A comparison of clinical outcomes between percutaneous endoscopic laminectomy decompression and traditional laminectomy decompression in Thoracic Ossification of Ligamentum Flavum with CT classification of type unilateral segments.

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Research article

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Abstract

Background: The aim of this study was to compare the effectiveness and safety of percutaneous endoscopic laminectomy decompression and traditional laminectomy decompression in the treatment of Thoracic Ossification of Ligamentum Flavum (T-OLF) with CT classification of type unilateral segments.

Methods: We executed a retrospective study on 24 cases of T-OLF with CT classification of type unilateral segments between May 2015 and January 2018. All the patients were divided into two groups based on the relation to surgical methods. Patients in group A underwent percutaneous endoscopic laminectomy, and in group B underwent traditional laminectomy. According to the selection criteria, there were 10 patients in group A and 14 patients in group B. We mainly analyzed and compared the clinical, radiologic, perioperative outcomes, and surgery-related complications of the two groups of data.

Results: Both groups improved significantly in the following projects the JOA scores, mean JOA recovery rate, leg pain and radiologic results of decompression. However, no significant difference was found between the two groups. One case occurred dural tear in the early phase of percutaneous endoscopic laminectomy group. One patient occurred dural tear in during removal of OLF adhered to the dura mater in traditional laminectomy group. There were no cases of failure or recurrence in both groups. The percutaneous endoscopic laminectomy group have significant advantages in the following areas: back pain recovery, blood loss, hospital stay, hospitalization expenses and return-to-work. No post-laminectomy kyphosis was observed in any patients.

Conclusions: Although percutaneous endoscopic laminectomy in thoracic region has a steep learning curve, percutaneous endoscopic laminectomy seemed to be an alternative surgical for T-OLF, type unilateral segments.

Background

Ossification of ligamentum flavum of thoracic spine is a relatively rare factor which ultimately result in acquired thoracic spinal canal stenosis. However, the incidence is mainly distributed in the Asian population [1–2]. The prevalence of population in Japanese is 36% [3] and 3.8% in China [4]. It's a slow progressive lesion. Naturally, patients eventually admitted to our department when their symptoms are more serious for severe spinal cord compression. Patients with T-OLF always complain about trunk or lower extremities sensory abnormality, gait disturbance and urinary dysfunction [5]. Because of the poor response to conservative therapy [6], surgical intervention is always needed. It is believed that posterior decompression can achieve satisfactory surgical results in patients with T-OLF [7]. At present, the main operation methods are laminoplasty, partial laminectomy, enbloc laminectomy, lamina fenestration technique and percutaneous endoscopic spine minimally invasive technique [8–12]. Nevertheless, there are few literature compares the effectiveness and safety between percutaneous endoscopic laminectomy and traditional laminectomy in T-OLF with CT classification of type unilateral segments.

We performed a study to compare the surgery related complications and clinical outcomes between percutaneous endoscopic laminectomy and traditional laminectomy in Thoracic Ossification of Ligamentum Flavum with CT classification of type unilateral segments. To our knowledge, this is the first study to compare the effectiveness between percutaneous endoscopic laminectomy and traditional laminectomy in Thoracic Ossification of Ligamentum Flavum with CT classification of type unilateral segments.

Methods

Study Design

A total of 24 consecutive patients with T-OLF of type unilateral segments who underwent surgical treatment between May 2015 and January 2018 were entered in this study. The inclusion criteria were as follows: (1) OLF-involved only one segment with thoracic spine radiographs, computed tomography(CT), and magnetic resonance image (MRI) corresponding to the clinical symptoms; (2) According to CT morphological classification, it belongs to type unilateral segments (Fig. 1); (3) Regular conservative treatment is ineffective above for 12 months before surgery.; (4) All operations are performed by the same doctor; and (5) follow-up for at least one year. Those who meet the following conditions were excluded: (1) Patients with other neuromuscular diseases; (2) Patients could not complete the follow-up records; and (3) Can't complete the preoperative and postoperative questionnaires very well.

All patients were divided into two groups according to the surgical methods. Patients in group A underwent percutaneous endoscopic laminectomy, and in group B underwent traditional laminectomy. All operations are performed by the same spine surgeon.

CT classification

According to the morphologic features of the CT scan thoracic-OLF can be divided into three types which include unilateral segments, bilateral and fused. The main character of the type unilateral segments is unilateral laminar ossification (Fig. 1A), type bilateral is characterized by bilateral ossification, can be asymmetry, but bilateral non-fusion (Fig. 1B), as for the characteristics of type fused, bilateral ossification fuses into one plate (Fig. 1C).

Neurological assessment

We use the modified Japanese Orthopaedic Association (JOA) scoring system [13] to evaluate the neurological status of patients before, 6 months after and 12 months after surgery decompression. As shown in Table 1, with 11 scores indicates normal function, total score ≤ 3 means severe neurological impairment, 4–6 means moderate, and ≥ 7 means mild [14]. Postoperative improvement of symptoms was estimated by the recovery rate (RR)= (postoperative JOA score − preoperative JOA score) / (11 − preoperative JOA score) × 100%. A score range from 75 to 100% means an excellent therapeutic effect, 50–74% as good, 25–49% as fair and 0–24% regarded as a poor effect [14]. At the same time the patients who were asked to finish a questionnaire which is consisted of a 10-point back and leg visual analog scale (VAS) for low back pain and leg pain preoperative and follow-up time points by their own.

