Retrospective Study

Minimally Invasive Interlaminar Decompression with a 10-mm Endoscope and Microscope in Cases of Adult Degenerative Scoliosis

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Background: Adult degenerative (de novo) scoliosis (ADS) usually occurs due to degenerative changes and is accompanied by progressive low-back pain and/or symptomatic lumbar stenosis. Interlaminar decompression is considered an effective treatment of lumbar stenosis, but some surgical contraindications to traditional open surgery limit its application in elderly patients with many disorders. A 10-mm endoscope has been used in the treatment of stenosis in individuals with ADS and its safety and efficacy should be assessed.

Objective: The objective was to conduct a retrospective analysis to compare interlaminar decompression with a 10-mm endoscope versus a microscope.

Study Design: Retrospective study.

Setting: This study took place at the First Affiliated Hospital of Harbin Medical University.

Methods: The data of 34 ADS patients treated in our hospital from January 2018 to December 2019, who underwent decompression with a 10-mm endoscope (ES group, 19 patients) or microscope (MS group, 15 patients) were retrospectively reviewed. The two methods were compared using the visual analog scale (VAS), Japanese orthopedic association (JOA) scale, and Oswestry disability index (ODI). Lumbar stability was also evaluated by the progression of scoliosis.

Results: There were no significant differences between the 2 groups in demographic or clinical characteristics. The mean preoperative Cobb angle of all patients was 23.34° ± 6.44°, which indicated degenerative scoliosis. The mean JOA and ODI scores were 8.09 ± 1.44 and 55.47 ± 11.91. The mean preoperative pelvic incidence (PI) and lumbar lordosis (LL) angles were 51.02° ± 7.21 and 38.26° ± 6.98 and the mean PI-LL mismatch was 12.76° ± 5.63. There was no significant difference in the VAS scores for back/leg pain between the groups at 1 week after the operation, but the scores of the ES group were significantly higher than those of the MS group at 3 months and 12 months. There were no significant differences of mean JOA and ODI between the ES and MS groups preoperatively, at 3 months, or at 12 months, but the JOA and ODI scores of the ES group were significantly higher than those of the MS group 1 week after the operation.

Limitations: The study showed that a novel method for the minimally invasive treatment of ADS is feasible; the safety and outcomes of this method should be verified with more cases.

Conclusions: Minimally invasive decompression with a 10-mm endoscope was suggested to be a safe and effective method, as expected, for the treatment of lumbar stenosis in ADS patients.

Key words: Adult degenerative scoliosis, endoscope, lumbar stability, microscopic decompression, minimally invasive

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Adult degenerative scoliosis (ADS) is a spinal column disorder characterized by a curvature of the spine of more than 10° in a skeletally mature individual and is usually accompanied by lumbar spinal stenosis, especially in elderly patients (1). ADS is a common spinal deformity that is highly prevalent in

individuals aged older than 65 years, with a prevalence ranging from 6% to 68% (1-4), and usually involves a complicated pathophysiological process.

The combination of aging, degeneration, and specific changes in discs, as well as facet joints, muscles, and ligaments between the vertebrae, can cause scoliosis (2). Bone density was, but is no longer, thought to be a causal factor (5). A previous study showed that the degenerative process begins in the intervertebral disc. The disc height decreases due to the loss of water and proteoglycan content and increased enzymatic degradation occurs (6). Due to the pathological changes in intervertebral and facet joints, the loads on the spine redistribute to prevent instability, and the lordosis angle of the lumbar spine usually decreases, as the severity of scoliosis increases (7). Canal and foraminal stenosis caused by the combination of ligamentum flavum hypertrophy, facet hypertrophy, disc collapse, and olisthesis may compress neural roots and directly lead to neural symptoms.

The duration of symptoms ranges from a short period to decades. In a preliminary study, almost all patients had a history of low-back pain, 72% of patients had symptoms in their lower extremities, and most cases involved the L4 and L5 nerve roots (5). Generally, severe low-back pain caused by the deformity and body imbalance were not the main complaints.

Nonoperative and operative treatments have various applications and limitations. Although ADS cases are classified mostly based on the existence of rotation and/or lumbar lordosis (LL) loss, selection criteria should be used to determine how to deal with symptoms and determine the mechanism of pain or other symptoms (8). Low back pain has different characteristics, depending on the cause. For example, degenerative facets and disc collapse may cause axial pain, but stenosis of the canal and foramina may compress neural structures and lead to radiogenic leg pain or neurogenic claudication (9). Identifying and categorizing the requirements of treatment can help provide suitable and exact measures for improving the efficacy of treatment and reducing complications.

