Int J Clin Exp Med 2016;9(6):9179-9186
www.ijcem.com /ISSN:1940-5901/IJCEM0015978

*Original Article*

# Long term effect of en bloc multi-laminectomy for the treatment of thoracic spinal canal stenosis

Yong Yang, Gang Liu, Yi-La-Tu Su

*The Affiliated Hospital of Inner Mongolia Medical University, Huhhot 010050, Inner Mongolia, China*

Received September 10, 2015; Accepted December 8, 2015; Epub June 15, 2016; Published June 30, 2016

**Abstract:** Object: We investigate the treatment effect of multi en bloc laminectomy thoracic spinal stenosis patients. Methods: 115 patients (65 men, 50 women, mean age, 57.5 years) who underwent multi-level en bloc laminectomy in our department were recruited successfully. Related medical data were recorded and compared. Results: Mean operative time was 150 minutes, mean blood loss was 400 ml and there was no post operative complication. All patients were ambulating normally after one week post-surgery. Operative results were examined using JOA scoring system and recovery rate. Significant difference in the average JOA score (8.435 + 2.655) at the last follow up was observed compared to preoperative statistical significance (t=-19.630, P < 0.01). The total effective recovery rate during the last follow up was 93% (107/115). Conclusions: The long-term follow-up results were satisfactory. Multi en bloclaminectomy is relatively safe and efficient for the treatment of thoracic spinal canal stenosis.

**Keywords:** Thoracic spinal stenosis, en bloc laminectomy, long-term effect, follow-up

## Introduction

Spinal stenosis is spinal canal narrowing caused by the compression of the neural elements. Of which thoracic spinal stenosis (TSS) [1, 2] is rare which often leads to myelopathy. The precise etiology of TSS is unknown. It's clinical manifestation caused by various developmental factors such as degeneration of the intervertebral disc herniation, osteophyma, facet joint hyperplasia, ossification of the posterior longitudinal ligament (OPLL), Paget's disease, ankylosing spondylitis, acromegaly, achondroplasia, osteochondrodystrophy, diffuse idiopathic skeletal hyperostosis (DISH), and various forms of rickets [2]. It is reported that more than 80% of thoracic spinal canal stenosis are caused by thoracic ossification of ligamentumflavum (OLF) [3], followed by thoracic disc herniation (TDH), and ossification of the posterior longitudinal ligament (OPLL) [4].

In 1971, Nakanishi reported that thoracic ossification of posterior longitudinal ligament could cause thoracic spinal canal stenosis. It is more commonly reported in East Asian countries and usually affects adults 40 to 60 years of age. In the same year, Marzluff reported the process of articular thoracic vertebra hyperplasia that could oppress the thoracic spinal cord. However, thoracic spinal stenosis was first reported in China at 1980 [5]. The occurrence of thoracic spinal stenosis is rare, but it could cause lumbago and walking difficulties, which affect the quality of life of the patients.

Earlier clinical reports suggest that immediate decompression of spinal compression by surgery is highly effective in the patients diagnosed with thoracic spinal canal stenosis. Early surgery could avoid the occurrence of irreversible damage to the spinal cord. Most clinical experts indicate that once the thoracic spinal canal stenosis is diagnosed, and the symptoms of spinal cord compression, decompression emerged, early operation is the only effective treatment. Early operation could avoid the occurrence of irreversible damage to the spinal cord. Currently, posterior decompression laminectomy is often adopted operation mode for thoracic spinal stenosis, which includes laminectomy, laminectomy fenestration, semi laminectomy, and drilling decompression laminectomy [6-9]. However, there are many disputes