Table 1. Modified Japanese Orthopaedic Association scoring system for thoracic myelopathy

Neurological status	Score
Lower-limb motor dysfunction	
Unable to walk	0
Able to walk on flat floor with walking aid	1
Able to walk up/downstairs with handrail	2
Lack of stability and smooth reciprocation of gait	3
No dysfunction	4
Lower-limb sensory deficit	
Severe sensory loss or pain	0
Mild sensory deficit	1
No deficit	2
Trunk sensory deficit	
Severe sensory loss or pain	0
Mild sensory deficit	1
No deficit	2
Sphincter dysfunction	
Unable to void	0
Marked difficulty in micturition	1
Minor difficulty in micturition	2
No dysfunction	3

Postsurgical evaluation

The evaluation of surgical efficacy is mainly reflected in the following aspects: operation time, blood loss, JOA score, back and leg VAS scores, hospital stay, hospitalization expenses,return-to-work time, complication rate, failure rate, and 12-month reherniation rate.

Radiological evaluation

Preoperative imaging data mainly include of ordinary X-ray, computed tomography, magnetic resonance imaging (MRI), and electromyography. After the operation, we also routinely performed ordinary X-ray, computed tomography and compared them with those before the operation to prove that the decompression was adequate

Surgical procedures

Traditional laminectomy

All operations at the involved levels were performed by a 20-year-old spine surgeon.

Routine intraoperative somatosensory-evoked potentials for all patients. Briefly, under general anesthesia, patients were placed in the prone position and fully exposed the posterior structure of the spine through a straight longitudinal incision centered over the diseased segment. After the necessary exposure, the vertebral lamina was taken out with detacher. The decompression covered at one level area which affected by the OLF. The width of the laminectomy was approximately one-third to one-half portion of the facet joint and could extend when ossification of the facet joint capsules occurred. When vertebral lamina was resected venous plexus bleeding can be seen, electrocautery, gelatin sponge strips and neuro patties can help stop hemostasis.

In order to reconstruction normal spinal alignment and restore spinal stability, posterior fixation is necessary with pedicle screws and longitudinal rods. After that, carefully suture the paravertebral muscle and place the drainage tube. All patients were required to stay in bed strictly for at least 3 days after operation, and discharge may be considered when wound healing is good. (Fig. 2).

2.3. Percutaneous endoscopic surgery

All percutaneous endoscopic laminectomy for the T-OLF at the involved levels were executed by a highly sophisticated spine surgeon. Local anesthesia was applied for all patients. Namely, we routinely use intraoperative motor evoked potentials to observe spinal cord activity in all patients.

All patients were operated in prone position with fluoroscopic guidance, by the use of fluoroscopic guidance the operative segment was defined and the needle insertion point was marked. Local infiltration anesthesia for the needle insertion point, after that an 18-gauge spinal needle was introduced with the fluoroscopic guidance. The standard position of needle tip at the medial margin of the facet joints on the anteroposterior projection and the trailing edge of the lamina on the lateral projection. Confirmation of good position of needle tip by repeated fluoroscopy, a guidewire was placed through the spinal puncture needle, and a working channel was placed according to the guidewire. A continuous fluid flow of 0.9% saline solution can ensure clear vision of surgery. Endo forceps and radiofrequency were used to remove some soft tissue and hemostasis which is good for maintaining clear vision. Using an endoscopic high-speed drill to grind the lamina carefully is main thought of this technical, ossified ligamentum flavum can be seen when the lamina is worn out. After that, slowly rotating the working channel into the spine canal. Careful use of drill to thin the ossified ligaments. When ossified ligaments are grind as thin as paper,the endo forceps may be a good device for removing the remain ossified ligamentum flavum which requires careful operation. The key to the surgery is to ensure that the dural sac was fully exposed, and pulsation well. Finally, the working channel and the endoscope were taken out and the skin was closed without suction drainage (Fig. 3).

Statistical analysis

All statistical analyses were carried out by SPSS 22.0 software. The differences in the results were compared between the two groups by an independent-sample t-test. Differences were considered statistically significant when the P value was < 0.05.

Results

Demographics

10 patients in group A and 14 patients in group B who meet our requirements of inclusion and exclusion criteria. Patient's basic information including the Mean duration of symptoms, Chief complaints and follow-up period were not significantly different between the 2 groups (Table 2)

Table 2
Comparison of the baseline information of the two groups.

Characteristics	Group A	Group B	P Value
Number of patients	10	14	
Mean age,(year)	62.38 ± 12.23	62.79 ± 11.46	P > 0.05
Sex, male/female	6/4	8/6	
Mean duration of symptoms(month)	15.23 ± 13.79	16.18 ± 12.93	P > 0.05
preoperative thoracic kyphosis	30.24 ± 7.19	29.53 ± 6.78	P > 0.05
Chief complaints			
numbness and sensory dysfunction	8	7	
weakness of the lower extremities	7	6	
gait disturbance	6	4	
tightness sensation of the trunk	3	2	
urinary disturbance	4	2	
local back pain	6	7	
Preoperative JOA	3.80 ± 0.29	3.86 ± 0.21	P > 0.05
Preoperative back VAS scores	6.60 ± 0.43	6.29 ± 0.30	P > 0.05
Preoperative leg VAS scores	6.30 ± 0.42	6.14 ± 0.29	P > 0.05
Follow-up (month)	25.01 ± 12.03	23.17 ± 13.43	P > 0.05