In addition to pain management, some conservative treatments can improve the quality of life of patients, indicating nonoperative management may be useful for ADS, but relevant evidence is lacking (10). Curve progression, as well as progressive neurological deficits, are indicators for surgical intervention. (5) Lenke-Silva type I–VI ADS is treated surgically. These treatment options are selected based on clinical analysis, radiographic analysis of the mechanical stability of the deformity, the causes of pain, and the need for sagittal balance (11).

Although a study indicated that the restoration of sagittal balance is the critical goal for any reconstructive spine surgery (12), the patients who decide to undergo operative treatment may be eager to experience leg pain relief rather than deformity correction in the back (13). Traditional operative techniques can be used for the treatment of ADS through efficient measures, but are associated with a high rate of complications (14), due to the inevitable surgical trauma and the risk of complications which seems especially high in elderly patients. Therefore, minimally invasive surgical approaches for treating spinal scoliosis that relieve imminent symptoms and are associated with a lower risk of surgical complications are more attractive.

Minimally invasive interlaminar decompression is a widely used technique for treating spinal disorders, especially in stenosis; the main treatment goal is to relieve radiogenic leg pain or neurogenic claudication. Choy (15) developed the MISDEF algorithm to help identify appropriate candidates for minimally invasive surgery deformity correction using radiographic parameters, clinical symptoms, the pathology, and medical comorbidities. Obviously, minimally invasive surgery is increasingly recognized as an effective and safe means to reduce the extent of dissection of muscles, decrease intraoperative blood loss, and minimize surgical site infections (16). Minimally invasive interlaminar decompression under a microscope has previously been proven to be an efficient and safe technology (17) and full-endoscopic decompression technology results in similar functional outcomes for lumbar spinal stenosis with mild-to-moderate deformities, while the endoscopic approach demonstrates a favorable rate of complications (18). In our study, the novel 10 mm endoscope was designed to allow more flexibility in decompression because traditional surgical instruments, such as laminectomy rongeurs, could be used. We evaluated whether this endoscope can yield an effect similar to that of a microscope, during minimally invasive interlaminar decompression, due to its unique advantages, but additional studies are needed.

Methods

Patient Selection

We retrospectively reviewed the data of 34 ADS patients, who separately underwent decompression

through a 10-mm endoscope (ES group, 19 patients) or microscope (MS group, 15 patients).

This study was approved by the institutional review board of the First Affiliated Hospital of Harbin Medical University in Nangang, Harbin, PR China.

The inclusion criteria were as follows: 1) a curvature of the spine greater than 10° confirmed by a radiological examination; 2) lumbar spinal stenosis confirmed by computed tomography and magnetic resonance imaging; 3) neurogenic claudication and/or radicular leg pain; and 4) conservative treatment failure after at least 12 weeks. The exclusion criteria were as follows: 1) Cobb's angle < 10°; 2) a history of spine surgery; 3) low back pain as the main symptom, without neurogenic claudication and/or radicular leg pain; 4) definite instability of the spine; and 5) incomplete follow-up data for any reason.

The demographic and clinical information of the study patients is shown below (Table 1). There were no significant differences in age, gender, bone mineral density (BMD), presence of hypertension, presence of diabetes, or surgery duration between the 2 groups. The surgical difference between the 2 groups was that the ES group underwent interlaminar decompression through a 10-mm endoscope under local anesthesia and the MS group underwent interlaminar decompression through a microscope under general anesthesia.

Surgical Technique

We previously used the endoscopic technique for interlaminar decompression of L5-S1 disc herniation (19); the 10-mm endoscope was generally the same, but had small differences. The patients were placed in a prone position for the operation. For local anesthesia, 15 to 20 mL of 0.25% lidocaine was injected layer-by-layer into the skin, subcutaneous tissue, fasciae, muscle, lumbar facet joint, and then, the ligamentum flavum to prevent pain caused by ligament cutting. Next, the working channel was placed and the 10-mm endoscope (Spinendos GmbH, München, Germany) placed. The translaminar space was enlarged by removing part of the superior articular process next to the working channel, using not only an endoscopic drill, but also a laminectomy rongeur. The ligamentum flavum under the laminae was then cut open, so that the epidural space and nerve root canal were exposed and 3 to 5 mL of 1.33% lidocaine was then injected into the epidural space via the working channel (Fig. 1A). Soon after anesthesia was induced, the working channel was rotated, and the nerve root was pushed gently away from the channel to avoid nerve damage (Fig. 1B). Finally, decompression of the canal was performed, so that there was no stenosis from the upper nerve root in the underarm area to the next vertebral pedicle (11-14).