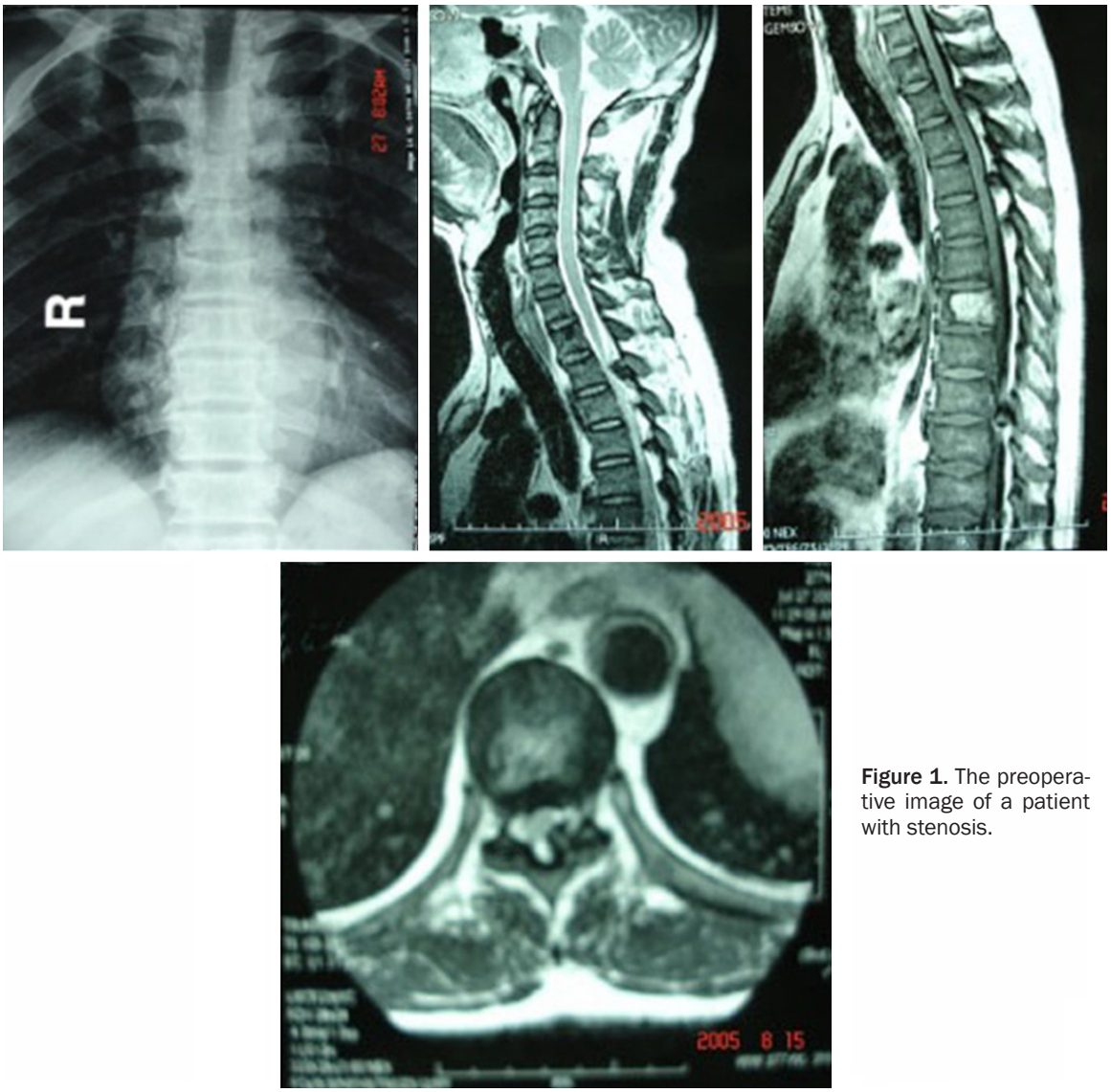


**Figure 1.** The preoperative image of a patient with stenosis.

and challenges in the operative mode of thoracic spinal stenosis [6-10]. In this study, we report the effect of multi en bloc laminectomy methods for the treatment of thoracic spinal stenosis in a single hospital.

## Patients and methods

*Patients and ethnic consideration*

This study was approved by the ethnic committee of The Affiliated Hospital of Inner Mongolia Medical University. Screening, treatment, and the follow up results of the patients were obtained after their given written informed consent. The study was carried out under the guidelines of the Declaration of Helsinki.

*Patients' information*

This study assessed 115 patients (65 men, 50 women) with a mean age of 57.5 (range 45-78) years. Age range of the cases was 45-78 years (Average of 57.5 years). Average disease course was 6.9 months (range 2-180 months).

