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Original Article

Comparative study on clinical efficacy of posterior laminectomy and a modified transfacet joints approach to treat thoracic spinal stenosis

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Abstract: Objectives: To investigate the clinical effect of posterior laminectomy and a modified transfacet joints approach to treat thoracic spinal stenosis. Methods: 162 patients with the disease of thoracic spinal stenosis treated at our hospital from October 2013 to October 2015 were enrolled in this study. According to the digital meter method, they were randomly divided into two groups, the transfacet joints group were underwent a modified transfacet joints decompression therapy, and the conventional posterior laminectomy group received en bloc hemi-articular laminectomy decompression treatment. The operation duration time, intraoperative blood lose, post-operation drainage, functional excise time on the ground, hospital stay, visual analogue pain scale (VAS) score at 1, 3, 5, 7 days before or after operation were observed and the vertebral body cobb angle were recorded before operation or at 1, 3 and 6 months after operation; Frankel was classified at 2 months before or after operation or at the last follow-up visit; JOA scoring, improvement rate and clinical efficacy were assessed at 6 months before or after operation or at the last follow-up visit. Results: All the patients were underwent follow-up examination for 12-26 months at home or at outpatient by therapists, averaged 17.29±4.39 months. The operation duration time, intraoperative blood lose, post-operation drainage, functional excise time on the ground and period of hospital stay in transfacet joints group were significantly less than that of conventional posterior laminectomy group, with a statistically significant difference ($P<0.05$); There were no significant differences in VAS score at 7 days before or after operation, without a statistically significant difference ($P>0.05$); However, VAS scores in transfacet joints group were significantly less than that of conventional posterior laminectomy group at 1, 3, 5 days after treatment, with a statistically significant difference ($P<0.05$); The recorded results showed that there were no significant differences in vertebral body cobb angle before operation, after finishing operation or at 3 or 6 months after operation, without a statistically significant difference ($P>0.05$); The Frankel classification in transfacet joints group was not significantly different from that of conventional posterior laminectomy group at 1 months after operation or at the last follow-up visit, without a statistically significant difference ($P>0.05$); The JOA scoring and improvement rate in transfacet joints group were moderately higher than that of conventional posterior laminectomy group at 6 months after operation and at the last follow-up visit, with a statistically significant difference ($P<0.05$); The clinical efficacy was assessed at the last follow-up visit, and we found that 41 cases were cured, 17 cases were markedly effective, 19 cases were effective and 4 cases were invalid, the total effective rate was 95.06% in transfacet joints group; In conventional posterior laminectomy group, 37 cases were cured, 18 cases were markedly effective, 16 cases were effective and 10 cases were invalid, the total effective rate was 88.98%; The clinical effective rate was moderately higher in transfacet joints group than that of conventional posterior laminectomy group, with a statistically significant difference ($P<0.05$). Conclusions: The modified approach of transfacet joints to treat thoracic spinal stenosis has better effects in decompression and fixation, in addition, the operation time is less and bring less damage to patients, the effect of overall recovery is better postoperationally. Thus, this approach is suitable for being used in clinic according to specific conditions.

Keywords: Thoracic spinal stenosis, modified transfacet joints approach, posterior laminectomy, clinical efficacy

Introduction

Thoracic spinal stenosis is not uncommon and is more often diagnosed with advances in imaging techniques [1]. Although thoracic spinal stenosis has lower incidence than lumbar spinal stenosis, it shows more severe symptoms and causes greater impacts on patients [2]. The

thoracic yellow and posterior longitudinal ligaments are the dominating structure for sustaining the rear of thoracic vertebra and efficiently protecting the spinal cord [3]. Whereas, when ligaments become ossified, this will directly impress the spinal cord and lead to abnormalities such as thoracic stenosis and dysfunctional spinal cord [4]. Surgery is the main therapy for severe thoracic spinal stenosis in clinic, with variable operation methods and corresponding therapeutic efficacies [5]. 162 patients with the disease of thoracic spinal stenosis treated at our hospital were enrolled in this study, two different operation methods were used and the clinical efficacy was observed and estimated; now it is reported as follows.

Materials and methods

General materials

Accepting criteria: ① Patients were diagnosed as thoracic spinal stenosis with observations such as X-ray, CT or MRI at positive side; ② Clinical manifestations mainly represent as numbed and painful lower limbs, which usually begin from feet up to chest and abdomen gradually, the feet have the feeling of stepping on cotton, most of them also have the feeling of girding in their back and abdomen, gra--dually deteriorating to walk hard; Sphincter dysfunction and abnormal urination and defecation can be generated; ③ According to the American society of Anesthesiologists (ASA) classification system, all the patients belonged to grade I, II, III; ④ Disease course was over 2 years. Excluding criteria: ① Patients with the history of surgery for spine fracture; ② With focal infection before operation, with abnormalities in respiratory system, immune system, endocrine and coagulation; ③ Accompanied with tuberculosis, metastatic tumors in thoracic vertebra, syringomyelia, primary lateral sclerosis and traumatic extradural hematoma; ④ Psychopath.