The method of minimally invasive, interlaminar decompression performed with the use of retractors and a microscope has been described previously (17). General anesthesia was induced first for the operation, then patients were placed in the prone position, as in the ES group. The skin of the surgical area was prepared and draped, before a 3 cm longitudinal incision was made approximately 1.5 cm from the posterior midline. A dilator was moved through the incision until the bony surface of the lamina or medial facet joint was reached. Dilators were inserted step by step for retractor setting. Under the microscope, the

Table 1. *Patient demographics and preoperative clinical data.*

	Overall	ES Group	MS Group	*P* Value
Patients (%)	34 (100)	19 (55.88)	15 (44.12)	
Mean age, years (± SD)	61.53 ± 10.20	62.53 ± 9.48	60.27 ± 11.25	0.530
Gender				
Male (%)	10 (29.41)	5 (26.32)	5 (33.33)	0.718
Female (%)	24 (70.59)	14 (73.68)	10 (66.67)	
Mean Height, cm (± SD)	163.47 ± 7.70	163.79 ± 7.81	163.07 ± 7.81	0.790
Mean Weight, Kg (±SD)	66.62 ± 9.52	67.26 ± 9.48	65.80 ± 9.84	0.663
Mean BMI (± SD)	24.88 ± 2.69	25.00 ± 2.26	24.73 ± 3.25	0.775
Mean BMD (± SD)	-1.27 ± 1.21	-1.28 ± 1.21	-1.27 ± 1.24	0.997
Hypertension (%)	16 (47.06)	11 (57.89)	5 (33.33)	0.185
Diabetes (%)	8 (23.53)	5 (26.32)	3 (20)	0.999
Mean medical history, Months (± SD)	16.35 ± 12.28	15.68 ± 13.53	17.20 ± 17.72	0.779
Mean preop VAS Back score (± SD)	5.29 ± 1.48	5.58 ± 1.36	4.93 ± 1.58	0.203
Mean preop VAS Leg score (± SD)	6.59 ± 0.83	6.68 ± 0.80	6.47 ± 0.90	0.483
Mean preop JOA score (± SD)	8.09 ± 1.44	8.05 ± 1.65	8.13 ± 1.19	0.869
Mean preop ODI (± SD)	53.65 ± 8.69	51.37 ± 8.11	56.53 ± 8.80	0.085

BMD = bone mineral density; BMI = body mass index

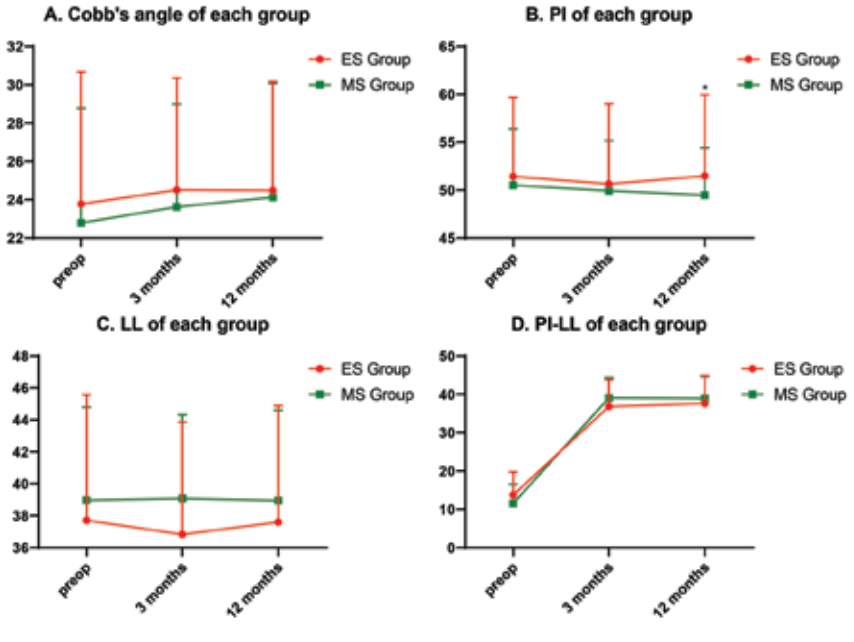

Fig 1. *Outcome of radiographic data over time.*

area of exposure for decompression spanned from the inferior edge of the lamina to the inferior edge and from the medial facet joint to the base of the spinous process. The extent and scale of decompression were similar to those of the ES group.

To preserve lumbar stability, the facet joint was not removed in either group.

Statistical Analysis

The continuous variables of the study are presented as the mean ± SD. The independent continuous variables were compared using a t-test, and the categorical variables were compared using the chi-square test; $P < 0.05$ was considered significant. The statistical calculations were carried out using IBM SPSS (version 23.0, IBM Corp.).

