Pain Physician 2020; 23: E629-E636 • ISSN 2150-1149

Retrospective Chart Review

Endoscopic Surgical Resection of the Retropulsed S1 Vertebral Endplate in L5-S1 Spondylolisthesis: Case Series

Albert E. Telfeian, MD, PhD, Sohail Syed, MD, Adetokunbo Oyelese, MD, PhD, Jared Fridley, MD, and Ziya L. Gokaslan, MD

From: The Warren Alpert Medical School of Brown University, Providence, RI

Address Correspondence:
Albert Telfeian, MD
Department of Neurosurgery
Rhode Island Hospital
593 Eddy Street
Providence, RI 02903
E-mail: ATelfeian@Lifespan.org

Disclaimer: There was no external funding in the preparation of this manuscript.

Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript.

Manuscript received: 10-07-2019
Revised manuscript received: 01-30-2020
Accepted for publication: 05-08-2020

Free full manuscript: www.painphysicianjournal.com

Background: A severe grade I and grade II spondylolisthesis at L5-S1 creates an anatomic distortion that can compress the traversing S1 nerve with a retropulsed S1 vertebral body endplate and (sometimes) herniated disc.

Objectives: To evaluate the feasibility for awake, endoscopic treatment of symptomatic radiculopathy secondary to the deformity that results from the retropulsed superior endplate of S1 in grade I/II L5-S1 spondylolisthesis in patients with and without previous fusion surgery.

Study Design: Retrospective chart review.

Setting: This study took place in a single-center, academic hospital.

Methods: In 325 patients over 4 years there were 19 patients (8 with previous L5-S1 fusions and 11 without) treated with transforaminal endoscopic spine surgery for decompression of the neural foramen at L5-S1 in the setting of spondylolisthesis (at least 5 mm) and a retropulsed superior vertebral endplate of S1.

Results: The average preoperative Visual Analog Scale (VAS) back and leg scores were 6.1 and 6.7, and the average preoperative Oswestry Disability Index (ODI) score was 50.4. The average 1-year VAS back and leg scores were 2.2 and 2.2, and the average 1-year postoperative ODI score was 20.5. There was no statistically significant difference between the fusion and nonfusion groups. Patients treated were patients who presented with an S1 or L5 and S1 radiculopathy as their primary complaint and a L5-S1 spondylolisthesis of 5 mm or greater. Patients treated had no instability on flexion-extension x-rays. Eleven patients had not had fusions at L5-S1, and 8 patients had previous fusions at L5-S1 but still had a spondylolisthesis of at least 5 mm. The average slip for nonfusion patients was 8.4 mm, and the average slip for fusion patients was 8.8 mm. At 1-year follow-up the improvement in VAS back scores was 44% in the nonfusion group and 49% in the fusion group, and the improvement in VAS leg scores was 84% in the nonfusion group and 58% in the fusion group. At 1-year follow-up the improvement in ODI scores was 63% in the nonfusion group and 54% in the fusion group.

Limitations: Retrospective case series.

Conclusions: Awake, endoscopic surgery for the treatment of radiculopathy in the setting of a grade I/II L5-S1 spondylolisthesis is a viable minimally invasive treatment option for patients with radiculopathy in the setting of a stable L5-S1 spondylolisthesis with foraminal narrowing caused by a retropulsed superior endplate of the S1 vertebral body.

Key words: Endoscopic spine surgery, minimally invasive spine, transforaminal, spondylolisthesis

Pain Physician 2020: 23:E629-E636

Spondylolisthesis, particularly of the degenerative variety, is a common cause of operative pathology. Some series identify that as many as 18% of patients with isolated low back pain may have coexisting spondylolisthesis (1). Surgical intervention is believed to be favored when nonoperative measures

are exhausted, or when there is concern for significant instability, with strong evidence supporting the efficacy of surgical intervention (2). Surgically managed patients report improvement in both pain and functional disability (3,4). The predominant surgical intervention is a posterior decompression and stabilization over simple decompression (2,5).