*Symptoms*

All patients had different degree of hypoesthesia or numbness caused by the compression in the spinal section and they all reported weakness in the lower limbs with stiffness, and instability in walking. Different symptoms in these patients were thoracic and abdominal areas of numbness in 37 patients, light reflex

**Table 1.** The distribution of segmental stenosis in 115 patients

| Thoracic segment | Affected segment number |
|---|---|
| T1 | 9 |
| T2 | 15 |
| T3 | 21 |
| T4 | 20 |
| T5 | 19 |
| T6 | 22 |
| T7 | 20 |
| T8 | 22 |
| T9 | 41 |
| T10 | 59 |
| T11 | 65 |
| T12 | 60 |
| Total | 374 |

abate or disappear in 52, patellar ankle reflex or hyperthyroidism in 54, pathological syndrome in 65, claudication in 32, and defecation dysfunction in 30.

*Preoperative evaluations*

All symptoms and pathological reflexes were evaluated and classified. Patients were evaluated pre- and 2 weeks postoperatively using the modified JOA scale ranged 2-9 points. For all patients, we obtained plain anteroposterior radiographs of the thoracic spine, magnetic resonance imaging (MRI) scans, and axial computed tomography (CT) scan. Preoperative JOA score [11] ranged 2-9 points, with an average of 6.67 + 1.76 points (Patient X, **Figure 1**). TSS with thoracic ossification of ligamentum flavum (OLF) (98 cases), with merger in the ossification of posterior longitudinal ligament (OPLL) (16 cases), multiple OPLL (14 cases), thoracic disc herniation (TDH) with OPLL (8 cases), only OPLL (6 cases), cervical spinal canal stenosis (4 cases), lumbar spinal stenosis with lumbar disc herniation (7 cases) and with had different degrees of combined cervical, thoracic, lumbar canal stenosis (2 cases). The recovery rate of JOA score is calculated using the following formula: recovery rate (%) n (postoperative score and preoperative score)/(score 11-preoperative)] × 100%, and the final result was divided into 5 group: excellent (75%-100%), good (50%-70%), improved (25%-49%), no change (0%-24%), and worsen (less than 0%). The distribution of segmental stenosis is shown in **Table 1**.

*Diagnosis and operation scheme*

According to the clinical manifestations and the imaging data, affected segment and related range were evaluated, and the decompression range was decided based on it. The patients underwent surgery with no systemic and local contraindication.

*Operation process*

General anesthesia was performed in prone position, and the median incision of compression levels were performed according to the clinical manifestation and imaging data. Routine exposure required decompression range of spinous process, lamina, and facet joint. The range of laminectomy should be more than 1 or 2 segments of the head and tail side, with facet along two sides of inner slotted rectangular lamina (**Figure 2A**).

Using a pointed nose bone rongeur or micro grinding drill, around 1 mm thick lamina was ground to residues. During this process, do not spit bone rongeur or drill grinding force into the spinal canal to avoid injury in the spinal nerve root. Using towel clamp holder, rectangular frame was placed in the range of spinous process or lamina. Periosteal elevator was placed into the bottom of the groove and lamina is multi sectioned and gelatin sponge compression or bipolar coagulator was used for hemostasis (**Figure 2B**).

When the dura adhered seriously, or part of dural ossification occurred, dural ossification was resected until the spine cord risen, and then the dura was repaired by fat or muscle. During this process, avoid cutting bone been shaken by bone knife, it may lead the equipment to enter the spinal canal and resection of lumbar laminae should avoid using laminectomy rongeur. When laminae are narrow, en bloc laminectomy incision of segment could be performed. For thoracic disc herniation within the decompression range, if the positioning is accurate, resection could be performed at one side of transverse section, and protruding was resected from the side front of the spinal disc tissue. After operation, 1-2 drainage tube was placed routinely at epidural, then suture of each layer of soft tissue were performed.