Results

We retrospectively reviewed the data of 34 ADS patients treated from January 2018 to December 2019 and followed up for at least 12 months. There were 19 patients who underwent decompression through a 10-mm endoscope and 15 patients who underwent decompression through a microscope. There were no significant differences between the 2 groups in the demographic or clinical characteristics, as shown in Table 1. A total of 58.82% of the patients had systemic diseases, such as hypertension and diabetes, and approximately 20.58% of the patients had severe osteoporosis, which was a disadvantage for fixation.

Some preoperative radiographic data of the patients are shown in Table 2. The mean preoperative Cobb's angle of all patients was 23.34° ± 6.44, which indicated degenerative scoliosis. The mean JOA and Oswestry Disability Index (ODI) scores were 55.47 ± 11.91 and 8.09 ± 1.44, indicating that the patients were severely disabled and needed to be treated.

The decision to undergo minimally invasive, interlaminar decompression with a 10-mm endoscope or microscope was made by the patient, but all 3 patients who underwent 2-level decompression chose general anesthesia, so that they were more comfortable during the operation. General anesthesia is accompanied by a relatively high risk of complications.

The sagittal balance of the spine was considered. The preoperative mean pelvic incidence (PI) and LL angles were 51.02° ± 7.21 and 38.26° ± 6.98, and the mean PI-LL mismatch was 12.76 ° ± 5.63. There were no significant differences between the 2 groups.

The visual analog scale (VAS) is a subjective assessment tool for back pain and leg pain. The clinical outcomes over time shown in Table 3 show significant symptom relief after the respective operation in each group. There were no significant differences in the VAS back/leg scores between the groups at 1 week after the operation, but the scores of the ES group were significantly higher than those of the MS group at 3 months and 12 months (Fig. 2).

The VAS score usually reflects the severity of pain during slight movements or at rest; therefore, the JOA and ODI scores may more closely reflect the quality of life of patients. The mean JOA and ODI scores before the operation were 8.09 ± 1.44 and 53.65 ± 8.69, respectively. A significant improvement in quality of life was confirmed from 1 week to 12 months postopera-

tively; there was no significant difference between the ES and MS groups preoperatively, at 3 months, or at 12 months, but the JOA and ODI scores of the ES group were significantly higher than those of the MS group 1 week after the operation, which indicates that the patients in the ES group may have recovered more efficiently in a relatively short time (Fig. 2).

The stability of the spine can partly reflect the coronal Cobb's angle and sagittal PI or LL in Table 4. According to our records, the values of these indices remained relatively stable from 1 week postoperatively to at least 12 months later and there were no significant differences between the 2 groups within these periods (Fig. 1).

Approximately 20.59% of all patients in our study may have suffered from an adverse event in Table 5. Postoperative cognitive dysfunction accounted for the largest proportion of events, but occurred in only the MS group, due to general anesthesia. Cerebrospinal fluid leakage without any significant dural damage occurred in one patient in the MS group, but one patient in the ES group had a dural tear with a nerve hernia; fortunately, there were no cases of cerebrospinal fluid leakage or nerve root injury after the surgery. One patient in the ES group who underwent not only interlaminar decompression, but also discectomy, complained of severe low-back pain when she tried to stand up on the day after surgery and radiogenic pain recurred. We speculated that the symptoms may be primarily caused by lumbar instability, but not stenosis. Finally, secondary open deformity correction surgery with total decompression and internal fixation was performed to restore lumbar stability (Fig. 3).

Table 2. *Preoperational radiographic data of patients.*

	Overall	ES Group	MS Group	*P* Value
No. of Levels				
Single (%)	31 (91.18)	19 (100)	12 (80.00)	0.076
Multiple (%)	3 (8.92)	0 (0)	3 (20.00)	
Stenosis Levels (multiple possible)	37 (100)	19 (51.35)	18 (48.65)	-
T12/L1 (%)	1 (2.70)	0 (0)	1 (6.67)	-
L1/2 (%)	0 (0)	0 (0)	0 (0)	-
L2/3 (%)	3 (8.10)	0 (0)	3 (13.33)	-
L3/4 (%)	3 (8.10)	2 (10.53)	1 (6.67)	-
L4/5 (%)	19 (51.35)	12 (63.16)	7 (46.67)	-
L5/S1 (%)	11 (29.73)	5 (26.32)	6 (40.00)	-
Side				
Left (%)	16 (43.24)	10 (52.63)	6 (40.00)	0.510
Right (%)	18 (48.65)	9 (47.37)	9 (60.00)	
Mean Cobb's angle, (°± SD)	23.34 ± 6.44	23.77 ± 6.90	22.79 ± 5.98	0.666
Mean PI, (°± SD)	51.02 ± 7.21	51.42 ± 8.24	50.51 ± 5.89	0.720
Mean LL, (°± SD)	38.26 ± 6.98	3.77 ± 7.88	38.97 ± 5.83	0.607
Mean PI-LL mismatch, (°± SD)	12.76 ± 5.63	13.72 ± 6.05	11.54 ± 4.99	0.269