Although fusion has become the predominant intervention, we believe that endoscopic neuroforaminal decompression may provide a viable technique for the management of 2 specific cases of grade I and grade II spondylolisthesis at L5/S1. First, as a tool for revision in grade I/II spondylolisthesis after a previous instrumented fusion in which alignment is not corrected and foraminal compression persists. Second, as a tool to treat patients with stable grade I/II spondylolisthesis who are symptomatic due to unilateral nerve compression at the L5/S1 neuroforamen. In both cases these patients have an anatomic distortion that can compress the traversing S1 nerve with a retropulsed S1 vertebral body endplate. These 2 varieties of patients may benefit from a minimally invasive intervention that expands the neuroforamen by resection of the retropulsed S1 endplate. Such a technique avoids the need for a massive revision operation in case of prior fusion or, in virgin cases, avoids destabilization associated with laminectomy without fusion.

Here we report our series in treating patients with severe grade I and grade II spondylolisthesis at L5-S1, with and without previous fusion, with a transforaminal endoscopic decompression procedure that targets the retropulsed S1 vertebral body endplate for decompression.

Methods

This study is a retrospective chart review of 325 patients operated on by one surgeon between 2014 and 2018 with a minimum follow-up of 1 year. The focus of this study is on the feasibility of offering awake, transforaminal endoscopic spine surgery to patients with severe grade I and grade II spondylolisthesis who only present with radicular symptoms due to foraminal compression and who are not mechanically unstable as verified by flexion-extension lumbar spine films.

Operative Procedure

For the endoscopic (Joimax, Karlsruhe, Germany TESSYS) spine procedures, the patient was positioned prone on a Wilson frame with flexed hips and knees. The procedure was done under local anesthesia (1% lidocaine with epinephrine) and intravenous sedation; the level of anesthetic was titrated, so the patient was able to communicate with the surgeon throughout the procedure. Percutaneous entry was established through the skin between 12 and 14 cm lateral to the midline. Using intermittent fluoroscopic guidance, alternating between lateral and anterior-posterior (AP) view, a 15-cm 18-guage needle was advanced and placed at the superior endplate of the S1 vertebral body through Kambin's triangle, between the exiting L5 and traversing S1 nerves. An AP fluoroscopic view was used to confirm the needle was at the medial border of the S1 pedicle. A 6-mm incision was made over the needle, and a K-wire was placed in the needle, the needle removed, and sequential dilators placed over the K-wire. Sequential reamers were used to enlarge the neural foramen by removing the ventral aspect of the superior articulating process of S1. At this point the beveled cannula tubular dilator was placed over the sequential dilators, the dilators removed, and the 7-mm outer diameter Joimax rigid working channel endoscope channel was inserted through the tubular retractor. Under endoscopic visualization, endoscopic graspers were used to remove any disc compressing the L5 and S1 nerve, the endoscopic drill was used to remove the retropulsed endplate of S1, and endoscopic Kerrison rongeurs and graspers were used to remove any compressive lateral recess ligamentum flavum. The endpoint of surgery in each case was visualizing the decompressed exiting L5 nerve and traversing S1 nerve.

Unlike other transforaminal endoscopic procedures, the operative technique used here required placing the beveled tubular retractor for the working channel endoscopic half on the corner of the retropulsed posterior superior endplate of S1 and the (often protruded) L5-S1 disc. To do this, initial reaming was targeted to remove a significant portion of the ventral part of the S1 superior articulating process and the top of the S1 pedicle. The spondylolisthesis turns an oval foramen into a sideways figure of 8. The goal of the surgical decompression is the recreate the oval shape by unroofing the foramen by drilling down the ventral portion of the superior articulating process and lower the floor of the foramen by removing herniated disc and the posterior, superior corner of the retropulsed S1 vertebral body.