162 patients with the disease of thoracic spinal stenosis treated at our hospital from October 2013 to October 2015 were enrolled in this study. According to the digital meter method, they were randomly divided into two groups, the transfacet joints group were underwent a modified transfacet joints decompression therapy, 42 cases male, 39 cases female, aged 28-77, averaged 43.49±3.27 years; disease course were 2-6 years, averaged 3.41±1.12 years; 17 cases were exclusive lumbar disc protrusion, 36 cases were lumbar disc protrusion combined with ossification of posterior longitudinal ligament, 28 cases were lumbar disc protrusion combined with ossification or thickening in ligamentum flavum; 21 cases were spinal canal stenosis involving two segments, 34 cases had three segments involved, 26 cases had four segments involved; In the classification of ASA, 33 cases were grade I, 47 cases were grade II; In Frankel classification before operation, 9 cases were grade A, B cases were 31 cases, 28 cases were C grade, 13 cases were D grade. JOA score were 4.52±1.34 preoperatively. Conventional posterior laminectomy group received en bloc hemi-articular laminectomy decompression treatment. 40 cases male, 41 cases female, aged 26-78, averaged 44.13± 2.62 years; disease course were 2-7 years, averaged 3.93±1.58 years; 18 cases were exclusive lumbar disc protrusion, 33 cases were lumbar disc protrusion combined with ossification of posterior longitudinal ligament, 30 cases were lumbar disc protrusion combined with ossification or thickening in ligamentum flavum; 19 cases were spinal canal stenosis involving two segments, 35 cases had three segments involved, 27 cases had four segments involved; In the classification of ASA, 35 cases were grade I, 46 cases were grade II; In Frankel classification before operation, 8 cases were grade A, B cases were 30 cases, 29 cases were C grade, 14 cases were D grade. JOA score were 4.48±1.16 preoperatively. General materials were compared and these are no differences in sex, age, disease course, types of thoracic spinal stenosis, segments involved, ASA classification and preoperational JOA score, etc., between two groups (P>0.05). After admission, patients and family members signed informed consent and operation agreement; the study received permission of the Medical Ethics Committee and was supervised by ethics committees during the whole course.

Methods for surgery

Transfacet joints group: Patients were underwent decompression therapy of a modified transfacet joints to resect vertebral canal and received general anesthesia, pronely positioned. The locations of segments with lesions were confirmed and marked by the perspective of C-arm X-ray machine. Patients were moni-

tored by somatosensory evoked potential (CSEP) during the whole operation. For the patients with lumbar disc protrusion combined with ossification of posterior longitudinal ligament, posterior incision was carried out, paravertebral muscle downside along protrusion was resected, the facet joints and vertebral disc of segments with lesions were exposed, the vertebral pedicle was punched, the locating pin was inserted, X-ray with C-arm machine, vertebral pedicle bolt was imbedded when position was correct, then stabilized the intervertebral space with screw-rod. Ball mill drill was used to remove the single or double sides of zygapophyseal joint and associated vertebral plate, let the narrow intervertebral disc fully exposed, resected the front of the zygapophyseal joint along posterolateral of intervertebral disc with lesions, looked under the ring and cut the fibrous rings open, avoided to damage the nerve root and arteries. If lumbar disc protrusion located at 1/3 of intervertebral space, the lumbar disc could be cut off directly. If lumbar disc located at the front side of spinal canal within the canalis vertebralis, it was allowed not to be removed. Sufficiently strike off the bones located at lumbar disc and vertebral posterior by curet, make lumbar disc and ossifying longitudinal ligaments become hollow, then utilize detacher to separate the lumbar disc protrusion, posterior longitudinal ligament and endorhachis. Chop lumbar disc with lesions, coalesce lumbar interbody sufficiently, immobilize with vertebral pedicle, seal the cut.