PI = preoperative pelvic incidence; LL = lumbar lordosis

Discussion

Nonoperative and operative treatments should be recommended in the clinic depending on the case, because the most common presentation in the adult scoliosis population is pain. Pain is the primary complaint in approximately 90% of these patients (20); therefore, whether the primary treatment goal is pain management, or deformity correction, tends to determine the direction of treatment. The methods used for pain relief play an important role in improving quality of life. Minimally invasive surgery is an important method of helping patients with neural symptoms return to their daily lives (18). In addition, elderly patients whose conditions are poor and have comorbidities, such as diabetes or coronary disease, can also benefit from a relative minimal invasive operation, supporting the development of these techniques.

A patient in the ES group required reoperation, which compelled us to determine the why reoperation occurred and attempt new approaches. This occurrence taught us that percutaneous endoscopic discectomy can also negatively affect the stability of the lumbar spine. Complete discectomy may not be appropriate. After studying the functions of every structure, we learned that the nucleus pulposus and facets support loads of up to 50% and 33%, respectively (21), during standing. The posterolateral approach can be used to decompress the nerve root directly, but facet resection is inevitable in foraminotomy and the canal must be decompressed by discectomy because the endoscope is located on the herniated disc. To avoid instability, we suggest that these structures are preserved during surgery. According to previous research that revealed that laminectomy in lumbar spines with degenerative

Table 3. *Effects of clinical outcome over time.*

	Overall				ES Group				MS Group			
	Mean score	From Preop	95% CI	*P* Value	Mean score	From Preop	95% CI	*P* Value	Mean score	From Preop	95% CI	*P* Value
VAS Back												
Preop	5.29 ± 1.48				5.58 ± 1.36				4.93 ± 1.58			
24 hours	2.10 ± 1.31	-3.19 ± 1.99	2.52 - 3.87	< 0.0001	1.94 ± 1.26	-3.65 ± 1.99	2.79 - 4.51	< 0.0001	2.31 ± 1.38	-2.62 ± 1.90	1.51 - 3.73	< 0.0001
1 weeks	1.46 ± 0.96	-3.84 ± 1.83	3.23 - 4.44	< 0.0001	1.33 ± 0.96	-4.25 ± 1.69	3.48 - 5.03	< 0.0001	1.62 ± 0.97	-3.31 ± 1.93	2.33 - 4.29	< 0.0001
3 months	1.12 ± 0.91	-4.17 ± 1.72	3.58 - 4.77	< 0.0001	1.34 ± 1.10	-4.25 ± 1.17	3.43 - 5.06	< 0.0001	0.85 ± 0.49	-4.08 ± 1.79	3.18 - 4.98	< 0.0001
12 months	1.01 ± 0.81	-4.29 ± 1.68	3.71- 4.87	< 0.0001	1.26 ± 0.97	-4.33 ± 1.79	3.55 - 5.10	< 0.0001	0.69 ± 0.37	-4.24 ± 1.58	3.35 - 5.13	< 0.0001
VAS Leg												
Preop	6.59 ± 0.83				6.34 ± 0.97				6.47 ± 0.89			
24 hours	1.34 ± 0.96	-5.25 ± 1.18	4.82 - 5.69	< 0.0001	1.41 ± 1.14	-5.27 ± 1.24	4.24 - 5.63	< 0.0001	1.25 ± 0.71	-5.23 ± 1.13	4.63 - 5.83	< 0.0001
1 weeks	1.25 ± 0.99	-5.34 ± 1.43	4.89 - 5.78	< 0.0001	1.23 ± 1.06	-5.45 ± 1.42	4.45 - 5.78	< 0.0001	1.29 ± 0.96	-5.19 ± 1.47	4.50 - 5.88	< 0.0001
3 months	0.86 ± 0.96	-5.73 ± 1.30	5.29 - 6.17	< 0.0001	1.01 ± 1.18	-5.67 ± 1.43	4.63 - 6.05	< 0.0001	0.67 ± 0.63	-5.81 ± 1.14	5.23 - 6.38	< 0.0001
12 months	0.64 ± 0.75	-5.94 ± 1.21	5.56 - 6.33	< 0.0001	0.72 ± 0.93	-5.96 ± 1.46	4.99 - 6.25	< 0.0001	0.55 ± 0.43	-5.92 ± 0.85	5.40 - 6.44	< 0.0001
ODI												
Preop	53.65 ± 8.69				51.37 ± 8.11				56.53 ± 8.80			
1 weeks	36.82 ± 8.89	-16.82 ± 8.08	12.57 - 21.08	< 0.0001	31.05 ± 5.75	-20.32 ± 7.84	15.67 - 24.96	< 0.0001	44.13 ± 6.44	-12.40 ± 6.10	6.63 - 18.16	< 0.0001
3 months	14.35 ± 6.54	-39.29 ± 10.03	35.56 - 43.02	< 0.0001	15.16 ± 7.22	-36.21 ± 11.09	31.16 - 41.26	< 0.0001	13.33 ± 5.64	-43.20 ± 7.04	37.67 - 48.73	< 0.0001
12 months	11.06 ± 6.42	-42.59 ± 10.76	38.88 - 46.29	< 0.0001	11.37 ± 7.18	-40.00 ± 12.24	34.96 - 45.04	< 0.0001	10.67 ± 5.54	-45.87 ± 7.84	40.37 - 51.37	< 0.0001
JOA score												
Preop	8.09 ± 1.44				8.05 ± 1.65				8.13 ± 1.19			
1 weeks	13.29 ± 1.33	5.21 ± 4.36	-6.68 - -3.73	< 0.0001	15.05 ± 3.88	7.00 ± 4.59	-8.96 - -5.04	< 0.0001	11.07 ± 2.99	2.93 ± 2.87	-4.63 - -1.23	< 0.0001
3 months	20.59 ± 1.44	12.50 ± 2.18	-13.20 - -11.80	< 0.0001	20.47 ± 1.50	12.42 ± 2.43	-13.46 - -11.38	< 0.0001	20.73 ± 1.39	2.60 ± 1.60	-13.57 - -11.63	< 0.0001
12 months	21.12 ± 1.41	13.03 ± 1.80	-13.72 - -12.34	< 0.0001	20.84 ± 1.50	12.79 ± 2.02	-13.83 - -11.75	< 0.0001	21.47 ± 1.25	13.33 ± 1.50	-14.24 - -12.42	< 0.0001