Clinical Outcomes

The mean JOA scores at 6 months and 12 months after operation were significantly better than those before operation ($P < 0.05$) and the mean JOA recovery rate was 75.48 ± 4.63% (range 50.00–100%) at 12 months after operation in group A. In group B the mean JOA scores at 6 months and 12 months after operation were significantly better than those before operation ($P < 0.05$) and the mean recovery rate was 75.71 ± 4.45% (range 42.80–100%) at 12 months after operation. However, there was no significant difference between the groups for JOA scores at 6 months and 12 months after operation (Table 3 and Fig. 4). Ten patients underwent percutaneous endoscopic laminectomy, surgical outcome was excellent in 6 (60.0%) patients, good in 4 (40.0%) patients, fair in 0 (0%) patient and poor in 0 (0%) patient. Fourteen patients underwent traditional laminectomy, surgical outcome was excellent in 10 (71.4%) patients, good in 3 (21.4%) patients, fair in 1 (7.2%) patients and poor in 0 (0%) patient. There was no significant difference between these two subgroups of surgical outcome. In group A the leg VAS scores were 6.30 ± 0.42 and 6.14 ± 0.29 in group B before surgery. While, in group A the back VAS scores were

6.60 ± 0.43 and 6.29 ± 0.30 in group B before surgery (Table 2). One year after the operation, the VAS scores for the back and leg decreased significantly in both groups. the back and leg VAS scores were 0.50 ± 0.17 and 0.20 ± 0.13 in group A and 0.64 ± 0.13 and 0.29 ± 0.13 in group B (Table 3). But six months after surgery, there were significant differences between the groups for back VAS score ($P < 0.01$) with back VAS scores were 1.00 ± 0.26 in group A and 3.64 ± 0.31 in group B (Table 3). However, there was no significant differences between the groups for leg VAS score six months after surgery (Table 3 and Fig. 5).

Table 3
Summary of Perioperative Outcomes, Complications,Failure, and Recurrence Rate

	Group A(n = 10)	**Group B(n = 20)**	**P Value**
Op time, min	151.10 ± 15.51	147.60 ± 11.69	P > 0.05
EBL, ml	23.30 ± 4.35	275.70 ± 50.34	P < 0.05
Hospital stay, days	2.20 ± 0.25	7.07 ± 0.20	P < 0.05
6 months after operation JOA	8.70 ± 0.47	8.93 ± 0.36	P > 0.05
12 months after operation JOA	9.20 ± 0.36	9.36 ± 0.29	P > 0.05
JOA recovery rate(%)	75.48 ± 4.63	75.71 ± 4.45	P > 0.05
6 months after operation back VAS	1.00 ± 0.26	3.64 ± 0.31	P < 0.05
12 months after operation back VAS	0.5 ± 0.17	0.64 ± 0.13	P > 0.05
6 months after operation leg VAS	0.50 ± 0.17	0.71 ± 0.16	P > 0.05
12 months after operation leg VAS	0.20 ± 0.13	0.29 ± 0.13	P > 0.05
Postoperative thoracic kyphosis	30.18 ± 7.26	30.06 ± 6.68	P > 0.05
Complications	10.00%	7.14%	P > 0.05
Failure rate, n(%)	0	0	P > 0.05

Radiologic Outcomes

The preoperative thoracic kyphosis was 30.24 ± 7.19° in group A and 29.53 ± 6.78° in group B (Table 2). The postoperative thoracic kyphosis was 30.18 ± 7.26° in group A and 30.06 ± 6.68° in group B (Table 3). there was no significant difference between the groups. All of the patients were fully Lamina decompressed.

Perioperative Outcomes

The mean operating time in group A (151.10 ± 15.51 minutes) roughly equal as compared with group B (147.60 ± 11.69 minutes) ($P = 0.35$)(Table 3 and Fig. 5). The mean intraoperative blood loss was significantly lower in group A (23.30 ± 4.35 mL) as compared with group B (275.70 ± 50.34) ml ($P < 0.05$)（Table 3 and Fig. 6）. The mean hospital stay was significantly shorter in group A (2.20 ± 0.25days) as compared with group B (7.07 ± 0.20 days) ($P < 0.05$)（Table 3 and Fig. 5）. The mean return-to-work time was significantly shorter in group A as compared with group B ($P < 0.05$).

Complications

There was one patient who occurred a small dural tear, making for an incidence of 10.00% in group A. Fortunately, no obvious cerebrospinal fluid leakage was found. The patient recovered normally through conservative treatment without prolonging hospital stay. No other postoperative complications were observed. In group B, dural tear occurred in one patient (7.14%) during removal of OLF adhered to the dura mater. We repaired the dura immediately during the operation, but the patient still complained about headache after surgery. To relieve headache symptoms, the patient was asked to keep in the dorsal elevated position in bed for about 2–3 days after operation. When the drainage volume is less than 50 ml per 24 h, pull out the subfascial drain. No other postoperative complications were observed. All the operations went smoothly without failing.