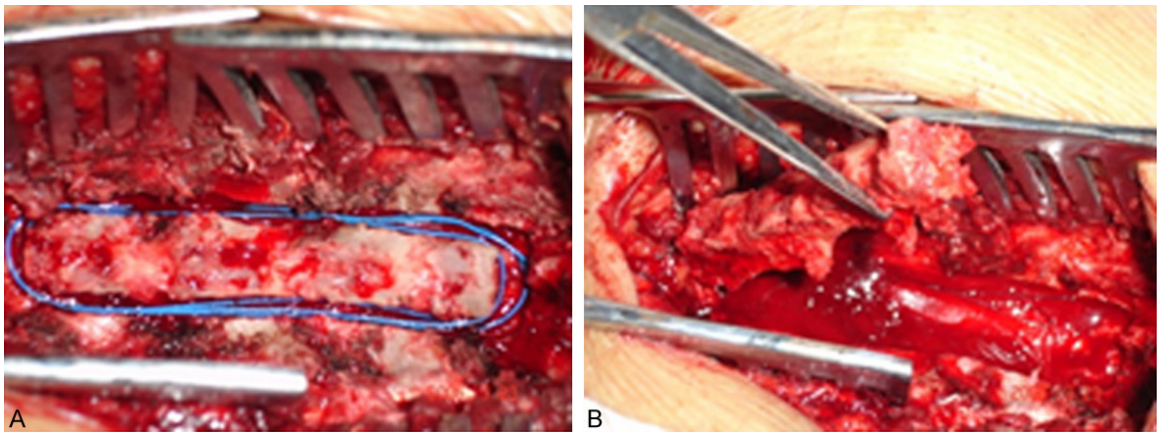


**Figure 2.** Surgical processes. A. Facet along both side of the vertebral edge showing slotted rectangular lamina; B. Entire multi-level laminectomy section is removed.

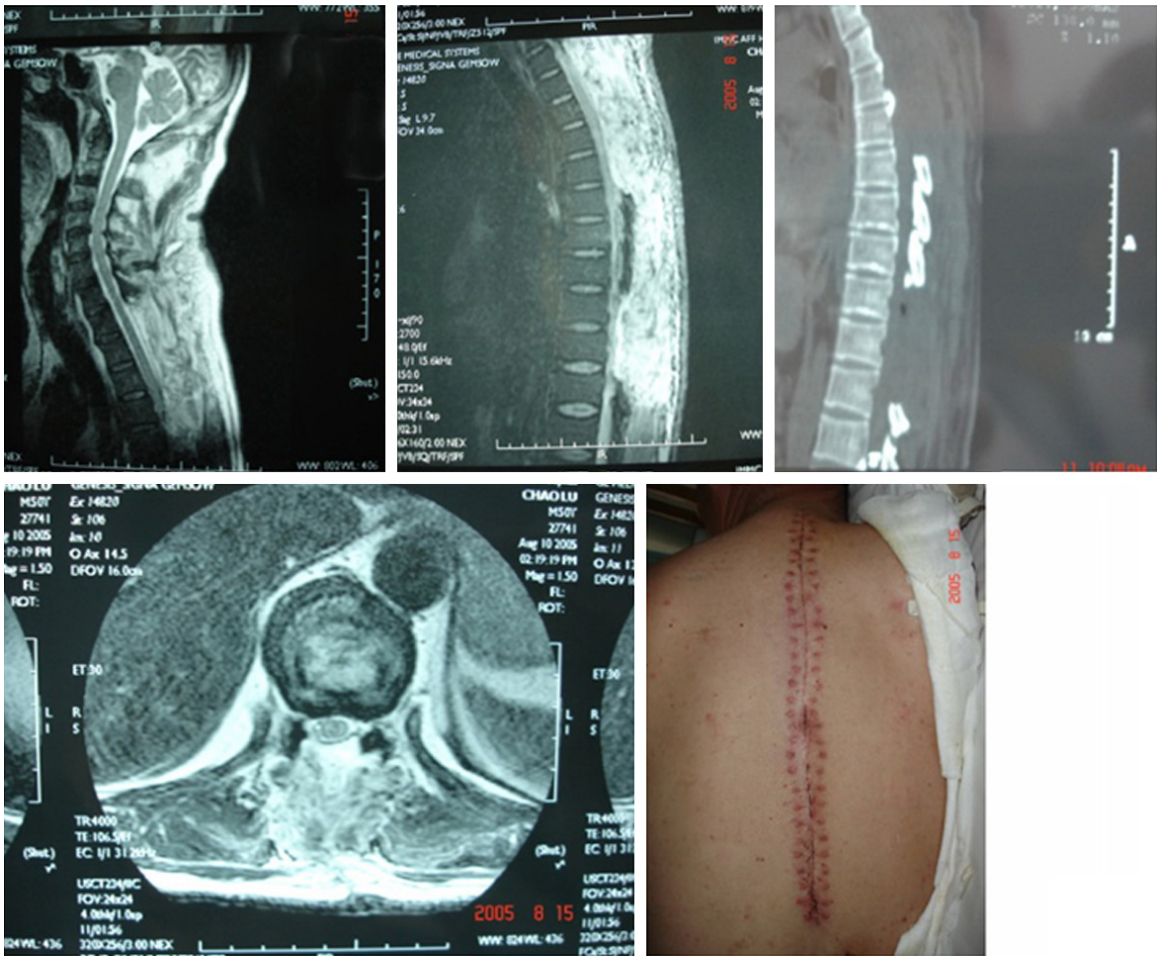

**Figure 3.** The post-operative image after 12 days.

*Postoperative treatment*

Antibiotics were used antibiotics for 3 days pre-operative and postoperatively. The drainage tube was removed when drainage is less than 50 ml. If the drainage of cerebrospinal fluid is more and appeared thin clear, removal of the tube was delayed to 7-10 days. Healing of inci-

