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Clinical Study

Selective intradural dorsal rhizotomy for persistent radicular leg pain: a contemporary series

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Abstract

BACKGROUND: Lumbar disc surgery for radicular leg pain is one of the most frequently performed spine procedures. In approximately 20% of patients poor outcome is achieved. The most complex cases have persistent leg pain without residual nerve root compression. Treatment for refractory cases is limited to medical pain management, spinal cord stimulation (SCS), and dorsal root ganglion stimulation. For the latter two, fair to good results are obtained in only 50% of patients and costs and complication rates are high. An alternative surgical procedure is selective intradural dorsal rhizotomy (SIDR). This procedure has been largely abandoned, likely due to poor historic results and readily available modern alternatives.

PURPOSE: The goal of this paper is to report our results for SIDR for persistent monoradicular leg pain without residual nerve root compression and to compare the results with those of SCS.

STUDY DESIGN: Prospectively followed case series.

PATIENT SAMPLE: Consecutive patients with persistent monoradicular leg pain without residual nerve root compression.

OUTCOME MEASURES: Visual Analogue Scale (VAS) for leg pain, Roland Disability Questionnaire, and Likert Scale for leg pain were recorded. Complications were documented and patients were asked if, in retrospect, they would undergo the procedure again.

METHODS: In Haaglanden Medical Center, SIDR was performed on eight consecutive patients with persistent monoradicular leg pain without residual nerve root compression between December 2013 and September 2017. Patients were followed prospectively and VAS for leg pain, Roland Disability Questionnaire (RDQ), and Likert Scale for leg pain were recorded at intake, 8 weeks and 1 year after surgery and yearly after that. Minimal clinically important differences (MCID) for VAS and RDQ were predefined. Means and ranges were calculated and due to the small sample size further analysis was limited to descriptive analysis.

RESULTS: Mean follow-up was 20 months. VAS for leg pain improved from 80 mm at intake to 34 mm at latest follow-up. Five out of eight patients (63%) had good Likert Scale outcome (complete or near complete recovery of leg pain). Patients scored 19, 5 on the RDQ at intake and 12, 7 at the end of follow-up. Four patients (57%) reached a MCID for VAS at 1 year post surgery and one reached borderline MCID. Five patients (71%) reached a MCID for RDQ at 1 year post surgery. Six patients (75%) would undergo the procedure again.

CONCLUSIONS: SIDR is a safe and effective procedure in strictly selected patients with persistent monoradicular leg pain without residual nerve root compression. Considering the high costs and complication rates of SCS, the results of this study warrant a randomized controlled trial comparing the cost-effectiveness of SIDR and SCS.

Keywords: Clinical; Intradural; Functional outcome; Neurosurgery; Prospective; Refractory radicular pain; Rhizotomy.

FDA device/drug status: Not applicable.

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Introduction

Lumbar disc surgery for radicular leg pain is one of the most frequently performed procedures in spine surgery. Although good results for lumbar disc surgery are generally achieved in about 80% of patients, not all patients benefit from the procedure [16]. A minority suffers from persistent pain and limited functional recovery, which can severely impact quality of life. Ongoing need for healthcare and delayed return to work lead to significant economic burden [24]. Explanations for persistent pain, despite adequate surgical decompression of the nerve root, vary from chemical inflammation of the nerve root due to inflammatory mediators from a ruptured intervertebral disc or annulus fibrosus to postoperative arachnoiditis and epidural fibrosis [2,10,15]. Furthermore, lumbar disc surgery is associated with a less favourable outcome when pain and radicular symptoms last preoperatively for 12 months or longer [17].

Redo lumbar surgery for pain, with or without spinal fusion, is restricted to clear signs of residual or recurrent compression or segmental instability on imaging. However, the most complex and challenging cases are those patients without nerve root compression, but nevertheless suffering from intractable radicular pain. Treatment options for these patients are limited to medical pain management strategies, spinal cord stimulation (SCS), and dorsal root ganglion stimulation in select cases. For the latter options fair to good results can only be obtained in approximately 50% of patients and costs are high, as are long-term complication rates. In particular, dislocation and infection requiring removal of the system occur in up to 30% of patients [3,7,12]. An alternative surgical treatment for persistent radicular leg pain is selective intradural dorsal rhizotomy (SIDR). This procedure was first performed by Sir Victor Horsley in 1888 and was based upon the theory that the dorsal radicular nerve root only contains afferent sensory nerve fibers [9]. Lesioning the dorsal root should thus lead to pain relief at the cost of sensory loss, but with preservation of the motor function of the lesioned root. Only several retrospective case series for the indication of persistent radicular pain have been published long ago, mainly describing an extradural procedure [23,25]. Published results of rhizotomy for radicular pain were generally fair and possibly the rise of new pain management and stimulation strategies have led to obsolescence of the technique. Nowadays, this ablative procedure is selectively performed for spasticity in children.