Discussion

T-OLF is not an uncommon disease in Japan and other Asian countries with an incidence rate of 5.1 per Million [15]. Since the course of T-OLF is more insidious and slow, when the symptoms are obvious, it means that the spinal cord is severely compressed [16]. Patients with T-OLF may complained about muscle weakness, gait disturbance, numbness and sensory disturbance of the lower limb [5]. So surgical intervention is generally necessary for symptomatic OLF due to ineffective by using conservative treatment. Decompressive surgery is recommended and should be performed if paralysis has developed [6–7, 17]. Some studies have discussed use traditional laminectomy for patients with T-OLF and few literatures have discussed use percutaneous endoscopic laminectomy through an interlaminar approach to treat Thoracic Ossification of Ligamentum Flavum (T-OLF) with CT classification of type unilateral segments. However, the comparison between traditional laminectomy and percutaneous endoscopic laminectomy for Thoracic OLF with CT classification of type unilateral segments has not been reported yet. Hence, we performed this study to compare the effectiveness between percutaneous endoscopic laminectomy and traditional laminectomy in the treatment of T-OLF with CT classification of type unilateral segments.

At present, a great majority literatures share the view that traditional laminectomy is still regarded as a standard technique in the treatment of OLF [8, 17]. Thomé et al [18] maintain the position that traditional laminectomy had more blood loss, incidental durotomy, infection and poor patient satisfaction compared with less invasive laminotomy. Okada et al [19] reported that 10 of 14 patients with thoracic OLF underwent laminectomy, only 3 achieved satisfactory results. The poor results are mainly caused by the following aspects: spinal cord injury, thoracic kyphosis and recurrence. In group B all the patients were treated with ultrasonic bone curette for lamina decompression, which produced effective neurological recovery. 13 of the 14 patients exhibited improvement of neurological function (excellent and good results). Dural injury is one of the most common complications during decompressive laminectomy because of adhesions between the dura and the ossified lesions. Especially, The dura is involved in the ossification [20]. The incidence rate was approximately 10–32% of procedures [21]. In our study, dural tear occurred in two patients (8.33%) during removal of OLF adhered to the dura mater. But no patient experienced neurological deterioration at the final follow-up compared with preoperatively. The overall JOA recovery rate at final follow-up was 75.71 ± 4.45% (range 42.80–100%) in group B, which is higher comparable to reported rates of 60.50–65.00% in the literature [17, 20]. This phenomenon is mainly due to the relatively short mean duration of symptoms in our patients and all patients in our study are type unilateral segments according to the CT classification.

In recent years, minimally invasive spinal surgery technology has developed rapidly. Percutaneous endoscopic surgery is one of the most advanced minimally invasive spinal surgery at present. Since 1999, Yeung et al [22] proposed the spinal endoscopic YESS system, percutaneous endoscopic technique has been used for about 20 years, which is more and more popular with doctors, and it has become a hot spot and direction of spinal surgery. Now days, spinal endoscopy technique is mainly used in the field of lumbar spine and cervical spine. There are still few relative discussions about the use of percutaneous spine endoscopic technique in the field of thoracic spine especially for patients with Thoracic Ossification of Ligamentum Flavum. Only one literature has reported percutaneous endoscopic spine technique in the treatment of Thoracic Myelopathy Caused by OLF [12]. However, it only provided two cases which may influence the results. And mean duration of follow up, complications, thoracic kyphosis, and surgical outcome is not included in their study. Percutaneous spine endoscopic technique is one of the minimally invasive surgery and has many advantages compared with traditional laminectomy surgery. Specific advantages are manifested in operating the surgery under local anesthesia, less intraoperative hemorrhage, back pain, significantly shorter hospitalization time, preserved normal posterior and paraspinal structures [23]. In our study, we compared the surgical results of percutaneous endoscopic laminectomy with those of traditional laminectomy surgery in Thoracic Ossification of Ligamentum Flavum (T-OLF) with CT classification of type unilateral segments. Percutaneous endoscopic surgery yielded clinical outcomes superior to traditional laminectomy surgery in terms of shortened admission days, decreased total blood loss, and lessened postoperative pain. In our studies, we found that there were significant differences between the groups for the back VAS at 6 months after surgery and no significant differences at 12 months after surgery. While there were no significant differences between the groups for the leg VAS at 6 and 12 months after surgery. A good many of literatures have analyzed the causes of this phenomenon, the main reason is that percutaneous endoscopic laminectomy preserve normal paraspinal structures, which was thought to be the high risk factor for postoperative back pain [24]. Operating traditional laminectomy requires extensive resection of muscles and posterior structures such as the lamina, yellow ligament, and facet joint, which may affect the stability of spinal structure causing postoperative back pain as well as physical and mental statuses [25]. For CT classification of type bilateral segments, we have performed two cases. First, we treated one side with more severe ossification, and then exposed the other side of ossified ligamentum flavum through inclined channels and patients. However, the management of the contralateral ligamentum flavum is dangerous, because the dura will gradually expand as the decompression progresses, which will hinder the decompression on the contralateral side. Although we had successfully completed these two operations, the risk of operations was high. Therefore, we recommend open surgery for patients with type bilateral and fused segments. Because of our small number of cases and limited follow-up time, there were no recurrent cases in the both groups.

We want to place great emphasis on that the crucial of training and surgical experience as percutaneous endoscopic laminectomy surgery has a steep learning curve [26]. It is universally known that percutaneous endoscopic surgery is difficult to perform in the thoracic region than in the lumbar region. A good grasp of the anatomical features of the thoracic spine is needed which can reduce surgical complications. Naturally, systematic training on the use of the endoscope system in lumbar region is needed to improve surgical outcomes.