For patients with lumbar disc protrusion combined with ossification in ligamentum flavum, the way to expose the facet joints and insert the locating pin were carried out as before, as for the concomitant repression to spinal cord coming from front and rear, firstly cut bones off vertebral plate to release canalis spinalis, apply abrasive drilling to grind off the outer plate by cutting off bones from interior facet joints at the double sides of lumbar disc, bone knife was used to truncate interior plate inferosuperior of vertebral plate to isolate the bilateral vertebral plate. Cut off ligamentum flavum, supraspinous ligament and interspinous ligaments, with the assistance of helper, leverage the vertebral plate to uphold spinous process and lamina complex. If ligamentum flavum adheres to dura mater, use sharp knife to isolate them, and then take down the spinous process and lamina complex, use abrasive drilling to cut off the facet joints with lesions and cut off the protrusion of lumbar disc. At this moment, the already removed double-side ligamentum flavum was sewn up with a piece of fine silk and stabilized and seal spinous process of vertebral plate and surroundings, at last, seal and stabilize the supraspinous ligament.

Conventional posterior laminectomy group: Patients received en bloc hemi-articular laminectomy decompression treatment and general anesthesia, pronely positioned. Place a sponge pillow under chest, two sides of the abdomen and the front ankles. Perform incision at the middle of spinal cord; reveal the spinous process, vertebral plate and facet joints of the segments which were going to be cut off. Generally, retain the spinous process for clamping the whole dissociative vertebral plate. Cut off the bottom end of stenosis segment and the laminar space can be seen from lower thoracic vertebrae. Expand the space to the half of the facet joints, cut open its ligamentum flavum, use air-drill to drill clean bones up to penetrating spinal canal along the axis of facet joints, cut off the superior border of vertebral plate inferosuperiorly, forming a bone groove with 4 mm width. When drilling clean the bones in the protrusion of lumbar disc, they are hard and thick, can be deep up to 20 mm, the drill can be inclined to middle line to reach the side of dura mater, inclining to outer is inhibited to reach to vertebral pedicle. Once one side of bone groove was cut open, the other side of it can be opened as well. Same methods were applied to the other parts. After double sides of bone groove were open, within which the ligamentum flavum and vertebral plate were broken, then vertebral pedicle and cut were sealed.

Observational parameters

The operation duration time, intraoperative blood lose, post-operation drainage, functional excise time on the ground, hospital stay, visual analogue pain scale (VAS) score at 1, 3, 5, 7 days before or after operation were observed and the vertebral body cobb angle were recorded at 1, 3, 6 months before or after operation; Frankel was classified at 2 months before or after operation or at the last follow-up visit; JOA scoring, improvement rate and clinical efficacy were assessed at 6 months before or after operation or at the last follow-up visit. Criteria for clinical evaluation and assessment of thera-

Table 1. Comparison of operation duration time, intraoperative blood lose, post-operation drainage, functional excise time on the ground and period of hospital stay between two groups

Group	Operation time (min)	Intraoperative blood lose (ml)	Post-operation drainage (ml)	Functional excise time on the ground (d)	Period of hospital stay (d)
Transfacet joints group	164.68±46.35	492.±43.24	235.78±12.47	2.49±0.62	8.39±2.05
Conventional posterior laminectomy group	213.89±32.74	788.19±27.61	378.16±19.28	4.17±0.13	11.74±1.83
T value	5.3928	7.0285	3.5381	2.4319	3.0165
P value	<0.05	<0.05	<0.05	<0.05	<0.05

Table 2. Comparison of VAS scores at 1, 3, and 5 days before or after operation between two groups

Group	Pre-operation	1 d post-operation	3 d post-operation	5 d post-operation	7 d post-operation
Transfacet joints group	7.63±0.81	4.01±0.74	3.37±0.85	2.49±0.88	2.11±0.73
Conventional posterior laminectomy group	7.42±0.53	5.69±0.92	4.84±0.91	3.76±0.92	2.58±0.94
T value	0.8362	2.4381	2.3396	1.3362	0.7449
P value	>0.05	<0.05	<0.05	<0.05	>0.05

Table 3. Comparison of vertebral body cobb angle before operation, after finishing operation or at 3 or 6 months after operation between two groups

Group	Before operation	After finishing operation	3 months after operation	6 months after operation
Transfacet joints group	13.26±3.51	21.35±1.36	19.53±1.22	19.03±1.35
Conventional posterior laminectomy group	14.28±2.02	20.18±1.27	18.97±1.14	18.46±1.41
T value	0.5582	0.7891	0.9283	0.8226
P value	>0.05	>0.05	>0.05	>0.05

peutic effects [4] include cure, no any unhealthy performances after operation, behave normally; significantly effective, accompanied by spasm stiffness or mild weakness, pain occurs occasionally, but the daily life and work are not influenced; effective, adverse clinical symptoms are improved to some extent, moderate fatigue and pain happens frequently, the daily life and work are influenced; invalid, clinical symptoms are not changed or even deteriorated.