scoliosis does not result in severe spinal instability (22), we believe that the interlaminar approach performed using an endoscope may protect the facet and posterior decompression can expand the space without discectomy. In addition to the advantages of minimal trauma focused on the compressed area and reliable results, percutaneous, endoscopic, interlaminar lumbar decompression can be performed under local anesthesia to reduce the risk of postoperative cognitive dysfunction. It is a proven technique which we used for the operative treatment of L5-S1 disc herniation (19); it led to satisfactory pain control and is a low-risk technique. Keeping a prone position and being conscious during the operation is uncomfortable and the efficiency of surgery is essential, especially in elderly patients. Because the interlaminar space above L4 is relatively narrow, we must perform partial bone resection of the lamina using an endoscopic drill. Different from the traditional 6.3-mm endoscope, which can allow only a 3.7-mm instrument in operation, the newly designed 10-mm endoscope can allow a 6-mm laminectomy rongeur for decompression. A drill is typically used with a traditional 6.3-mm endoscope, but the details of decompression were different with the 10 mm endoscope. We could thin the lamina with the drill and enlarge the interlaminar space with the rongeur. In addition, the ligament flava could be removed efficiently. A drill is usually inserted deep into the spine, but we could decompress the under-lamina

with the laminectomy rongeur and enlarge the intervertebral foramen, so that there was enough space for the nerve roots (Fig. 4). The surface of the lamina was partially reserved to preserve the stability of the spine, without any influence on the extent of decompression.

The Lenke-Silva classification system can help us determine the indications of minimally invasive, interlaminar decompression, but we suggest that the criteria are relaxed. The reason local decompression is more suitable for ADS is that most patients' spines have achieved balance and stability by compensation. Some degenerate changes in the lumbar spine, such as vertebral osteophytes, occur to maintain stability. Regarding parameters such as PI and LL, the patients in the 2 groups who underwent minimally invasive, interlaminar decompression were followed up for at least 12 months and most patients showed no evidence of lumbar instability or other problems. Owing to the minimal invasiveness of the working channel regarding muscle and fascia stripping, compared with the retractors, the patients who underwent decompression with a full endoscope showed better outcomes at 1 week after the operation, than did those who underwent decompression with a microscope. However, the long-term recovery results were relatively the same between groups. Furthermore, we considered that the normal saline environment instead of the air environment under endoscopy may protect nerve roots and tissue from heat and other injury factors.

According to the results obtained thus far, the 10 mm endoscopic technology may benefit elderly patients who suffer from ADS. Additional retrospective studies of more patients are in progress and we are confident of the results.