Figures 1 to 3 are case illustrations from a nonfusion patient (Fig. 1), an instrumented fusion patient

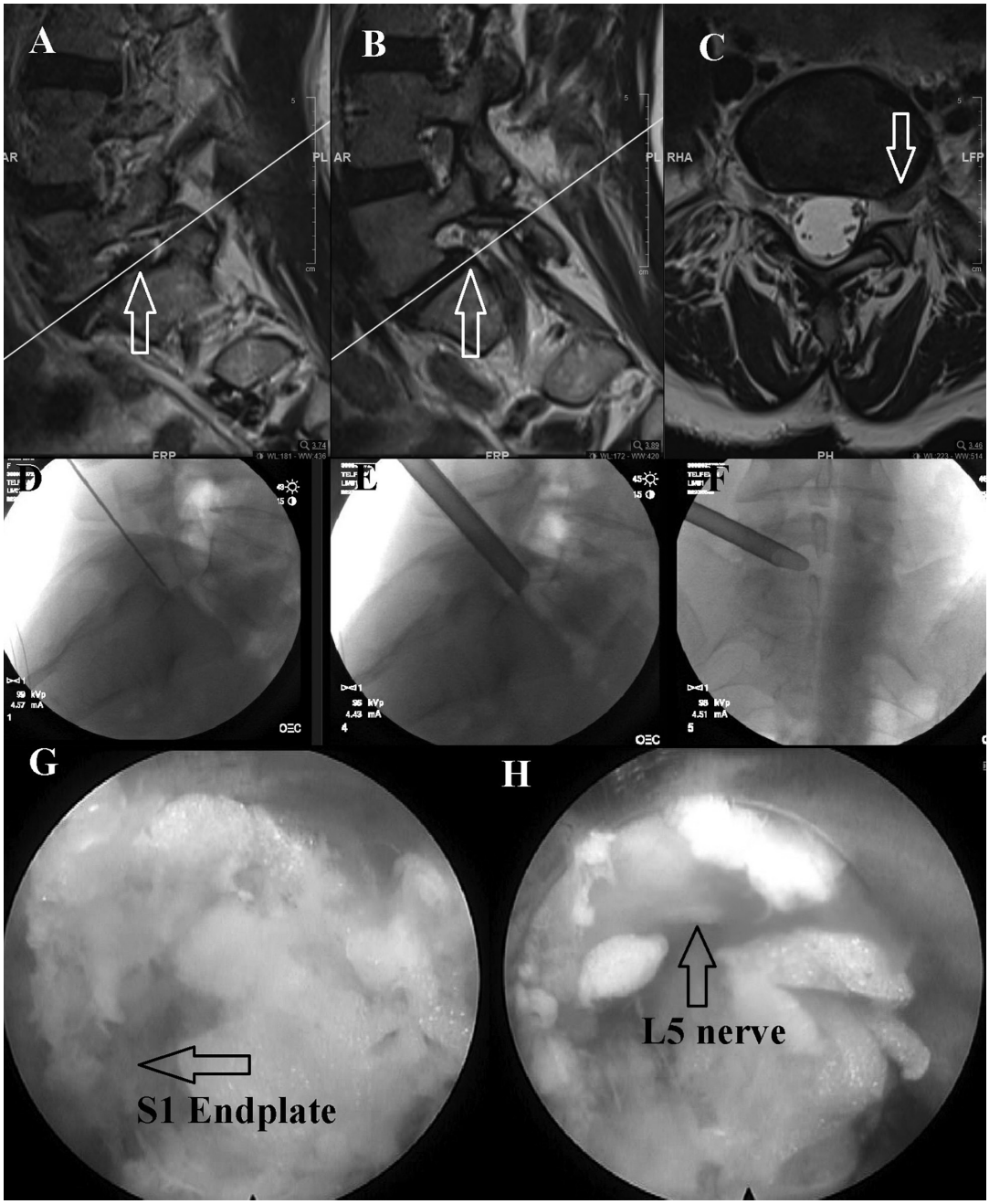

Fig. 1. *L5-S1 spondylolisthesis in a nonfusion patient. (A) Sagittal T2-weighted magnetic resonance imaging (MRI) through the left L5-S1 foramen demonstrates the change in foraminal dimensions that results from the spondylolisthesis and the L5 exiting nerve root compression and the disc protrusion (arrow). (B) Sagittal T2-weighted MRI through the right L5-S1 foramen demonstrates the relative sparing of the foraminal contents from compression despite a mild disc bulge (arrow). (C) Axial T2-weighted MRI through the L5-S1 disc demonstrates the L5 nerve compression on the left side (arrow). (D) Lateral fluoroscopic image showing the targeting with the spinal needle at the posterior superior edge of the S1 vertebral body. (E) Lateral fluoroscopic image shows the beveled tubular retractor not in the disc, but on top of the disc in the foramen at the edge of the S1 vertebral endplate. (F) AP fluoroscopic view shows the beveled tubular retractor seen in Fig. 1E simultaneously medial to the pedicle of S1. (G) Endoscopic camera view of the left L5-S1 neural foramen: disc is inferior, endplate of S1 is to the left, and the S1 nerve is running in the foraminal fat at the top of the image. (H) Endoscopic camera view with the scope upside down in the foramen, and now the L5 nerve can be visualized at the top of the image and the disc at the bottom.*