Statistical methods

Data base was established with SPSS 19.0 software, by which statistical analysis through count data (%) using X^2 test is applied in this study, P<0.05 were considered with statistical significance.

Results

All the patients were underwent follow-up examination for 12-26 months at home or at outpatient by therapists, averaged 17.29±4.39 months. The operation duration time, intraoperative blood lose, post-operation drainage, functional excise time on the ground and period of hospital stay in transfacet joints group were significantly less than that of conventional posterior laminectomy group, with a statistically significant difference (P<0.05), see **Table 1**.

There were no significant differences in VAS score at 7 days before or after operation, without a statistically significant difference (P>0.05); However, VAS scores in transfacet joints group were significantly less than that of conventional posterior laminectomy group at 1, 3, and 5 days after treatment, with a statistically significant difference (P<0.05), see **Table 2**.

The recorded results showed that there were no significant differences in vertebral body cobb angle before operation, after finishing operation or at 3 or 6 months after operation, without a statistically significant difference (P>0.05), see **Table 3**.

Table 4. Comparison of Frankel classification before operation, 1 month after operation or at the last follow-up visit between two groups

Group	Frankel classification before operation	Cases	Frankel classification 1 month after operation					Frankel classification at the last follow-up visit				
			A	B	C	D	E	A	B	C	D	E
Transfacet joints group	A	9	8	1				7	2			
Conventional posterior laminectomy group		8	8					8				
Transfacet joints group	B	31		12	19				7	14	10	
Conventional posterior laminectomy group		30		15	15				13	9	8	
Transfacet joints group	C	28			2	19	7			1	10	17
Conventional posterior laminectomy group		29			5	18	6			4	11	14
Transfacet joints group	D	13				5	8				1	12
Conventional posterior laminectomy group		14				7	7				3	11

Table 5. Comparison of JOA scoring and improvement rate before operation or at 6 months after operation and at the last follow-up visit between two groups

Group	Cases	JOA scoring before operation	JOA scoring at 6 months after operation	JOA scoring at the last follow-up visit	Improvement rate
Transfacet joints group	50	5.72±1.63	7.89±2.74	9.93±2.58	(49.02±21.47)%
Conventional posterior laminectomy group	50	5.91±1.35	6.72±1.96	8.14±2.03	(41.05±19.31)%
T/X^2 value		0.9726	2.0117	2.8336	3.2918
P value		>0.05	<0.05	<0.05	<0.05

Table 6. Assessment of clinical efficacy between two groups

Group	Cure	Markedly effective	Eeffective	Invalid	Effective rate
Transfacet joints group	41	17	19	4	95.06%
Conventional posterior laminectomy group	37	19	16	9	88.89%
X^2 value					2.1195
P value					<0.05

The Frankel classification in transfacet joints group was not significantly different from that of conventional posterior laminectomy group at 1 months after operation or at the last follow-up visit, without a statistically significant difference (P>0.05), see **Table 4**.

The JOA scoring and improvement rate in transfacet joints group were moderately higher than that of conventional posterior laminectomy group at 6 months after operation and at the last follow-up visit, with a statistically significant difference (P<0.05), see **Table 5**.

The clinical efficacy was assessed at the last follow-up visit, and we found that 41 cases were cured, 17 cases were markedly effective, 19 cases were effective and 4 cases were invalid, the total effective rate was 95.06% in transfacet joints group; In conventional posterior laminectomy group, 37 cases were cured, 18 cases were markedly effective, 16 cases were effective and 10 cases were invalid, the total effective rate was 88.98%; The clinical effective rate was moderately higher in transfacet joints group than that of conventional posterior laminectomy group, with a statistically significant difference (P<0.05), see **Table 6**.

Discussion

The pathogenesis underlying thoracic spinal stenosis are complicated, most of them have no obvious causes and the progression is slow, therefore it's hard to be detected at earlier phase, usually accompanied by traits manifes-

tation resulted from oppression on spinal nerves [6]. The damage to spinal cord is exacerbated by oppression on spinal cord and incomplete ischemia of thoracic spinal cord, clinically, abnormalities of sense and activity would emerge, most of the patients will mainly be seen as lower limb numbness, hypo dynamic, feeling of stepping on cotton, pain in thoracic, lumbar and back and radiating pain, persistently or discontinuously [1, 7-9]. For the diagnosis of thoracic spinal stenosis, it can be confirmed by clinical feature, reflectance signature and imageological examinations, the diagnostic rate is relatively high.