Conclusion

From our point of view, percutaneous endoscopic laminectomy seemed to be an alternative surgical in the treatment of T-OLF with type unilateral segments with satisfactory effect in back pain, less intraoperative hemorrhage and a significantly shorter hospitalization time, although a long learning curve needs to be overcome.

Abbreviations

T-OLF Thoracic Ossification of Ligamentum Flavum

OLF Ossification of ligamentum flavum

CT Computed tomography

MRI Magnetic resonance image

JOA The modified Japanese Orthopaedic Association

ODI Oswestry Disability Index

VAS Visual analog scale

Declarations

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Availability of data and materials

All data analyzed during this study are included within the manuscript. The datasets used and/or analyzed during this study are available from the first author (Hui.Wu) on reasonable request.

Authors' contributions

XGC and HW contributed to the concept and design of the study. WZH, DWH performed the data analysis. JJD and JY contributed to the statistics of data and manuscript revision. All authors read and approved the final manuscript.

Ethics approval and consent to participate

The Ethics Committee of the second affiliated hospital of nan chang university approved this study. All participants signed informed consent for using their data for the research purposes.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Figures

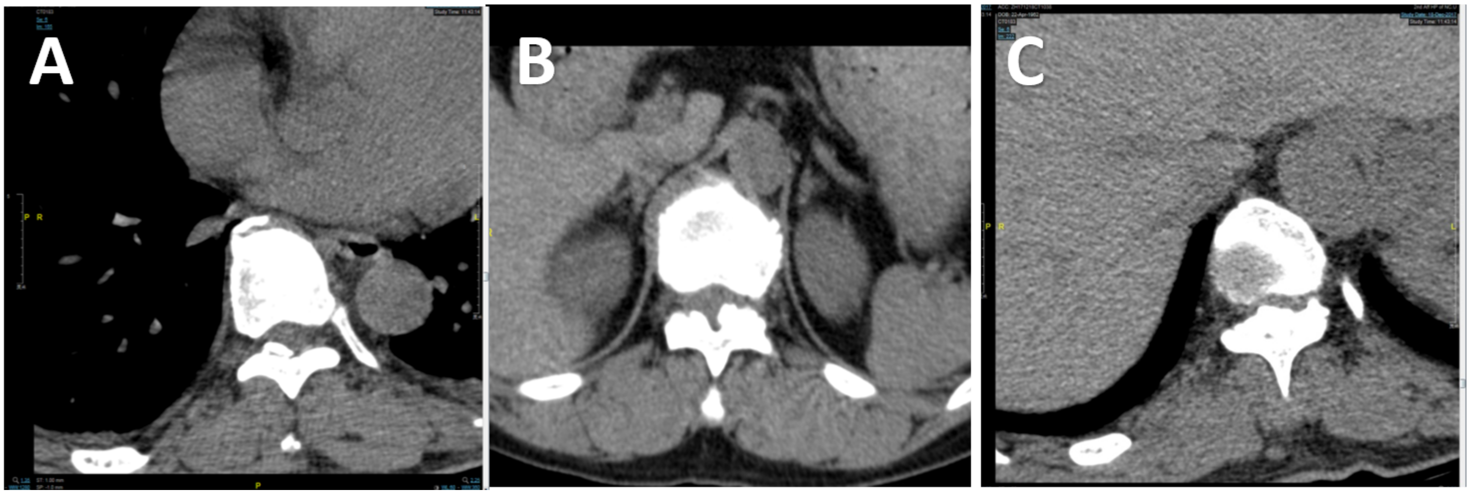

Figure 1

Thoracic Ossification of Ligamentum Flavum with CT classification. type unilateral segments is unilateral laminar ossification(A), type bilateral is characterized by bilateral ossification, can be asymmetry, but bilateral non-fusion (B), type fused, bilateral ossification fuses into one plate (C).

