Retrospective Study

Endoscope-Assisted Minimally Invasive Interlaminar Lumbar Decompression for Spinal Stenosis

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Background: Lumbar stenosis is characterized by a narrowing of the spinal canal in association with progressive degenerative changes in the lumbar spine and surrounding structures, including hypertrophy of the ligamentum flavum (LF).

Objectives: The aim of this study was to examine the usefulness of endoscope-assisted interlaminar lumbar decompression (EILD) for patients with lumbar stenosis and hypertrophy of the LF.

Study Design: Retrospective study.

Setting: Department of Anesthesiology and Pain Medicine, Neurosurgery at Wooridul Spine Hospital.

Methods: A total of 51 patients were enrolled in this study. Outcomes were evaluated at baseline and at 2 weeks and 6 months postprocedure via the Numeric Rating Scale, Oswestry Disability Index (ODI), and Zurich Claudication Questionnaire (ZCQ).

Results: Mean posttreatment pain scores at 2 weeks and 6 months were significantly lower, and ODI scores were significantly decreased compared with baseline. ZCQ scores were also significantly decreased compared with pretreatment surveys. Two patients required reoperation within one month. At postprocedure 6 months, a ≥ 50% reduction in pain score was recorded in 26 (80%) of 51 patients, and there was ≥ 40% reduction in ODI score in 82% of patients. No serious complications including epidural bleeding, dural or neural injuries, or infection were recorded.

Limitations: This study lacked secondary outcome substantiation. In addition, the follow-up period was short (< 6 months), and no patients had postprocedure magnetic resonance imaging. The number of patients was also small.

Conclusions: EILD provided good outcomes and may be a reasonable treatment option for carefully selected patients with hypertrophy of the LF.

Key words: Spinal stenosis, ligamentum flavus, hypertrophy, decompression, endoscope, minimally

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The spinal canal is formed by the vertebral body anteriorly, the pedicles laterally, and the lamina posteriorly. Progressive degenerative changes in the lumbar spine and surrounding structures tend to occur with aging, and include osteophyte formation, degeneration of the facet joints, and hypertrophy of the ligamentum flavum (LF), with associated lumbar stenosis (1-4).

The LF connects the vertebral laminae superiorly and inferiorly. It consists of 75% elastic fiber (4). LF hy-

pertrophy is characterized by fibrosis, thickening of the normal elastic layer, and damage to the collagenous layer secondary to spinal instability (2,4).

Neurogenic claudication is a common manifestation of lumbar stenosis that presents as pain encompassing the buttocks, posterior legs, and groin secondary to nerve root compression (5) that is often accompanied by numbness, tingling, weakness, and cramping. Conservative management of these symptoms usually includes a combination of physical therapy and analgesics. Epidural steroid injection, which is known to provide long-term symptom relief, has also become a mainstay of conservative treatment for patients with lumbar dysfunction, including lumbar stenosis (6-9).

Lumbar decompression may be recommended for patients with symptoms refractory to conservative treatment or steroid injection, and minimally invasive percutaneous decompression based on c-arm fluoroscopy (i.e., mild) is a treatment option for patients with symptomatic lumbar stenosis associated with LF hypertrophy (10-15). Mild has shown good results during one-year follow-up (16). However, traditional mild does not allow direct visualization of the procedure site, and complications including bleeding, nerve injury, and dural puncture have been reported (17). In addition, there is a possibility of inadequate decompression. Use of endoscopy during the procedure could limit these shortcomings.

The aim of this study was to examine the usefulness of endoscope-assisted interlaminar lumbar decompression (EILD) for patients with spinal stenosis associated with hypertrophic LF.

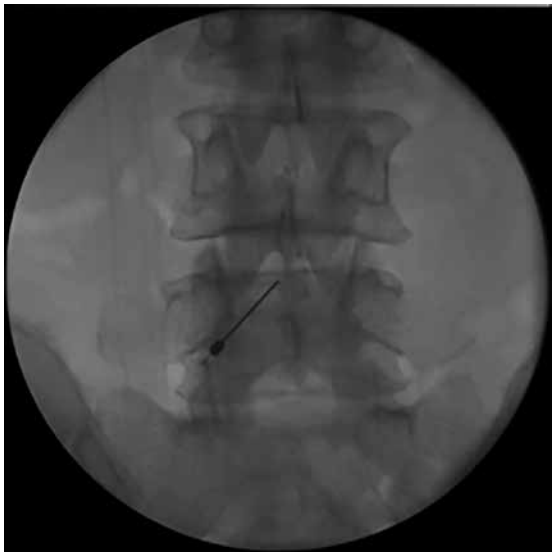

Fig. 1. *Epidural puncture was performed with a 22-G Tuohy needle, and 1 mL contrast medium agent was injected.*