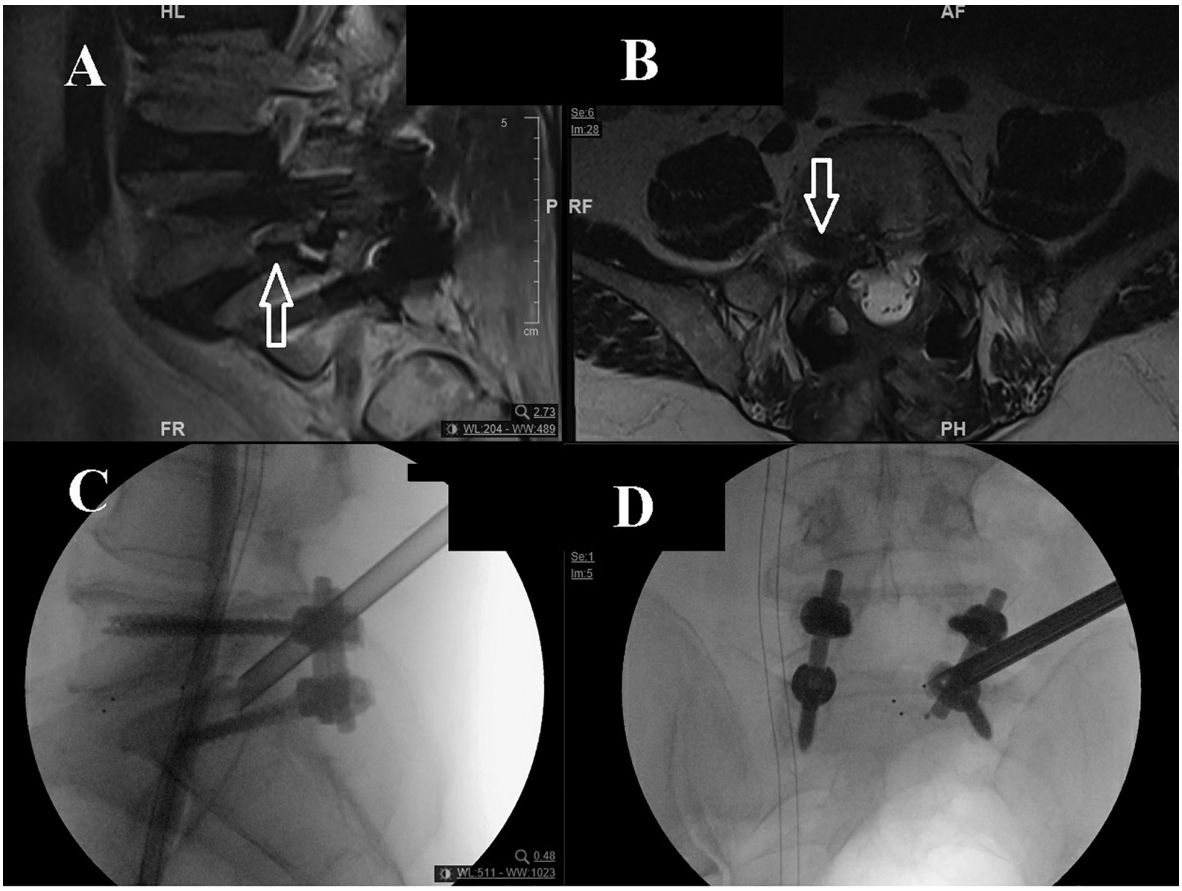

Fig. 2. *L5-S1 spondylolisthesis in a patient with an instrumented fusion. (A) Sagittal T2-weighted magnetic resonance imaging (MRI) shows the uncorrected spondylolisthesis after a transforaminal lumbar interbody fusion with persistent compression of the right L5 nerve (arrow). (B) Axial T2-weighted MRI shows the foraminal compression on the right caused by uncovering of the disc (arrow). (C) Lateral fluoroscopic image of the beveled tubular retractor in the right L5-S1 foramen, half on the endplate of S1 and half on the L5-S1 disc. (D) AP fluoroscopic image of the beveled tubular retractor in the right L5-S1 foramen.*