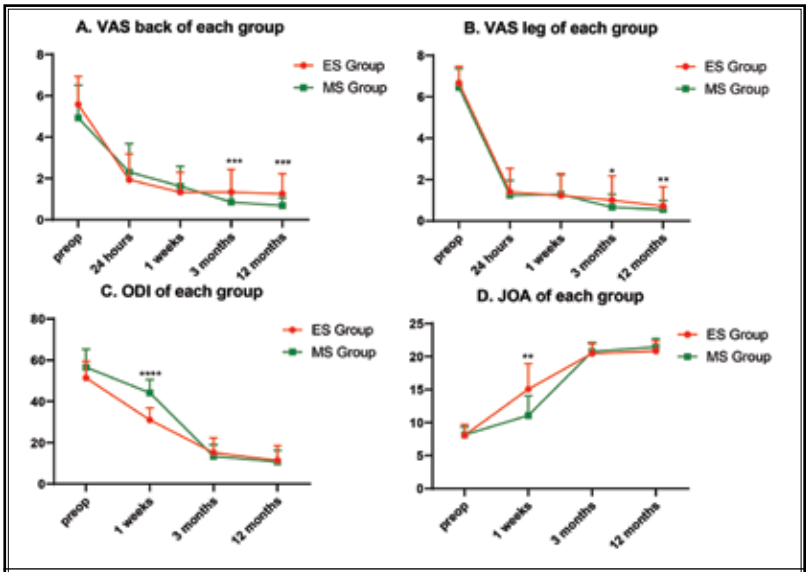

Fig 2. *Effects of clinical outcome over time.*

Table 4. *Outcome of radiographic data over time.*

	Overall	ES Group	MS Group	*P* Value
Mean Cobb's angle (°± SD)				
Preop	23.34 ± 6.44	23.77 ± 6.90	22.79 ± 5.98	0.666
3 months	24.11 ± 5.58	24.50 ± 5.86	23.62 ± 5.38	0.655
12 months	24.32 ± 5.72	24.48 ± 5.69	24.12 ± 5.96	0.859
PI (°± SD)				
Preop	51.02 ± 7.21	51.42 ± 8.24	50.51 ± 5.89	0.720
3 months	50.33 ± 7.08	50.64 ± 8.39	49.93 ± 5.22	0.763
12 months	50.59 ± 7.12	51.47 ± 8.48	49.48 ± 4.95	0.400
LL (°± SD)				
Preop	38.26 ± 6.98	37.70 ± 7.88	38.97 ± 5.83	0.607
3 months	37.81 ± 6.32	36.82 ± 7.03	39.07 ± 5.24	0.309
12 months	38.19 ± 6.56	37.59 ± 7.29	38.95 ± 5.66	0.559
PI-LL (°± SD)				
Preop	12.76 ± 5.63	13.72 ± 6.05	11.54 ± 4.99	0.269
3 months	12.51 ± 6.13	13.82 ± 6.30	10.85 ± 5.69	0.165
12 months	12.40 ± 6.05	13.87 ± 6.60	10.53 ± 4.86	0.111

Table 5. *Adverse events of patients over time.*

	No. of Patients (%)			*P* Value
	Overall	ES Group	MS Group	
Any adverse event	7 (20.59)	2 (10.53)	5 (33.33)	0.199
Postoperative Cognitive Dysfunction	4 (11.76)	0	4 (26.67)	0.029
CSF Leakage	1 (2.94)	0	1 (6.67)	0.441
Dural tear	1 (2.94)	1 (5.26)	0	1.000
Nerve Root Injury	0	0	0	-
Infection	0	0	0	-
Reoperation	1	1 (5.26)	0	1.000