Methods

A total of 51 patients who gave written informed consent were enrolled in this retrospective study, which was approved by the institutional review board. Inclusion criteria were evidence of neurogenic intermittent claudication presenting as reduced walking distance with numbness, weakness, and discomfort in the legs after walking or prolonged standing and regressing during rest; symptoms persisting after 4 to 6 weeks of conservative treatment/epidural steroid injection; and axial magnetic resonance imaging (MRI) finding of spinal stenosis with LF thickness > 2.5 mm (2) and cross-sectional area of the dural sac < 130 mm^2. Patients with nonspecific symptoms, lateral recess or foraminal stenosis, spondylolisthesis, previous back surgery, or contraindication to surgery due to bleeding tendency were excluded from the analysis.

Imaging Protocol

Lumbar spine MRI was performed with a Philips Achieva 1.5T scanner (Philips, Amsterdam, the Netherlands). T2-weighted axial images were obtained with the following parameters: matrix 296 × 188 pixels, field of view 16 cm, slice thickness 4 mm, gap 0.44 mm, and echo train length 25. The cross-sectional area of the central canal was measured in transverse sections, and the LF thickness was measured at the middle portion of the interlaminar LF.

Operative Technique

EILD was performed with the patient in a prone position on the radiolucent operating table. Before starting the procedure, epidural puncture was performed with a 22-gauge Tuohy needle, and 1 mL of contrast medium agent is injected (Fig. 1).

After the epidurogram, a skin entry site was marked at one level below the pedicle at the target interlaminar space. The presumptive skin entry site and needle track were infiltrated with 1% lidocaine, and a 15-gauge spinal needle was inserted and directed toward the targeted interlaminar level. The working cannula and trocar were then inserted percutaneously and advanced through the fascia and muscle to the

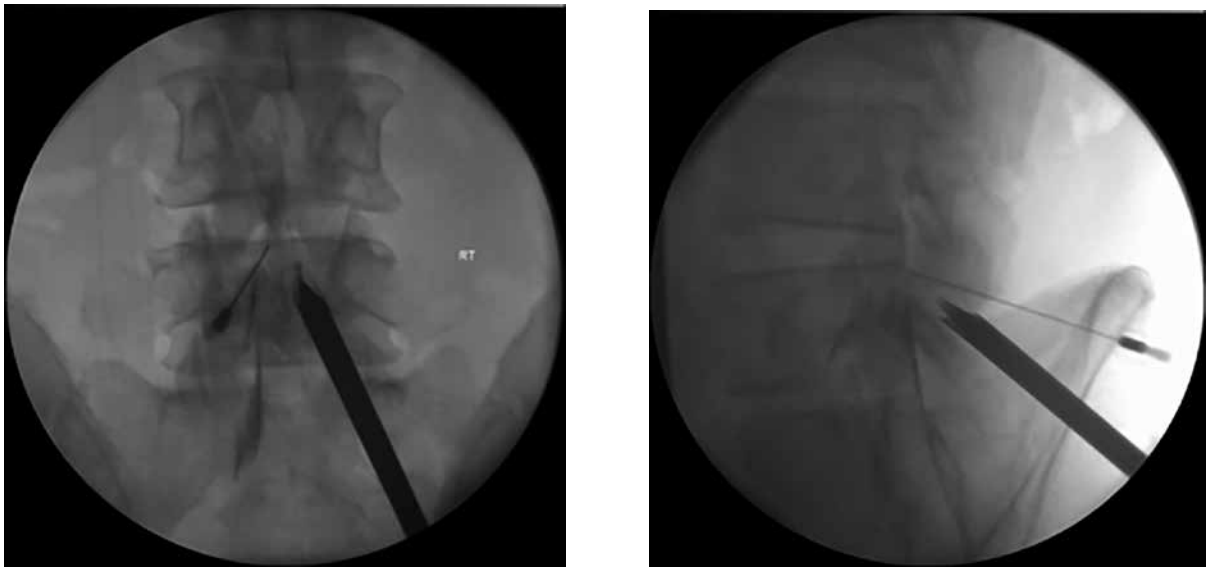

Fig. 2. *Both working cannula and trocar were then inserted into the right L45 interlaminar in anteroposterior view (A) and contralateral oblique view (B).*

desired interlaminar region (Fig. 2A,B). The trocar was then removed, and the endoscope (outer diameter 4.2 mm) was inserted through the working cannula (outer diameter 4.3 mm) (Fig. 3) until the interlaminar structures and hypertrophied LF were seen.