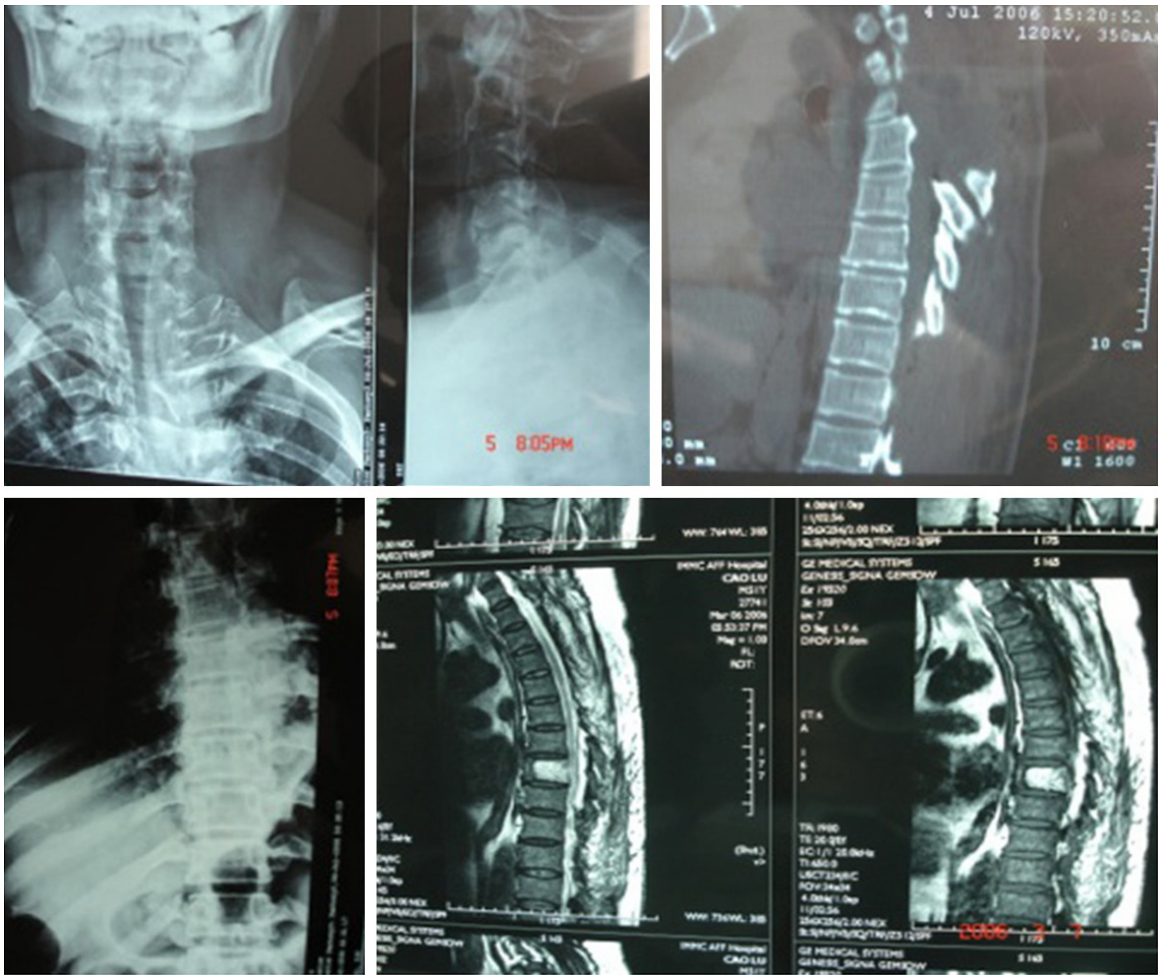

**Figure 4.** Post-operative images after 10 years.

sion should not be affected by premature removal of drainage tube, which could cause a lot of exudation of cerebrospinal fluid from the incision. If there is cerebral spinal fluid outflow after removal of drainage pipe, large angle needle suture was used.