In Haaglanden Medical Center, SIDR for persistent intractable leg pain has a long history with good results for selected cases, but results were not published previously. The goal of the present study was to prospectively analyze and report the long-term outcome of SIDR of a contemporary series of patients with intractable radicular pain, chosen according to the strict criteria we employ to select patients. Results are discussed in light of current diagnostic and therapeutic options for this difficult patient group.

Methods

Between December 2013 and September 2017, patients meeting the following criteria were operated in Haaglanden Medical Center: intractable unilateral monoradicular leg pain for 12 months or longer, VAS for leg pain >5, and leg pain worse than back pain, previous surgery for radicular pain, no radiographically identifiable (remaining) cause for pain (eg, foraminal stenosis), positive analgesic selective nerve root block, 18 years of age, or older. Patients completed questionnaires before surgery, 8 weeks after surgery and 1 year after surgery. Subsequently, questionnaires were sent to patients by mail yearly in order to document long term outcome as part of routine follow-up. The design of this study was outlined in a protocol before inclusion started. Hence this study can be considered a prospectively followed case series. Patients provided written informed consent for analysis and publication of the anonymized results. At the time this study was conducted, ethical review board approval was not required for this type of research at our institution.

Surgical procedure

All patients were operated by the third or fourth author. Both these neurosurgeons are experienced spine surgeons, who perform standard and highly complex (fusion) surgery. Rhizotomy was performed under general anesthesia with patients positioned in prone position on a Wilson frame. The proper lumbar level was intraoperatively identified by lateral X-ray. After midline lumbar incision, the paravertebral muscles were retracted laterally. Fibrous scar tissue was removed if necessary and the upper lamina was further reduced in order to identify the nerve root proximal from the neuroforamen. The dura was opened in the midline and fixed using tack-up sutures. Using the microscope, the nerve root exiting the neuroforamen on the affected side and level was identified. The sensory fibers were carefully dissected away from the motor fibers. Neurostimulation (stimulus set to 1 milliampère) was used to identify the non-responding sensory root, which was then coagulated and transsected. Five millimeters of the nerve were removed to prevent axonal sprouting (see Image 1). After hemostasis, the dura was closed with Prolene and covered with Tachosil. The wound was closed in layers without a drain. Patients were mobilized without restrictions 24 hours after surgery.

Outcome measures

Outcome assessment consisted of a Visual Analogue Scale (VAS; range 0−100 mm, 0 mm representing no pain, 100 mm representing worst pain ever experienced) to record leg pain. The Roland Disability Questionnaire

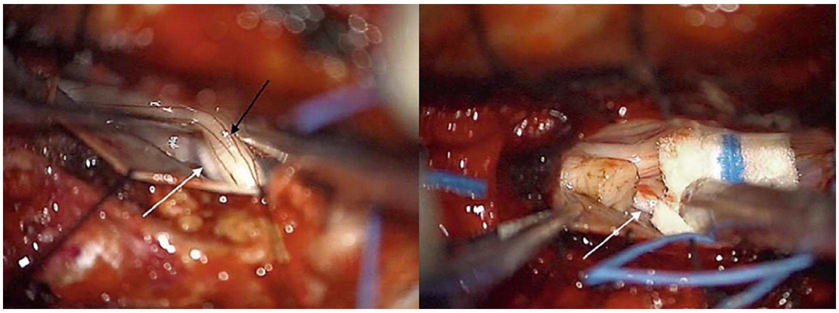

Image 1. *Intraoperative microscope images of procedure.*

Spinal nerve roots running horizontally from cranial (left of image) to caudal (right of image). Dura tacked up using sutures.

Left: the correct dorsal (sensory) root is identified (black arrow) using X-ray to identify the proper operative level, anatomical landmarks, and a neurostimulator. The sensory root is mobilized away from the motor root (white arrow).

Right: after identification of the proper dorsal root and safely mobilizing it away from its motor counterpart (white arrow), a surgical patty is put between the sensory and motor fibers and the sensory root is coagulated and transsected, removing 5 mm of its total length.