CSF = Cerebrospinal fluid

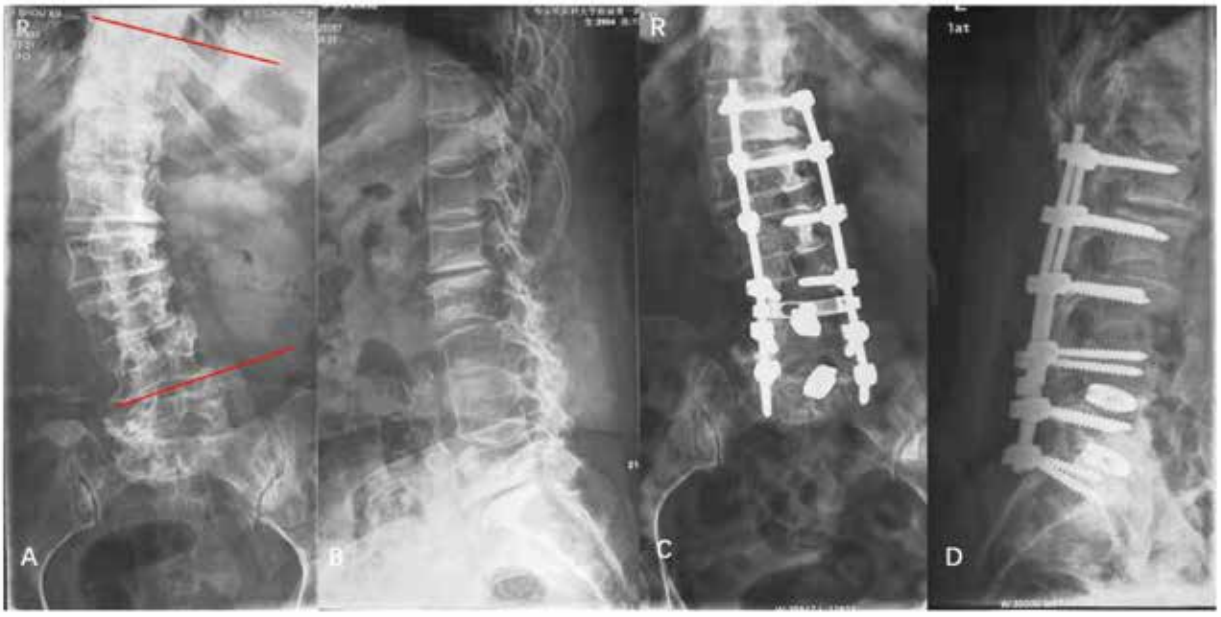

Fig 3. *Reoperation of one patient after discectomy in the ES group.*

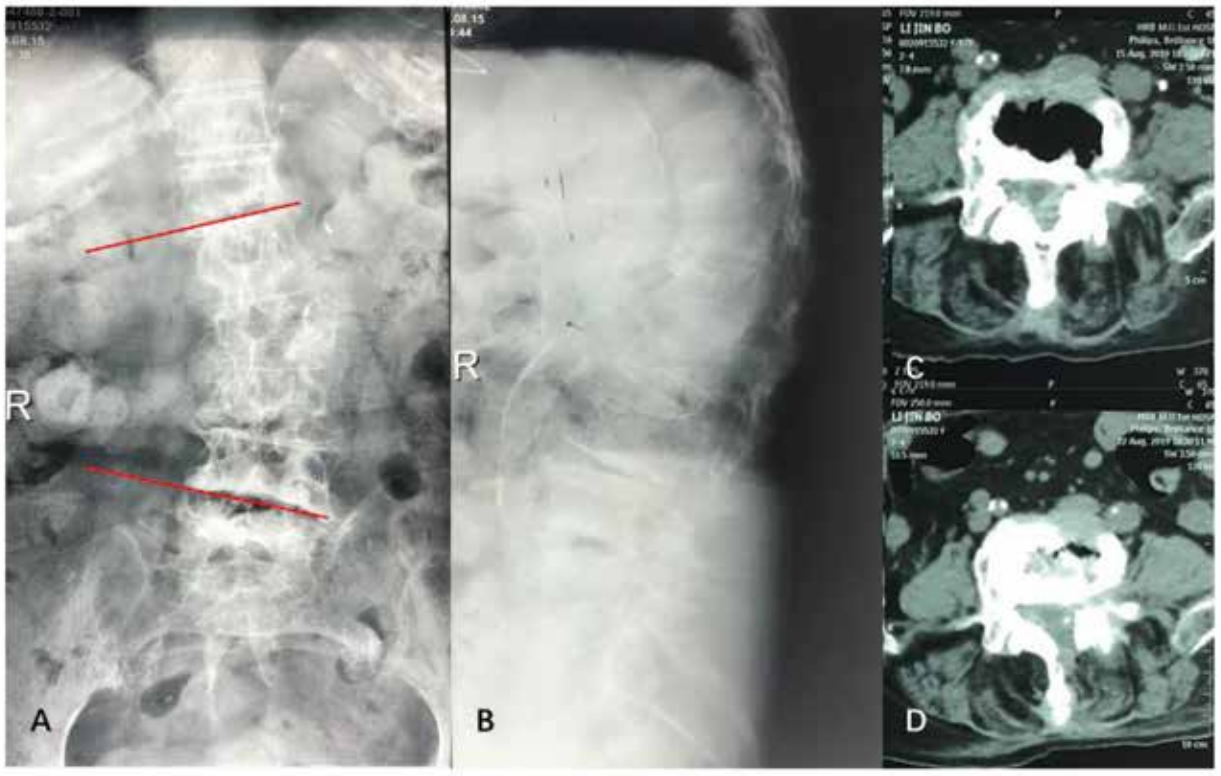

Fig 4. *The space of interlaminar decompression with a 10-mm endoscope.*

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