(Fig. 2), and a patient with scoliosis and 12 previous fusion surgeries (Fig. 3).

Results

Patients treated were those who presented with an S1 or L5 and S1 radiculopathy as their primary complaint and a L5-S1 spondylolisthesis of 5 mm or greater. Patients treated had no instability on flexion-extension x-rays. Eleven patients had not had fusions at L5-S1, and 8 patients had previous instrumented fusions at L5-S1 but still had a spondylolisthesis of at least 5 mm. The clinical data for the individual patients are displayed in Table 1, and the averaged clinical data and outcomes are displayed in Table 2. The average slip for nonfusion patients was 8.4 mm, and the average slip for fusion patients was 8.8 mm (Table 2). Table 2 lists the preoperative, 3-month postoperative, and 1-year postoperative Visual Analog Scale (VAS) back, VAS leg, and Oswestry Disability Index (ODI) scores for the overall 19 patients, as well as the 11 patients without fusion and the 8 patients with fusion. There was no significant difference in the outcomes of the 2 groups. At 1-year follow-up the improvement in VAS back scores was 44% in the nonfusion group and 49% in the fusion group, and the improvement in VAS leg scores was 84% in the nonfusion group and 58% in the fusion group. At 1-year follow-up the improvement in ODI scores was 63% in the nonfusion group and 54% in the fusion group.