(RDQ; range 0−23) was used to document functional outcome. Higher scores reflect worse functional impairment. In addition, the patient's self-reported recovery was documented using the Likert Scale (LS), ranging from 1 (complete recovery of leg pain) to 7 (leg pain worse than ever). The minimal clinically important difference at 1 year post surgery was predefined at 20 mm for VAS and 3 points for the RDQ. Good outcome on the Likert Scale was defined as "complete recovery of leg pain" or "near complete recovery of leg pain" (Likert 1 or 2, respectively) [6,13,14].

During scheduled follow-up visits, we documented a sensory descriptor of the dermatome corresponding with the operated nerve root, consisting of "normal sensation," "hypesthesia," "anesthesia," "dysesthesia," or "hyperesthesia." Since sensory changes are inherent to the objective of the procedure, changes within these descriptors are not defined as complication. We documented postoperative changes in use of pain medication and any complications or side effects of the procedure (eg, wound infection, paresis, worsening of pre-existent paresis). Patients were asked whether they would be willing, in retrospect, to undergo the same procedure again.

Analysis

Questionnaires were filled in by patients in the absence of the treating physician and researchers. The results were analyzed in a nonblinded fashion. Means and ranges were calculated for baseline and outcome parameters. The small sample size confined further analysis to description of patient characteristics and outcome measures.

Results

Patients

Between December 2013 and September 2017, eight consecutive patients were operated (Table 1). Three of them were male (38%) and the average age at time of surgery was 57 years (range 40−77). The duration of preoperative leg pain ranged from 20 to 201 months (average 75, 8 months). Patients had undergone 2−5 previous surgical procedures, or in one case multiple successful selective analgesic nerve root blocks, for the same radicular pain. The most frequently affected nerve root was L5 (n=6), followed by L4 and S1 (n=1 for both). Follow-up ranged from 2 to 36 months (average 19, 8 months).

Table 1
Baseline patient characteristics

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6	Patient 7	Patient 8
Age	62	54	72	77	60	50	40	45
Sex	F	F	M	F	M	M	F	F
Duration of complaints (m)	138	20	53	29	69	67	201	29
Previous surgery (n)	2	2	2	0	4	4	5	2
Root affected	L5−R	L5−L	L4−R	L5−R	L5−L	L5−L	L5−L	S1−R
Duration of follow-up (m)	36	36	24	24	12	12	2	12

Sex: M = male, F = female.
Root affected: L, lumbar; S, sacral; L = left, R, right.

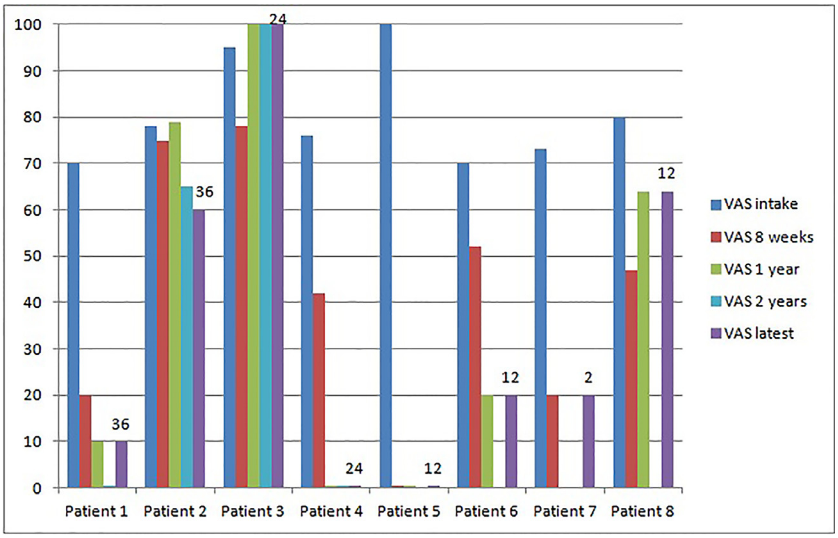

Fig. 1. *VAS for leg pain.*
VAS score for leg pain in millimeters (range 0–100) on y-axis.
Above purple column number of months after baseline measurement.
VAS, Visual Analogue Scale.

During the follow-up period, none of the patients underwent another procedure for the same root the SIDR was performed for.

VAS, RDQ, and LS

The mean VAS score at intake was 80 mm (range 70–100 mm; Fig. 1, Table 2), which improved to a mean of 42 mm (range 0–78 mm) after 8 weeks and 39 mm (range 0–100mm) after 1 year. The average most recently recorded VAS score was 34 mm (range 0–100 mm).