Although the causes leading to thoracic spinal stenosis are variable, the main therapy for it is surgery, the fundamental purpose is to release the damage oppression on spinal cord, ameliorate or eradicate associated clinical symptoms, improve the quality of life after operation effectively [10]. With the advancement of medical studies, how to make a suitable surgery method and reduce damage around the narrow spinal tissue as far as possible and eradicate lesions thoroughly are the main challenges facing clinicians nowadays [11].

The conventional decompression and internal fixation therapy of posterior vertebral lamina laminectomy has already been widely accepted and used in clinic, but the clinical efficacy doesn't reach its predictive level. In our study, we modified the cutting range of articular process approach, which was enlarged to extend the perspective of surgery. The double sides of facet joints were cut off, along with the ossification of posterior longitudinal ligament and central disc herniation (CDH), the criteria of articular process approach were increased, and pedicle screw fixation was used after cutting off, bringing significant effects. In this study, the transfacet joints group were underwent a modified transfacet joints decompression therapy, and the conventional posterior laminectomy group received hemi-articular laminectomy decompression treatment. The results show that in comparison of Frankel classification during the follow-up visit after operation, it indicates that in transfacet joints group, 9 cases were A grade, 31 cases were B grade, 28 cases were C grade and 13 cases were D grade before operation, in the last follow-up visit, 7 cases were A grade, 9 cases were B grade, 15 cases were C grade, 21 cases were D grade and 29 cases were E grade; however, in conventional posterior laminectomy group, 8 cases were A grade, 30 cases were B grade, 29 cases were C grade and 14 cases were D grade before operation, in the last follow-up visit, 8 cases were A grade, 13 cases were B grade, 13 cases were C grade, 22 cases were D grade and 25 cases were E grade. It can be seen that the recovery of Frankel classification in transfacet joints group was slightly better than that of the conventional posterior laminectomy group; this maybe had some relationship with effective protection for spinal cord in transfacet joints group.

In addition, the results shows that the operation duration time, intraoperative blood lose, post-operation drainage, functional excise time on the ground and period of hospital stay in transfacet joints group were significantly less than that of conventional posterior laminectomy group, with a statistically significant difference ($P<0.05$); There were no significant differences in VAS score at 7 days before or after operation, without a statistically significant difference ($P>0.05$); However, VAS scores in transfacet joints group were significantly less than that of conventional posterior laminectomy group at 1, 3 and 5 days after treatment, with a statistically significant difference ($P<0.05$); The JOA scoring and improvement rate in transfacet joints group were moderately higher than that of conventional posterior laminectomy group at 6 months after operation and at the last follow-up visit, with a statistically significant difference ($P<0.05$). The clinical efficacy was assessed at the last follow-up visit, and we found that 41 cases were cured, 17 cases were markedly effective, 19 cases were effective and 4 cases were invalid, the total effective rate was 95.06% in transfacet joints group; In conventional posterior laminectomy group, 37 cases were cured, 18 cases were markedly effective, 16 cases were effective and 10 cases were invalid, the total effective rate was 88.98%; The clinical effective rate was moderately higher in transfacet joints group than that of conventional posterior laminectomy group, with a statistically significant difference ($P<0.05$).

Our study shows that the advantages of modified method rely on simultaneously resecting the oppressions from forward and rearward of spinal cord via a single cut, posterior laminato-

my decompression can simultaneously cut off the thickened ossification of ligamentum flavum and joints; the lateral and front tissue of canalis spinalis can be effectively exposed after cutting off the single-side and double-side of vertical facet joints, which can be cut off upon being seeing. The operation time is effectively shortened and the blood lose during operation is reduced, which bring patients less damage caused by operation. The soft tissue along the cut route is less damaged, the posterior lateral protruding intervertebral disc just be needed cut off one side of vertical facet joints, and less bone tissue is cut off; Abrasive drilling slots facet joints lateral of dura mater, because of the remaining interspace between spinal cord, which reducing the damage to spinal cord and the pain in back after operation, this is proved by the VAS score of patient after operation. The main disadvantages are for the obese patients with thoracic spinal stenosis, the number of cut is limited, and the revealing of lesions becomes hard. Corresponding instruments are needed to complete operation for central disc herniation and ossification of posterior longitudinal ligament, so the operational processes are increased and become tedious; Because of the back cut is small and the self-obstacle at the posterior of anterior vertebrae, it's hard to perform decompression for spinal cord.

In conclusion, this study suggests that the modified approach of transfacet joints to treat thoracic spinal stenosis has better effects in decompression and fixation, in addition, the operation time is less and brings less damage to patients, the effect of overall recovery is better post operationally. Thus, this approach is suitable for being used in clinic according to specific conditions.

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Disclosure of conflict of interest

None.

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