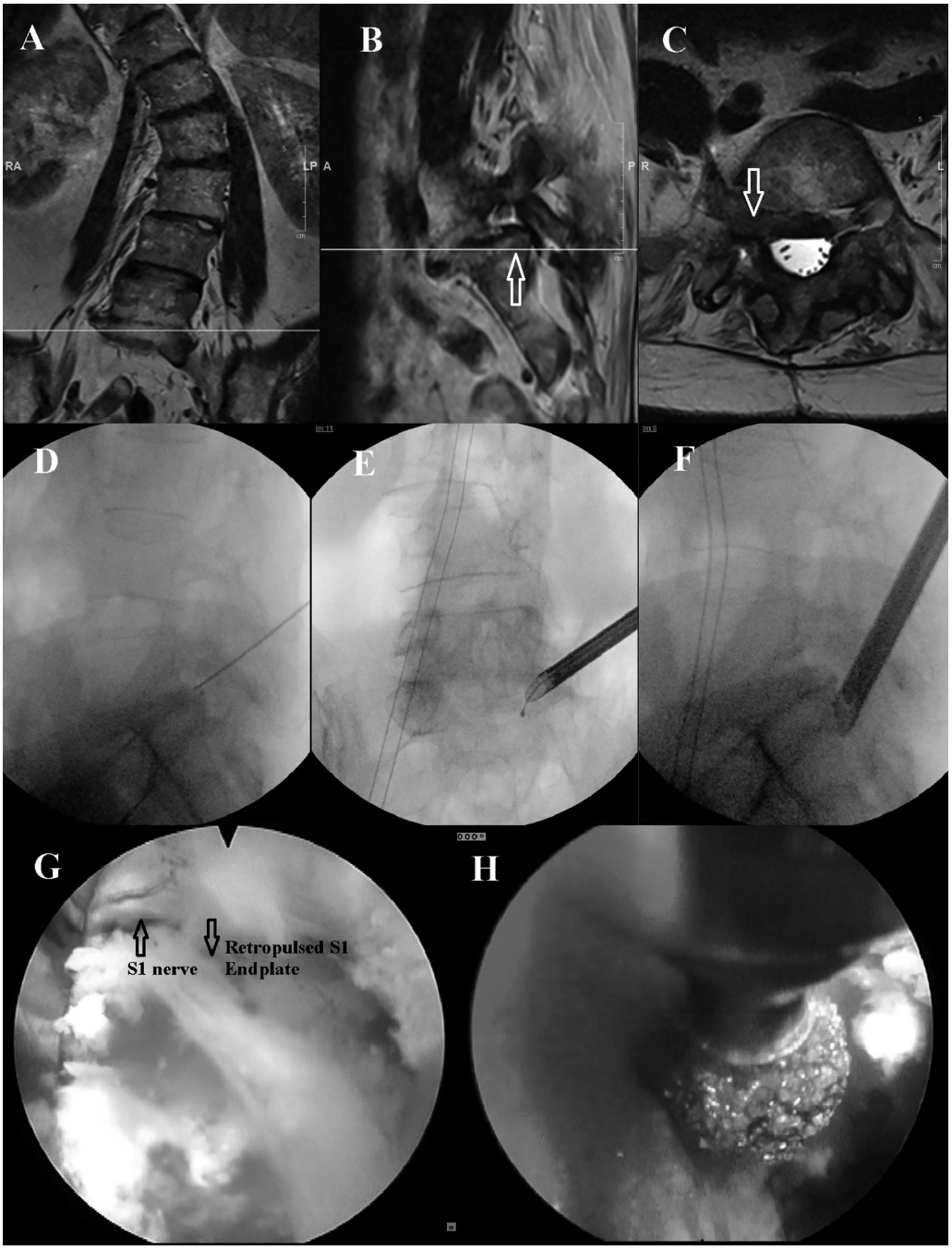

Fig. 3. *L5-S1 spondylolisthesis in a patient after 12 surgeries for scoliosis. (A) Sagittal T2-weighted coronal magnetic resonance imaging (MRI) demonstrating severity of coronal scoliosis despite 12 previous surgeries. (B) Sagittal T2-weighted MRI demonstrates the severity of the right S1 nerve compression form the retropulsed posterior superior corner of the S1 vertebral body endplate (arrow). (C) Axial T2-weighted MRI shows the obliteration of the right L5-S1 foramen (arrow). (D) Lateral fluoroscopic image shows needle targeting at the posterior superior corner of the S1 vertebral body endplate. (E) AP fluoroscopic image shows the beveled tubular retractor in the right L5-S1 foramen. (F) Lateral fluoroscopic image shows the beveled tubular retractor placed directly on the S1 vertebral body (under the S1 nerve). (G) Endoscopic camera view from Fig. 3F of the bone compressing the S1 nerve. (H) Endoscopic camera view of the Shrill drill used to reduce the bone endplate of S1 and decompress the S1 nerve.*

Table 1. *Overall patient demographics and clinical data.*

	Overall	No Preop Fusion	With Preop Fusion
No. of patients	19	11	8
Mean age, years (SD)	67 (10.6)	63.6 (11.2)	71.6 (8.2)
Gender			
Male	10	5	5
Female	9	6	3
Mean slip measurement, mm (SD)	8.4 (2.8)	8.1 (2.5)	8.8 (3.3)
Mean preop back VAS score (SD)	6.1 (1.5)	6.1 (1.0)	6.1 (1.5)
Mean 3-month postop back VAS score (SD)	3.0 (1.6)	2.9 (1.0)	3.4 (1.5)
Mean 1-year postop back VAS score (SD)	2.2 (1.4)	3.4 (1.3)	3.1 (1.0)
Mean preop leg VAS score (SD)	6.7 (1.7)	6.9 (1.4)	6.7 (1.7)
Mean 3-month postop leg VAS score (SD)	3.0 (1.6)	3.1 (1.4)	3.1 (2.0)
Mean 1-year postop leg VAS score (SD)	2.2 (1.4)	1.8 (1.6)	2.8 (1.2)
Mean preop ODI (SD)	50.4 (13.4)	52.4 (11.0)	52.5 (10.2)
Mean 3-month postop ODI (SD)	24.1 (10.7)	20.9 (7.2)	31.0 (11.8)
Mean 1-year postop ODI (SD)	20.5 (7.3)	19.3 (7.7)	24.0 (5.1)

None of the patients in the nonfusion group went on to need fusion surgery in the 1-year follow-up. There were no cases in either group of disc reherniation, durotomy, or infection. A 2-week period of nerve dysesthesia that commenced 48 to 72 hours after surgery was typical and frequently treated with gabapentin and oral steroids. There were no cases of permanent or long-lasting dysesthesia.