In one patient (12, 5%) pain had worsened postoperatively (patient 3, 5 mm increase on VAS). A clinically important difference in VAS leg pain score at 1 year post surgery (decrease of 20 mm or more) was seen in 4 patients (patients 1, 4, 5, and 6; 57%). Borderline clinically important differences were reached in 1 patient at 1 year (patient 8) and in another at 3 years (patient 2).

The mean score on the RDQ at intake was 19, 5 (range 15–23; Fig. 2, Table 2). At 8 weeks after surgery, the mean RDQ score was 13, 1 (range 0–21) and in only one patient the score (and thus complaints) increased (patient 3, 1 point increase). One year after surgery, the mean RDQ score was 11, 9 (range 0–22). The most recent RDQ score was on average recorded 19, 8 months (range 2–36) after surgery and the mean was 12, 7 (range 0–22). In one patient (patient 3) there was a persistent postoperative increase in RDQ score (patient 3, 2 point increase).

A clinically important difference in RDQ score at 1 year post surgery (decrease of 3 points or more) was seen in 5 patients (patients 1, 4, 5, 6, and 8; 71%). RDQ score worsened in a clinically important amount (increase of 3 points or more) after 1 year in 1 patient (patient 1; also reflected by an increase in mean RDQ score at 2 and 3 years compared with at 1 year), despite the fact that VAS score remained the same at 10 mm.

Eight weeks after surgery, one patient (12, 5%) completely recovered from leg pain (patient 5; Fig. 3). In four patients (patients 1, 6, 7, and 8; 50%) leg pain recovered nearly completely. In 2 patients (patient 3 and 4; 25%) there was some recovery of leg pain. In one patient (patient 2; 12, 5%) pain was unchanged 8 weeks postoperatively.

After 1 year, three patients (43%) had completely recovered from their leg pain (patients 1, 4, and 5). Leg pain of two patients remained the same compared with the pain scored at 8 weeks (patients 2 and 6; 29%). Two patients' (29%) leg pain increased, as reflected by an increase on the

Table 2
Mean VAS and RDQ score

Time point (m)	N	Mean VAS *(std dev)*		Mean RDQ *(std dev)*	
0	8	80,3	(11,3)	19,5	(2,9)
2	8	41,8	(27,4)	13,1	(6,6)
12	7	39	(41,2)	11,9	(8,6)
24	4	41,3	(49,7)	13,3	(9,6)
36	2	35	(35,4)	16,5	(3,5)

N, number of patients; RDQ, Roland Disability Questionnaire; std dev, standard deviation; VAS, Visual Analogue Scale.

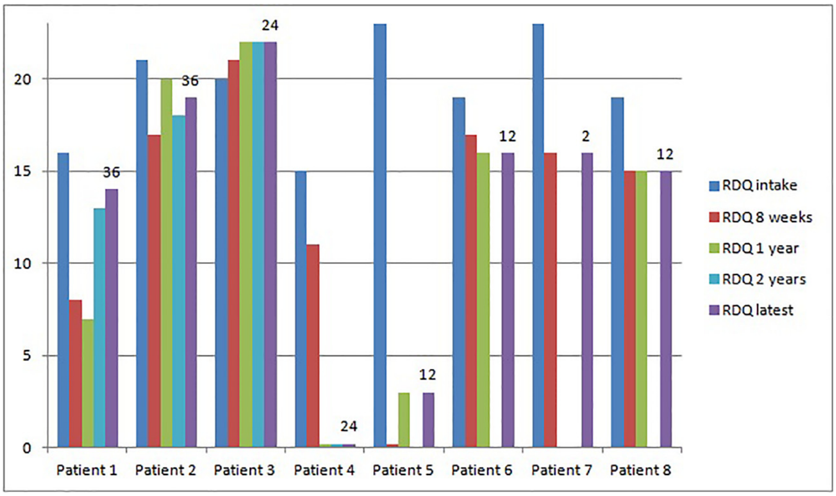

Fig. 2. *Roland Disability Questionnaire.*
RDQ score (range 0−23) on y-axis.
Above purple column number of months after baseline measurement.
RDQ, Roland Disability Questionnaire.

Likert scale from 3 (some recovery of leg pain) to 7 (leg pain worse than ever; patient 3) and from 2 (near complete recovery of leg pain) to 3 (some recovery of leg pain; patient 8). The most recent measurement took place on average 19, 8 months after surgery. One patient was lost to follow-up (patient 7), so no second LS measurement is available for them. LS scores at the most recent follow-up moment did not differ from 1 year scores. Five out of eight patients (63%) had good outcome on the LS (defined as "complete recovery of leg pain" or "near complete recovery of leg pain").

