts)	39 (33%)
Moderate (3-4 attempts)	60 (50%)
High (>4 attempts)	20 (17%)
Puncture level	
Th10-Th11	25 (21%)
Th11-Th12	20 (17%)
Th12-L1	74 (62%)
Distance (cm)	5.5 (0.99)
Ropivacaine dose (mg)	46.6 (10.1)
Paresthesias	39 (33%)
Anesthesia complications	39 (33%)
Hypotension	30 (25%)
Nausea/vomiting	5 (4%)
Bradycardia	15 (13%)
Neurological complications	0
Breathing depression	0
Sensory levels of blockade	
Th5	20 (17%)
Th6	74 (62%)
Th7	25 (21%)
Quality of analgesia	
No pain (VAS: 0)	94 (79%)
Low pain (VAS: 1-3)	25 (21%)
Moderate pain (VAS: 4-7)	0
Severe pain (VAS: 8-10)	0
Degree of agitation (Richmond score)	
Agitated (+4 to +2)	5 (4%)
Restless (+1)	20 (17%)
Calm and alert (0)	94 (79%)
Sedation (- 1 to -5)	0
Stimulation variables	
Intraoperative channel 1 amplitude (V)	4.3 (1.5)*
Postoperative channel 1 amplitude (V)	3.2 (1.3)*
Intraoperative channel 2 amplitude (V)	4.6 (1.3)*
Postoperative channel 2 amplitude (V)	3.4 (1.1)*
Values are shown as number of patients (%) or mean (SD) * Statistically significant ($p < 0.05$) between the intraoperative and postoperative values. VAS: visual analogue scale.	

technique for SCS lead implant. Satisfactory analgesic levels were obtained by epidural block in the majority of patients, requiring additional sedation in only five cases. However, anesthesia by epidural route using conventional loss-of-resistance technique was not possible in 13.7% of our patients. This failure rate is slightly lower than the 32% failure rate in thoracic epidural placements and 27% in the lumbar reported by other authors [15]. The difficulties of administering epidural analgesia in patients with failed back surgery syndrome sometimes requires an alternative plan including moderate sedation. General anesthesia may not be the best alternative in these cases, since intraoperative testing of paresthesia is needed for correct lead placement, although use of fluoroscopy guidance for epidural anesthesia can enhance results.

Previously described surgical placement of leads for SCS have used local or spinal anesthesia. A larger study [16] lacked information on patient discomfort when laminectomies are performed under local anesthesia alone. Lind et al. [1] were the first to introduce flat electrodes with spinal anesthesia. In our study we chose epidural over subarachnoid anesthesia due to better hemodynamic stability, absence of meningeal puncture and the continuous anesthesia provided through the epidural catheter.

Several factors can account for the patient's ability to feel electrical paresthesia in the painful area during SCS lead placement under neuraxial anesthesia. First, the epidural local anesthetic acts on nerve roots, inhibiting nociceptive sensation mainly in the affected dermatome, while the large diameters of L5 and S1 nerve roots make them difficult to completely block with epidural anesthesia. Likewise, the spinal cord is not completely blocked by the local anesthetic, and the patient feels paresthesia under SCS stimulation [18-20]. Studies have shown that the transmission of impulses in the spinal cords persists after epidural anesthesia, despite total numbness in the area during sensory examination [21].

The increased use of SCS is supported by studies that have attempted to identify and refine guidelines and mechanisms of action [16,22,23]. The use of laminectomy leads, despite being a more invasive technique than the percutaneous approach, achieves better long-term results in terms of pain relief, return to work, and improvement in the patient's daily living activities [24]. Although the initial cost of the technique is high, medium and long-term benefits were noted in health care utilization [14,25,26]. Complications of SCS laminectomy lead placement are minimal, easily treatable, and rarely cause spinal cord injuries.

Conclusion

In conclusion, ours is the first study of epidural anesthesia used for SCS lead implantation under laminectomy in a wide range of patients. With this technique the patient is alert, receives effective anesthesia during surgery, and is able to identify paresthesia, resulting in optimal placement of the SCS leads.

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