Next, a bone rongeur was placed through the endoscopic working channel, and the superior and inferior portions of the lamina are trimmed to create an adequate work space. Tissue forceps were then advanced to the dorsal aspect of the hypertrophic LF and the ligament was debulked posteriorly using the forceps and, if necessary, laser or radiofrequency for additional decompression (Fig. 4). The hypertrophied ligament was decompressed until thinning of LF using endoscopic view. All instruments were then removed, and the tiny incision was closed with a sterile adhesive strip.

Patient age and gender were noted. The main outcome measures were pain score as determined by the Numeric Rating Scale (NRS-11) at baseline and at 2 weeks and 6 months postprocedure, and the Oswestry Disability Index (ODI) and Zurich Claudication Questionnaire (ZCQ) at baseline, at 2 weeks, and at 6 months postprocedure. Success was defined as a reduction in pain scores of at least 50%, or ODI score reduction of at least 40%.

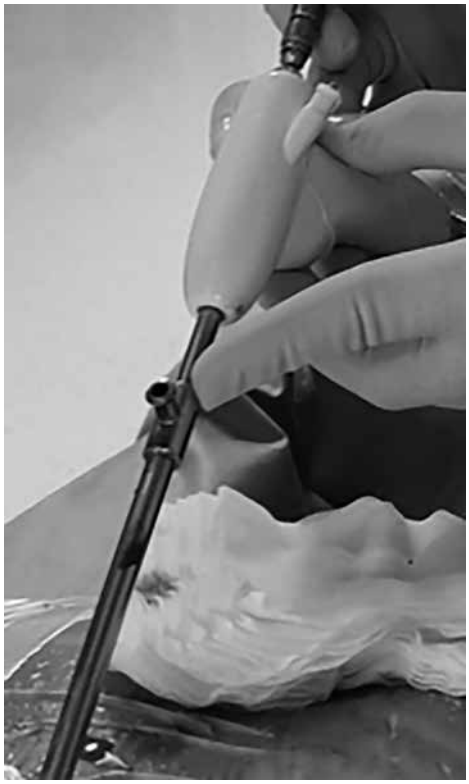

Fig. 3. *Endoscope was inserted through the working cannula.*

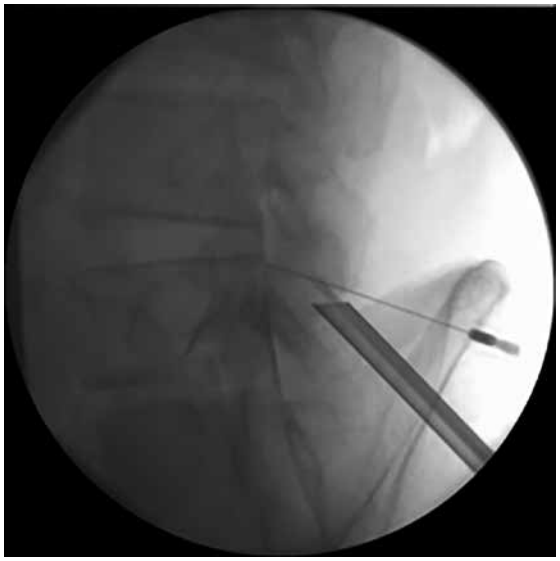

Fig. 4. *Forceps advanced to the dorsal aspect of the hypertrophic ligamentum flavum.*

Table 1. *Patient characteristics.*

Characteristic	Procedure (n = 51)
Age (yrs)	68.1 ± 9.4
Gender	
Male	20 (40%)
Female	31 (60%)
Procedure level	
L23	1
L34	5
L45	38
L5S1	7
Thickness of ligamentum flavum (mm)	
Right LF	7.2 ± 1.8 (4.1-11.3)
Left LF	7.1 ± 1.9 (3.9-10.8)
Thecal sac diameter (mm2)	93.4 ± 24.0

Statistical Analysis

Data were analyzed by independent t test, the chi-square test, and analysis of variance, equating statistical significance with type 1 error rates of < 0.05. All computations were performed with standard software (SPSS Version 23; IBM Corporation, Armonk, NY).