Discussion

The most commonly employed intervention for spondylolisthesis is a decompression followed by simple posterolateral fusion (2). This technique is familiar and well within the comfort of most surgeons. There is, however, an increasing focus being treated to interbody techniques, specifically for their benefit with respect to spinopelvic parameters. A transforaminal, anterior, or oblique lumbar interbody fusion may be favorable as it can provide indirect decompression, supplementation of direct decompression, and anatomic realignment. The theoretical benefits of an interbody procedure may explain why studies suggest lower rates of reoperation compared with posterolateral fusion only (6). Furthermore, prior research has only compared laminectomy to laminectomy and fusion, whereas comparisons of limited midline sparing interventions to decompression and instrumented fusion are currently ongoing (5,7).

Our series suggests that endoscopic decompression may be a possible tool among many for addressing symptomatic lumbar spondylolisthesis. Clinically our results for endoscopic decompression are similar to those established in the literature for other techniques. At 1 year, our patients had a mean improvement in ODI scores of approximately 30 points in both groups, similar to the mean improvement of 20 points seen at 1-year follow-up in the SPORT cohort (4). In a recent review by Levin et al (8), both posterolateral fusion and transforaminal lumbar interbody fusion were shown to have mean ODI score improvements ranging from 15 to 30.4 points, closely replicating our results. The same review found a range of mean improvement for back VAS of 2 to 3 points and leg VAS of 3 to 4 points, which was closely replicated by our results (mean back VAS improvement of 3.9 and leg VAS improvement of 4.5) (8). Although outcome profiles are similar, the complication profile for endoscopic surgery appears to be much more favorable. In our series there were no significant complications associated with the procedure, this low rate is similar to other reports of complication associated with endoscopic spine procedures (9). In particular there seems to be a very low rate of durotomy associated with endoscopic interventions when compared with open surgical procedures, particularly fusion procedures—approximately 4% to 13% (8). Furthermore, none of our unfused patients required additional fusion operation, whereas Sato et al (10) describe the reoperation rate at as high as 14.4% in tradition fusion approaches to spondylolisthesis. The most common reason identified

Table 2. *Individual patient demographics and clinical data.*

Age and Gender	Measure of L5-S1 Slip (mm)	Previous Surgery	Preop Leg VAS Score	3-Month Postop Leg VAS Score	1-Year Postop Leg VAS Score	Preop Back VAS Score	3-Month Postop Back VAS Score	1-Year Postop Back VAS Score	Preop ODI	3-Month Postop ODI	1-Year Postop ODI
Nonfusion											
44 M	5	No	6	2	0	5	2	2	44	18	28
73 F	6	No	8	2	3	7	2	2	50	28	28
64 F	6	No	6	3	0	5	3	1	60	32	28
75 M	6	No	9	6	5	7	5	5	66	28	30
66 M	8	No	5	3	1	7	2	2	38	16	14
69 F	8	No	6	4	2	6	4	4	44	24	18
79 F	8	No	7	2	1	4	2	1	62	14	16
67 F	9	No	8	5	4	6	3	2	52	28	14
46 F	9	No	9	2	1	7	4	2	70	14	14
61 M	10	No	5	3	1	6	3	1	38	12	8
56 M	14	No	7	2	2	7	2	2	52	16	14
Fusion											
76 M	5	L4-S1 fusion	6	1	3	7	0	1	42	24	24
70 M	6	L5-S1	7	7	4	8	4	4	66	24	24
86 M	7	L1-S1 fusion	6	3	4	5	3	3	40	30	30
63 M	7	L2-S1 fusion	7	2	2	8	5	4	52	28	28
69 F	8	T11-S1	9	2	1	6	4	4	66	30	30
72 F	11	T11-S1	8	2	2	7	4	3	52	20	20
77 F	11	L4-S1	7	3	2	7	4	3	58	20	20
60 M	15	L5-S1 fusion	7	5	4	6	3	3	44	16	16

for revision is persistent or recurrent pathology at the same segment (10).