*Data analysis*

Clinical data of the 115 patients who received multi en bloc laminectomy were recorded before and after surgery, and JOA scores collected pre and 2 weeks post operatively, data were statistically analyzed using SPSS software. $P < 0.05$ was considered as statistical significance.

## Results

The mean operative time was 150 minutes (ranged 90-180 minutes), mean blood loss was 400 ml (ranged 300-800 ml) and there was no post operative complication. All patients underwent internal fixation and they were ambulating normally after a week post surgery. Laminectomy was performed in the 115 patients with average of 4.4. Forty patients resected in 3 vertebral plate, 24 in 4, 27 in 5, 15 in 6, 6 in 7, 2 in 8, and 1 in 12 patients.

*Complications*

Dural tear or defect in operation was seen in 31 cases. Dural tear was carefully repaired after completion of the spinal decompression and if it is too large, subcutaneous fat flakes were cut for mending, coupled with tight suture of incision of different layers. Cerebrospinal fluid leakage was not seen in any patients post operatively. Superficial skin infection (3 cases), and was healed after fresh dressing for the wound.

*Follow up*

The 115 patients were followed up for 18-180 months (average of 62.5 months). The symptoms in 90 patients relieved immediately after operation, 9 had no obvious relief, 9 had disease history over 10 years, and 2 had symptoms aggravated after operation. Average JOA score was 8.435 + 2.655 at the last follow-up, which were significantly different compared with the preoperative statistical significance ($t=-19.630$, $P < 0.01$). Based on the therapeutic effect, recovery rate was analyzed using standard JOA score (Patient X, **Figures 3** and **4**). At the last follow-up, the recovery rate was excellent in 45, good in 47, improved in 15, no change in 6 cases, and worsened in 2 patients. Overall the excellent and good recovery rate was 80% (92/115), with the total effective rate as 93% (107/115).

## Discussion

The clinical symptoms of patients with thoracic spinal canal stenosis are often progressive, and if they did not received surgical treatment, it could cause irreversible damage in the spinal cord. Once spinal canal stenosis is diagnosed, earlier surgery to induce decompression on the related segments would be effective [12]. A number of patients investigate other, less invasive, options for thoracic spinal stenosis prior to giving consent for spine surgery. For decompression surgery in thoracic spine, along with a corpectomy, discectomy, laminotomy, laminoplasty or other procedure could be considered. Posterior laminectomy past method we used to treat thoracic spinal canal stenosis in our hospital. The multi lamina en bloc resection for the treatment of thoracic spinal canal stenosis has obvious advantages compared with laminectomy: The high speed grinding in the two sides of the lamina could minimize spinal cord injury because there is no instrument entering the spinal canal during the decompression process. In addition to, the multiple vertebral en bloc resected ranges involving the 1, 2 of upper and lower section, the decompression process is to cut off the whole plate, and the laminectomy decompression using “open window” type decompressed in a small range, this stepwise decompression could prolapse of spinal cord in the decompression “window”, leading to symptoms aggravated; and after a decompression, it will occur reperfusion injury, plus the surgical interference, early postoperative of laminectomy may appear different degree of edema, resulting in “decompression” window under the margin compression, later may cause a second operation due to periphery osteophyte occurred again around “window”.

Posterior wide decompression was adopted for OLF [13], but for OPLL or thoracic disc herniation, the operation approach varies. OPLL or thoracic disc herniation often understood that it’s located in the anterior wall of the vertebral canal, leading spinal cord ventral compression and anterior decompression operation could direct excise the lesion. But due to physiological effect of thoracic kyphosis, removal of OPLL is advocated and pathological change of intervertebral disc creates forward space for spinal cord anterior decompression. The method is time consuming, with high level of haemorrhage and even with increased risk of spinal cord injury, so its application is limited. Transthoracic anterior decompression by bone grafting and internal fixation is only applicable for localized OPLL and thoracic disc herniation, and the majority of patients are treated with posterior wide decompression. Posterior decompression is relatively simple, with less bleeding and spinal cord after decompression has buffer space to expand with no string effect on the spinal cord and nerve as they are viscoelastic material and good outcome was observed after surgery.