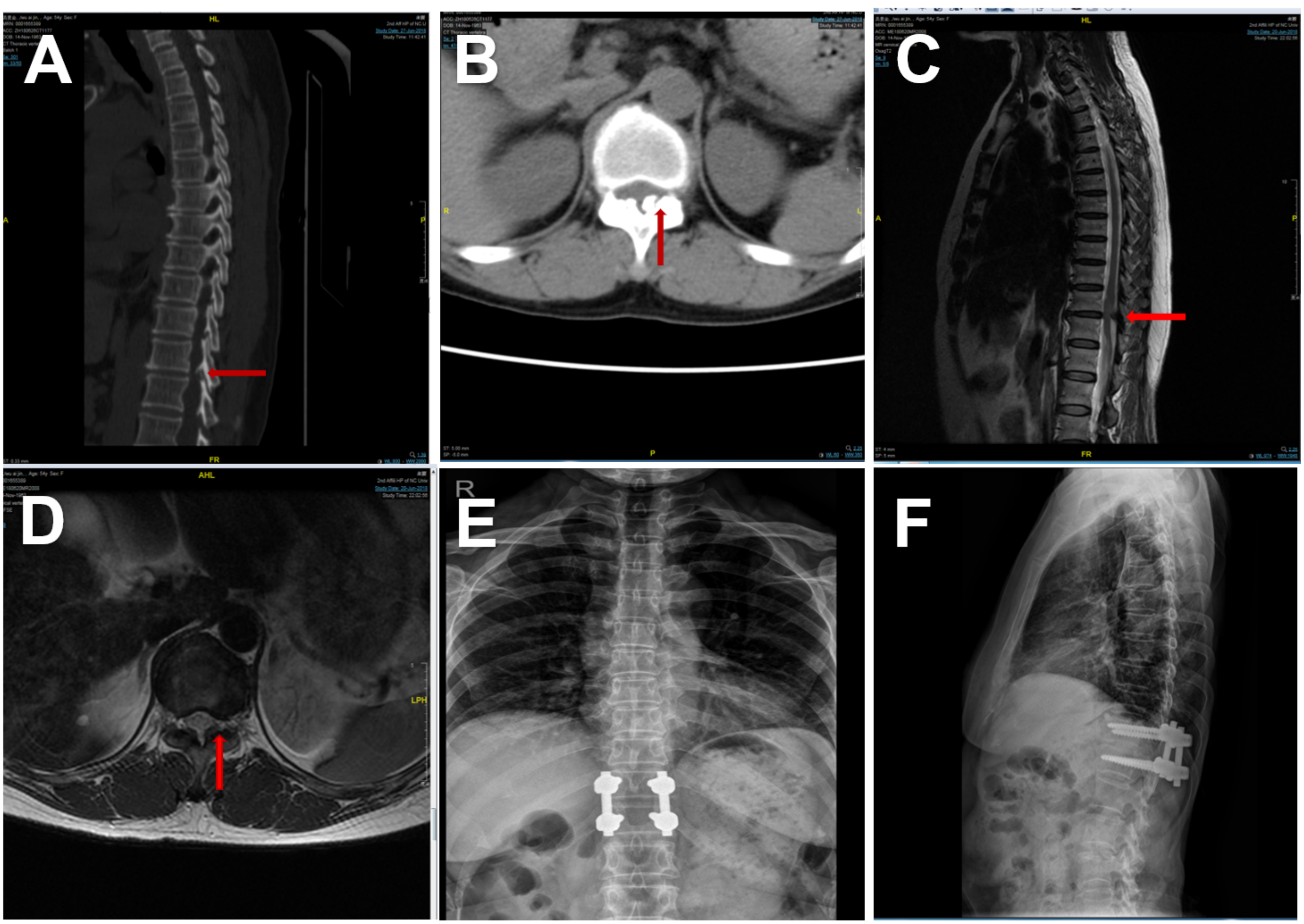

Figure 2

Preoperative images of CT (A/B) and MRI(C/D), Traditional laminectomy postoperative images of x-ray(E/F). Red arrows represent the affected segments and location of OLF in Location on sagittal and transverse planes.