When analyzing revisions of prior fusions, outcomes are less promising for traditional revision methods (repeat decompression, extension of fusion and/or interbody from a posterior or anterior/lateral approach). Cassinelli et al (11) in their series on revision for pseudarthrosis show that despite achieving near 100% fusion rates, there was little to no improvement in ODI score. When analyzing revision purely in cases of spondylolisthesis, Dede et al (12) report an improvement of 20 points in ODI score, but the majority of these patients required extensive procedures often including combined anterior and posterior approaches.

Our case series provides evidence for the use of a limited decompressive technique in select patients with stable grade I or II spondylolisthesis with corresponding radicular pain. Although our case numbers are relatively low, all patients showed a durable improvement in ODI score, back and leg pain.

Conclusions

Transforaminal endoscopic surgery to target foraminal compression secondary to ventral compressive disc and bone in the foramen in the setting of a severe grade I/II spondylolisthesis is a feasible treatment option for patients with lumbar radiculopathy. For patients with foraminal compression at L5-S1 and spondylolisthesis, despite a previous fusion, transforaminal endoscopic surgery may be a useful salvage procedure.

References

1. Vining RD, Potocki E, ScLean I, et al. Prevalence of radiographic findings in individuals with chronic low back pain screened for a randomized controlled trial: Secondary analysis and clinical implications. *J Manipulative Physiol Ther* 2014; 37:678-687.
2. Golinvaux NS, Basques BA, Bohl DD, YacobA, Grauer JN. Comparison of 368 patients undergoing surgery for lumbar degenerative spondylolisthesis from the SPORT trial with 955 from the NSQIP database. *Spine (Phila Pa 1976)* 2015; 40:342-348.
3. Kaftandziev I, Trpeski S, Filipce V, et al. Operative treatment of degenerative lumbar spine spondylolisthesis. *Pril (Makedon Akad Nauk Umet Odd Med Nauki)* 2015; 36:129-135.
4. Weinstein JN, Lurie JD, Tosteson TD, et al. Surgical versus nonsurgical treatment for lumbar degenerative spondylolisthesis. *N Engl J Med* 2007; 356:2257-2270.
5. Ghogawala Z, Dziura J, Butler WE, et al. Laminectomy plus fusion versus laminectomy alone for lumbar spondylolisthesis. *N Engl J Med* 2016; 374:1424-1434.
6. Macki M, Bydon M, Weingart R, et al. Posterolateral fusion with interbody for lumbar spondylolisthesis is associated with less repeat surgery than posterolateral fusion alone. *Clin Neurol Neurosurg* 2015; 138:117-123.
7. Austevoll IM, Hermansen E, Fagerland M, et al. Decompression alone versus decompression with instrumental fusion the NORDSTEN degenerative spondylolisthesis trial (NORDSTEN-DS); study protocol for a randomized controlled trial. *BMC Musculoskelet Disord* 2019; 20:7.
8. Levin JM, Tanenbaum JE, Steinmetz MP, Mroz TE, Overley SC. Posterolateral fusion (PLF) versus transforaminal lumbar interbody fusion (TLIF) for spondylolisthesis: A systematic review and meta-analysis. *Spine J* 2018; 18:1088-1098.
9. Soliman HM. Irrigation endoscopic assisted percutaneous pars repair: Technical note. *Spine J* 2016; 16:1276-1281.
10. Sato S, Yagi M, Machida M, et al. Reoperation rate and risk factors of elective spinal surgery for degenerative spondylolisthesis: Minimum 5-year follow-up. *Spine J* 2015; 15:1536-1544.
11. Cassinelli EH, Wallach C, Hanscom B, Vogt M, Kang JD. Prospective clinical outcomes of revision fusion surgery in patients with pseudarthrosis after posterior lumbar interbody fusions using stand-alone metallic cages. *Spine J* 2006; 6:428-434.
12. Dede O, Thuillier D, Pekmezci M, et al. Revision surgery for lumbar pseudarthrosis. *Spine J* 2015; 15:977-982.