Results

A summary of patient characteristics is provided in Table 1. Initial LF thickness was 7.2 mm and 7.1 mm, right and left, respectively.

All patients had significant decreases in NRS-11, ODI, and ZCQ scores over time (Table 2). Two patients required reoperation during the first month after EILD. Mean posttreatment pain scores at 2 weeks and 6 months were significantly lower (P = 0.000) (Table 2). ODI scores were also significantly decreased compared with baseline (Table 3). In addition, ZCQ scores were significantly decreased compared with pretreatment. At postprocedure 6 months, pain score reductions of ≥ 50% were recorded in 26 of 51 patients, and ≥ 40% reduction in ODI score was reported in 82% of patients (Table 3).

There were no serious complications such as epidural bleeding, dural or neural injury, or infection recorded.

Discussion

This retrospective observational study showed that EILD provided pain relief in patients with LF hypertrophy and lumbar stenosis. Our findings are consistent with those of previous reports (13,15,18,19). Mekhail et al (18) reported an excellent safety profile and long-term pain relief with improved functionality during a one-year follow-up period in 58 patients undergoing mild.

LF hypertrophy with spinal stenosis is commonly found at the L3/4 and L4/5 levels, and it is reported more frequently in older patients (2-4). Accordingly, in our study, the mean age of the patients was 68 years,

Table 2. *Mean change of outcome measurement.*

Outcome measurement	Pre-treatment	2 weeks after procedure	6 months
NRS	7.7 ± 0.7	3.2 ± 1.3	3.1 ± 0.8
ODI	56.8 ± 5.6	25.7 ± 4.8	26.2 ± 3.9
ZCQ	0.7 ± 0.7	0.5 ± 0.1	0.5 ± 0.1

Table 3. *The number who obtained the percentage improvement of pain at post-procedure 6 months.*

n = 51	Procedure	
NRS	< 50	11 (21.6%)
	≥ 50	40 (79.4%)
ODI	< 40	9 (17.6%)
	≥ 40	42 (82.4%)

and debulking of the hypertrophied LF by EILD was most commonly performed at the L4/5 level.

The LF is comprised of interspinous, interlaminar, capsular, foraminal, and extraforaminal portions (20), and it consists of both superficial and deep components. The superficial component of the LF inserts onto the superior edge and the posterosuperior surface of the caudal lamina, and the deep LF inserts for a variable distance onto the anterosuperior surface of the caudal lamina (21). It is close to the thecal sac posteriorly, the nerve root laterally, and the epidural venous plexus, which may all be at risk of iatrogenic injury during percutaneous decompression. Reported complications after mild have included persistence of refractory neurogenic claudication, dural tear, epidural hemorrhage, and transected nerve root (17). EILD is based on direct endoscopic visualization of the hypertrophied LF, as well as the critical venous and neural structures around it. As such, adequate and safe debulking with the potential for fewer complications should be possible. Furthermore, during EILD, intraoperative bleeding can be controlled with cautery. We do not recommend EILD for patients with spondylolisthesis because debulking of a hypertrophied LF in such cases can cause destabilization of the spine.

The mild procedure approach one pedicle below. EILD also approach same method. In general, endoscopic procedure for lumbar decompression was used traditional same level interlaminar approach. Because EILD procedure performed guided under both c-arm and endoscope, approach was one pedicle below.

Two patients required reoperation during the first month after EILD. We postulated that although, interspinous and interlaminar portion of LF was decompressed sufficiently, foraminal portion of LF may not be decompressed sufficiently. However, foraminal portion of LF may not be removed sufficiently.

An acknowledged limitation of our study is that the significant improvements in pain and ODI scores versus baseline lacked secondary outcome substantiation. In addition, the follow-up period was short (< 6 months) and unaccompanied by mid- or long-term follow-up results, and no patients had postprocedure MRI. Additionally, the number of patients was small, and additional pathologies, such as combined stenosis, were excluded. Finally, we did not directly compare efficacy or complication rates between EILD and mild.

Conclusions

Our preliminary results indicate that EILD may be a good option for carefully selected patients with spinal LF hypertrophy in association with spinal stenosis.

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