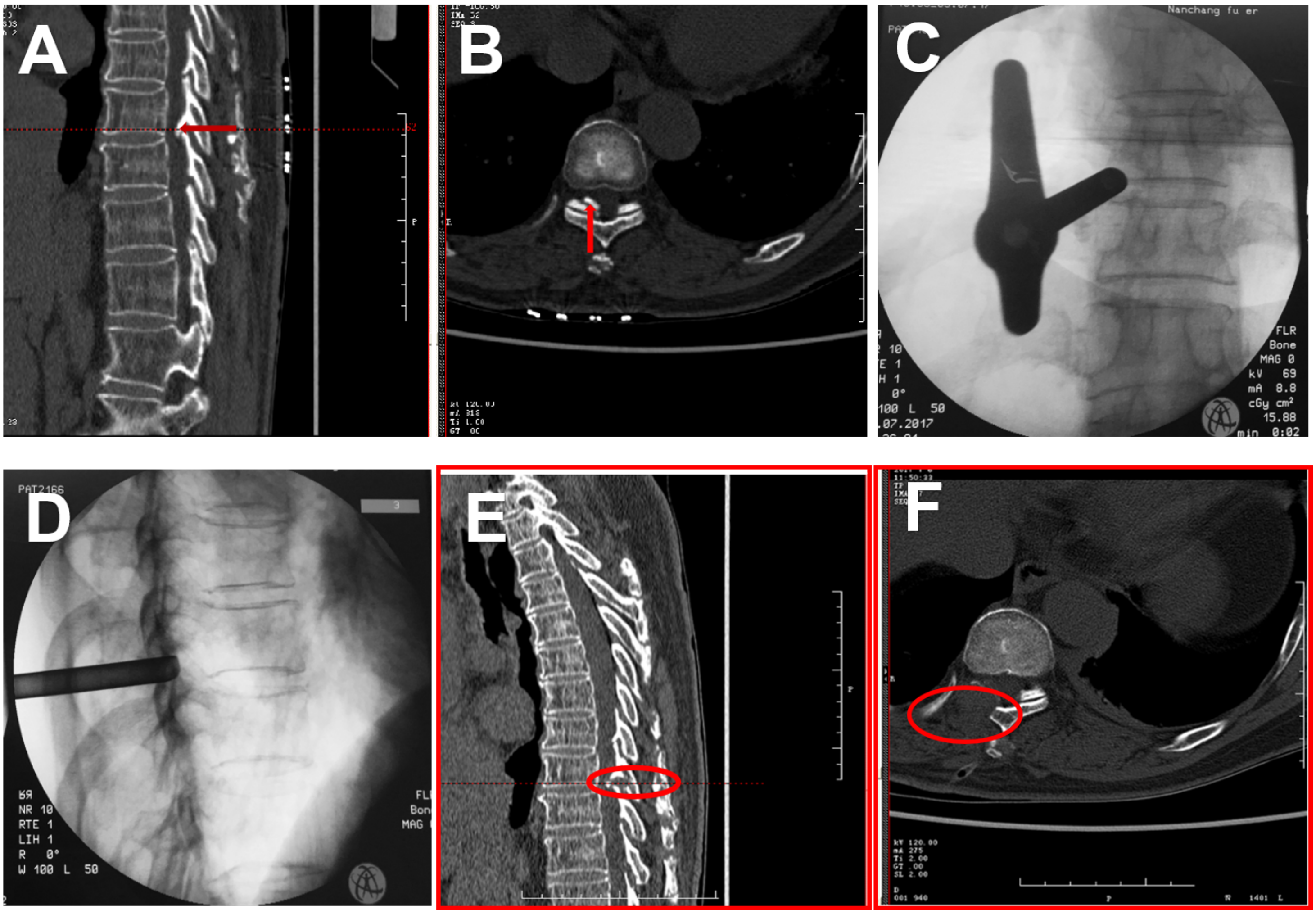

Figure 3

Preoperative images of CT (A/B) showed Ossification of ligamentum flavum located in the thoracic 9/10，which cause thoracic spinal canal stenosis，Working channel positioning (C) anteroposterior and (D) lateral view，Percutaneous endoscopic surgery postoperative images of CT (E/F)，red circles represent Ossified ligamentum flavum was removed.

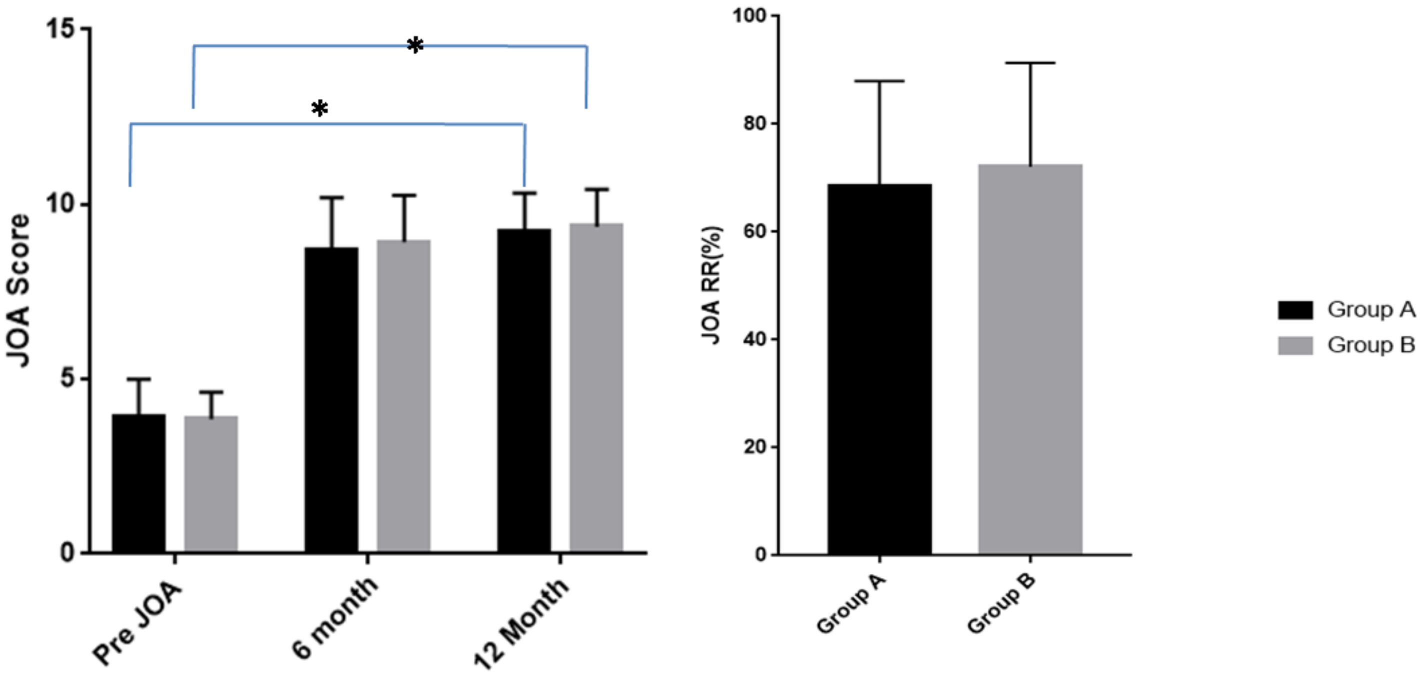

Figure 4

Clinical Outcomes using JOA Score（A）：*Statistically significant differences between preoperative and 6 months after operation (P<0.05).The mean JOA recovery rate（B）no significant differences between preoperative and 6 months after operation (P>0.05).