Six out of eight patients (75%) answered "yes" to the hypothetical question if they would undergo SIDRR for their leg pain if they would have known the postoperative result beforehand. Two patients (patients 2 and 3; 25%) stated that they would choose not to undergo SIDR again.

Postoperative changes in use of pain medication

One patient (patient 1; 12, 5%) completely stopped using pain medication after SIDR. Five patients (patients 2, 5, 6, 7, and 8; 63%) have reduced use postoperatively. In one

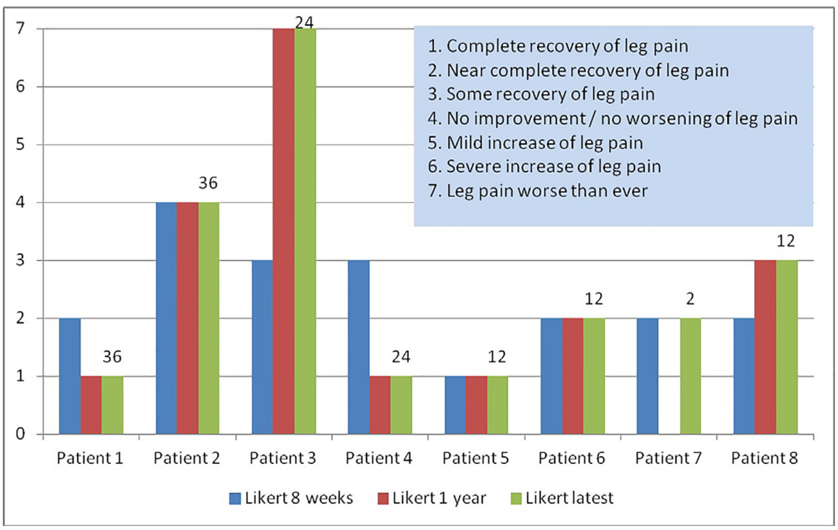

Fig. 3. *Likert Scale after selective dorsal rhizotomy.*
Above purple column number of months after baseline measurement.

patient (patient 3; 12, 5%) the use of pain medication increased after surgery. Patient 4 did not report their pain killer use postoperatively.

Postoperative sensory changes

Five patients (patients 1, 2, 3, 6, and 7; 63%) experienced unchanged hypesthesia in the dermatome associated with the operated nerve root. One patient (patient 4; 12, 5%) had no sensory deficits preoperatively and experienced hypesthesia postoperatively. Another patient (patient 5; 12, 5%) went from experiencing dysesthesia preoperatively to experiencing hypesthesia postoperatively in the entire lower leg, causing difficulty walking. Last, one patient (patient 8; 12, 5%) experienced hypesthesia preoperatively and anesthesia postoperatively.

Complications

Postoperative superficial wound infection occurred in one patient (patient 6; 12, 5%) and was treated with oral antibiotics. No (increase of pre-existent) paresis occurred.

Discussion

To our knowledge, this is the first prospectively followed case series reporting the medium to long-term results of SIDR in patients with persistent monoradicular leg pain without residual nerve root compression after lumbar surgery. Our results show that leg pain can be markedly reduced and functioning improved in the majority of carefully selected patients, as demonstrated by a clinically important difference in VAS leg pain score at 1 year in 4 patients and by a clinically important difference in RDQ score at 1 year in five patients. In addition, VAS score reached borderline clinically important difference in one patient at 1 year and in another at 3 years postsurgery.

Good outcome on the LS (complete or near complete recovery of leg pain) was achieved in five out of eight patients (63%). These findings raise the question how to appropriately identify the subgroup of patients most likely to benefit from the procedure. To answer this question, subgroup analyses should be performed on a bigger number of patients. Improvement in leg pain is associated with improved functioning (higher RDQ scores) in most patients, but in some patients, pain score improved markedly postoperatively while RDQ score remained similar. RDQ score worsened in a clinically important amount after 1 year in one patient (patient 1; also reflected by increase in mean RDQ score after 1 year), despite the fact that VAS score remained the same at 10 mm. A possible explanation is that the RDQ covers both leg and back pain in most questions, whereas VAS was only recorded for leg pain since surgery was not expected to influence back pain. Patients 1, 6, and 7 might have experienced back pain postoperatively that still negatively impacts their functioning, despite the fact that leg pain was predominant preoperatively. Future studies should consider monitoring VAS for back pain to further investigate this phenomenon.