Traditional laminectomy is a gun type bone rongeur, which is time-consuming and laborious, and can aggravate spinal cord injury. Multi lamina en bloc resection [14] is similar to that of Spinal spinal posterior wall resection [10], as it is more secure, fast, with relatively low positioning requirements, and it is suitable for treatment of thoracic spinal canal stenosis.

We believe that the range of the upper and lower laminectomy of must be more than 1 segment over compression level, not for the “open window” type pressure relief, so as to avoid spinal dural sac hernia “window”. Reperfusion injury is inevitable with different degrees of edema after spinal cord decompression, and the emergence of new compression at the lower margin in the “window” with peripheral osteophyte formation can cause second operation [15].

The scope of internal and external decompression might reach within facet joint point, which can reach the dural sac side wall, and should not excessively resect small joint, especially the lower thoracic and thoracolumbar, in order to prevent the occurrence of instability. Unless the clinical manifestation and imaging data has shown that the plane or the side of the compression is due to the small joint side, it is mainly induced by the excessive hypertrophy. In our study, these cases were caused by ankylosing spondylitis, or skeletal fluorosis or degeneration. Simple laminectomy had no spinal instability risk, and the follow-up results showed no obvious instability.

In our experiences, the principles of decompression for thoracic spinal multiple compressions are to first decompress the liable position of the stenosis and then according to the body condition of the patient, different stage solutions were decided for other parts of the lesions. If the imaging data suggest that compression is not only from OLF, lamina thickening, and facet hypertrophy, but also from thoracic disc herniation caused by anterior compression, generally laminectomy decompression was performed from the rear end followed by correction of disc herniation and 3 patients had this issue in our study.

The literature has reported success in transpedicular approach in the treatment of thoracic disc herniation, but we need to be careful as special designed instruments is essential to facilitate the surgery [16]. If OLF and OPLL coexist, we preferred the posterior laminectomy decompression, and careful consideration was given for one stage anterior decompression. Posterior decompression of spinal cord often makes a shift, and it can effectively relieve the oppression. In OPLL, the surgery is highly difficult and can lead to spinal cord injury, so posterior decompression should be carefully implemented.

For multi segmental decompression laminectomy, whether the need for fixed fusion is need is still controversial, and long-term follow-up is needed. In our study, patients were treated with posterior decompression laminectomy, without the use of internal fixation and bone grafting fusion. But, autologous or allogeneic bone graft fusion is widely used in many Chinese hospitals for posterior decompression laminectomy. Occurrence of laminectomy kyphosis may be due to various factors extent of facetectomy or capsule resection, aggressiveness of posterior soft tissue resection, multiplicity of laminectomy level, and irradiation history. Extension of facetectomy and capsule resection of more than 50% are thought to cause significant kyphosis and instability [17].

In multi lamina en bloc resection laminectomy, the slot only reach on both sides of facet joint with spinal cord lateral being retained, this could minimize the damage of spinal cord and retains the stability of the spine by reducing the positive posterior decompression on spinal cord stimulation and the blood supply.

For patients with yellow ligament ossification or/and OPLL in thoracic rib, a “cage” structure formed due to extensive calcification and ossification in intervertebral connection and therefore, using multi en bloc laminectomy for decompression is safe and didn’t affect the stability. Long-term follow-up in our study also confirmed that the decompression segment had no obvious aggravated kyphosis.

Therefore, we adopted multi lamina en bloc resection in the treatment of thoracic spinal canal stenosis, with the characters of shorter operation time, less trauma, without internal fixation, low cost and similar therapeutic effect and multi lamina en bloc resection in the treatment of thoracic spinal canal stenosis is worthy in clinical application.

## Conclusion

Early diagnosis and early treatment of thoracic spinal stenosis are very important. Using multiple en bloc laminectomy for the treatment of thoracic spinal canal stenosis is a relatively safe, efficient, relatively low positioning requirement, and has the characters of thorough decompression, less bleeding, generally does not require internal fixation, the with the long-term follow-up results showing satisfactory effect.

## Disclosure ofconflict of interest

None.

**Address correspondence to:** Dr. Yong Yang, The Affiliated Hospital of Inner Mongolia Medical University,

Tongdao North Street No. 1, Huhhot 010050, Inner Mongolia, China. Tel: 86-471-6636643; Fax: 86-471-6636644; E-mail: yangy776@163.com

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