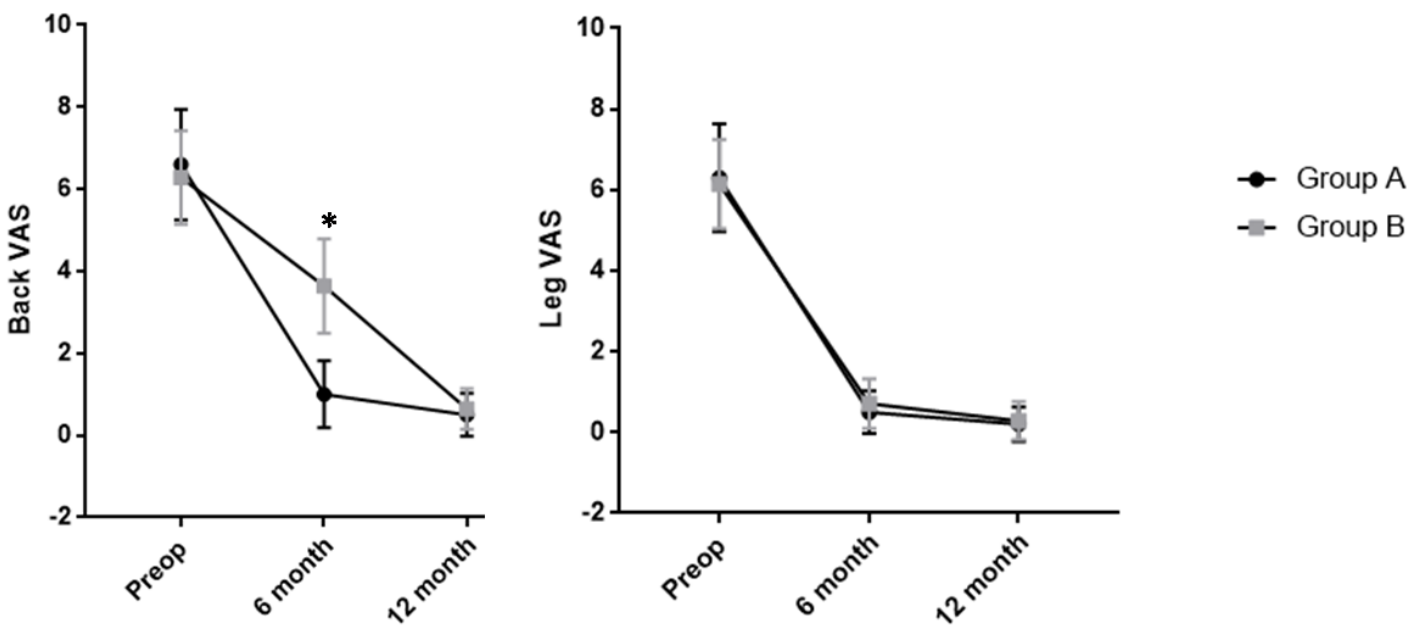

Figure 5

Clinical outcomes using visual analog scale (VAS) scores：back VAS scores (A) *Statistically significant differences between two groups at 6 months after surgery (P<0.05).The back VAS scores (B）no significant differences between two groups at 6 and 12 months after surgery.

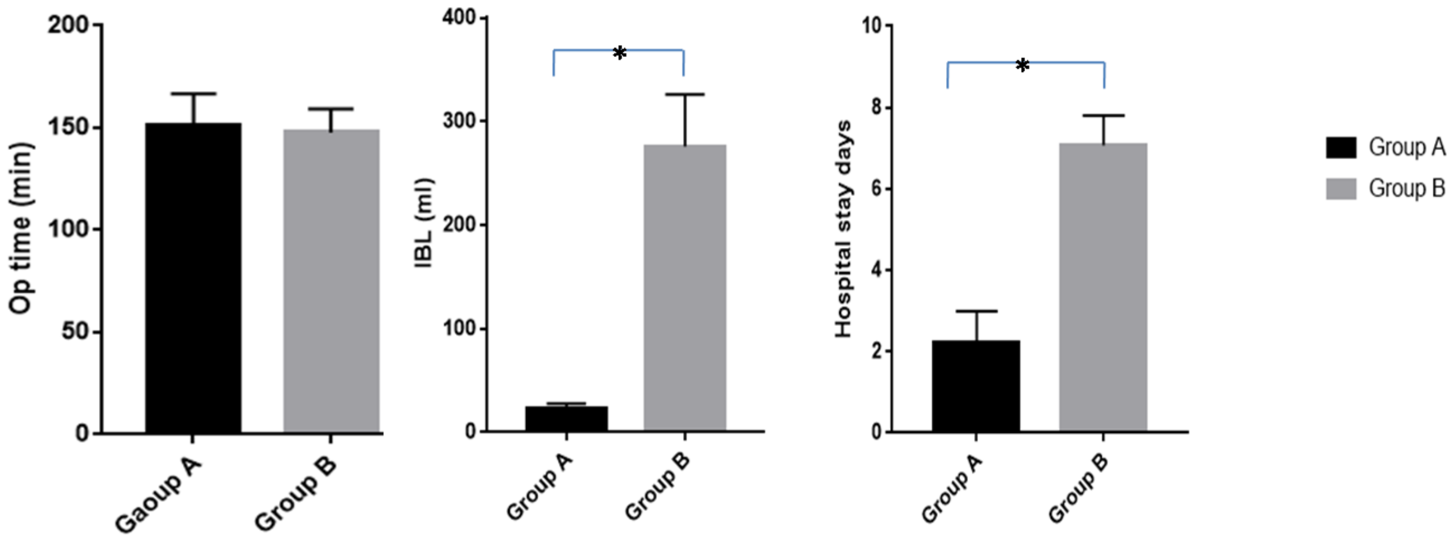

Figure 6

Perioperative Outcomes using mean operating time .No significant differences between two groups (P>0.05)（A）. Perioperative Outcomes using mean intraoperative blood loss. * Statistically significant differences between two groups (P < 0.05)（B）.Perioperative Outcomes using mean hospital stay. *Statistically significant differences between two groups (P<0.05) (C).