All patients reported postoperative hypesthesia or anesthesia in the dermatome formerly innervated by the transsected nerve root, but most of these sensory deficits were unchanged when compared with the preoperative condition. Only one superficial postoperative infection was observed and no major complications occurred. Most patients reduced their use of pain medication postoperatively and the majority would, in retrospect, choose to undergo the procedure for their leg pain again.

SIDR is traditionally reserved for a limited number of indications, of which spastic cerebral palsy is the most common [22]. Other indications include pain due to brachial plexus avulsion and pain due to spinal cord or cauda equina injuries [20,21]. In this context, the procedure is often called selective dorsal rhizotomy or selective DREZotomy. In the case of spastic cerebral palsy, the mechanism of action is based on reducing the afferent input to the reflex arc, whereas in the other cases, all concerning refractory pain, the mechanism of action is based on influencing gate control and interrupting changed signals generated by the dorsal root ganglion [8,11,18]. Contemporary published series describing dorsal rhizotomy for persistent radicular leg pain do not exist. However, the present series demonstrates promising results for a difficult patient group and a safe procedure. In our opinion, applying strict criteria for patient selection is crucial in order to obtain good results. Patients should have intractable, unilateral, monoradicular pain without identifiable residual nerve root compression after surgery and pain relief after analgesic selective nerve root block.

Studies demonstrate that 20% of patients with radicular leg pain due to disc herniation do not experience improvement of pain after disc surgery and repeat procedures often result in worse outcome [4,5,16]. The condition of this patient group is often categorized as failed back surgery syndrome, which is defined as persistent chronic low back and/or leg pain for more than one year despite one or more spinal surgical procedures [1,5]. As the definition implies, this is a very heterogeneous group of patients. With respect to failed back surgery syndrome the results described in this paper should be interpreted with caution. We believe strict patient selection to be the vital factor for the success of SIDR for refractory leg pain after lumbar disc surgery. This includes ruling out back pain in predominant over leg pain and adhering to the criteria listed earlier. Possibly, the potential for SIDR could be extended, since we operated with good results one patient who did not meet the selection criteria. This patient had no prior surgical history, but did have debilitating monoradicular leg pain without nerve root compression on imaging and multiple successful selective analgesic nerve root blocks. Carefully managing expectations, we agreed to perform SIDR on this patient. More patients with similar complaints, no prior surgery and no nerve root compression but with successful nerve root block should be examined before drawing conclusions for this patient group.

Strengths of our study are the strict indications for SIDR and the use of validated, frequently used outcome parameters. It can be considered a prospectively followed case series since the protocol was designed prior to patient inclusion. Furthermore, we performed SIDR in an era with availability of modern, high quality imaging and advanced surgical fusion techniques, resulting in better patient selection. Also, in contrast to earlier days, SIDR was performed on our patients through the use of modern, minimally invasive surgery, typically reducing the procedure from a five level laminoplasty to a single level laminotomy. Limitations of this study include other aspects of the design. Sample size and follow-up are limited and it is a case series, hence no randomization was performed and no control group was selected for comparison. In addition, no quantitative information on the use of pre and postoperative use of pain medication was collected. Hence no definitive conclusions about their influence on postoperative perception of pain and recovery could be drawn.

Despite these limitations, the results are encouraging. Moreover, comparing our results with those of SCS, SIDR seems to be considerably more cost-effective than expensive SCS, which apart from being expensive tends to cause more complications and reoperations. For example, the review published by Shamji et al. reports complication rates for SCS ranging from 3% to 81%, with half of the included studies reporting rates of 30% or (significantly) higher [19]. These complications include lead migration or misplacement, pulse generator failure, migration, loss of therapeutic efficiency, pain at place of implantation, and wound infection. It should be noted however, that a spinal cord stimulator can be removed, whereas SIDR cannot be undone. In certain subgroups of patients qualifying for SIDR, including smokers, patients with severe comorbidity, and palliative patients, SIDR might be a more obvious choice than the expensive and frequently complicated placement of a spinal cord stimulator.

In conclusion, we feel that, considering our promising results, SIDR has its place in a patient group with persisting radicular leg pain without remaining nerve root compression after lumbar surgery. In the light of the increasing number of surgical lumbar procedures being performed and thus the increasing number of patients with persistent pain after surgery, with a paired increase in health care costs, the results of this study warrant a randomized controlled trial, in which cost-effectiveness of SIDR and SCS are compared.

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