Hemilaminoplasty for the treatment of lumbar disc herniation

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Abstract The aim of this study was to evaluate the clinical outcome of the hemilaminoplasty technique for the treatment of lumbar disc herniation (LDH). Forty-three cases of single-level LDH underwent a discectomy and hemilaminoplasty procedure. The preoperative JOA score and VAS of lower back and leg pain were 10.4 ± 1.3 , 7.8 ± 2.1 , and 8.6 ± 1.7 , respectively. The Cobb angle of lumbar sagittal alignment was 10.1 ± 2.0 . Twenty-five patients who agreed to lumbar discectomy through fenestration were enrolled as the control group. The postoperative JOA score and VAS of low back and leg pain of the hemilaminoplasty group were 19.4 ± 1.3 , 1.4 ± 0.4 , and 2.1 ± 0.5 , respectively. The Cobb angle was 29.2 ± 1.9 degrees. There was no epidural scar observed in any of the patients. The Cobb angle of the hemilaminoplasty group was higher than that of the control group ($p < 0.05$), while the VAS was significantly lower ($p < 0.05$). Hemilaminoplasty is a useful method to improve clinical outcome, prevent epidural scar, and preserve the normal alignment of lumbar spine.

Résumé Le but était d'évaluer le résultat clinique de l'hémilaminoplasty pour le traitement de la hernie discale lombaire avec l'étude de 43 cas de hernie d'un seul niveau. Le score JOA pré opératoire, le niveau de l'échelle visuelle des lombalgies et des douleurs de jambe étaient respectivement: $10,4 \pm 1,3$; $7,8 \pm 2,1$ et $8,6 \pm 1,7$. L'angle de Cobb était de $10,1 \pm 2,0$. Vingt cinq patients ayant accepté la discectomie classique furent enrôlés comme groupe de contrôle. Les résultats montraient un score JOA, les douleurs lombaires et les douleurs de jambe cotés respectivement:

$19,4 \pm 1,3$; $1,4 \pm 0,4$ et $2,1 \pm 0,5$. L'angle de Cobb était de $29,2 \pm 1,9$ degrés. Il n'y avait pas de cas d'atteinte épidurale. L'angle de Cobb du groupe Hémilaminoplasty était plus grand que celui du groupe de contrôle ($p < 0,05$), et le niveau de l'échelle visuelle de la douleur était significativement plus bas ($p < 0,05$). En conclusion l'hémilaminoplasty est une bonne méthode pour améliorer le résultat fonctionnel, prévenir les lésions épidurales et préserver l'alignement du rachis lombaire.

Introduction

The laminoplasty technique has been widely used in spine surgery. It may be useful in preserving the posterior arch of spine, protecting paraspinal muscles, and preventing postoperative instability, epidural adhesion, and kyphotic deformities. Many reconstructive methods have been reported in the literature, such as transverse placement laminoplasty, restorative laminoplasty, inverse laminoplasty, en bloc laminoplasty, and expansive laminotomy [1, 3–5, 9, 11]; however, few papers have reported the hemilaminoplasty technique for the treatment of lumbar disc herniation (LDH) patients. In this study, we retrospectively reviewed the follow-up outcome of 43 LDH patients who underwent discectomy and hemilaminoplasty in our institution.

Materials and methods

The subjects of this study were patients with single-level LDH associated with typical sciatica, excluding patients with:

1. A history of lumbar surgery
2. Bony spinal canal stenosis

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Table 1 Preoperative characteristics of the hemilaminoplasty group (A) and the fenestration group (B)

Characteristic	Group A	Group B	<i>P</i> value
Age (years)	34.2±2.6	33.9±1.6	0.171
Duration of symptom (months)	6.4±3.1	5.7±2.0	0.251
Preoperative JOA	10.4±1.3	11.3±2.1	0.330
VAS of low back pain	7.8±2.1	8.2±1.3	0.819
VAS of leg pain	8.6±1.7	8.7±2.1	0.944
Cobb angle (°)	10.1±2.0	11.1±1.0	0.915

3. Any other neurological lesions
4. Any other diseases that might affect precise clinical assessments or physical examinations

A total of 83 cases of single-level LDH were enrolled in our study and randomly divided into a hemilaminoplasty group (group A) and a fenestration group (group B). There were 43 cases (26 males and 17 females) in group A. The affected levels were L3–4 in four, L4–5 in 27, and L5–S1 in 12 cases. The other 40 patients (23 males and 17 females) underwent traditional discectomy through fenestration (group B). The affected levels were L3–4 in two, L4–5 in 22, and L5–S1 in ten cases. The age, duration of sciatica, preoperative Japanese Orthopedics Association scoring system (JOA score), visual analog scale (VAS) of low back and leg pain, and Cobb angle of sagittal lumbar spinal alignment of the two groups were collected and are shown in Table 1. The operations on the two groups were performed by the same senior surgeon (Y. Zheng).

Surgical technique of hemilaminoplasty

After general anaesthesia, patients were put in prone position. Through a 3-cm midline posterior approach, the paravertebral muscles on the affected side were detached

from the spinous processes and laminae, while the supraspinal ligaments and interspinal ligaments were preserved. The laminae were cut carefully in a trapezoid manner just medial to facet joints. The inferior two thirds of the spinous process and laminae of the superior vertebra and superior one third of the spinous process of the inferior vertebra and ligamentum flavum (LF) were detached (Fig. 1). The laminae and spinous processes were carefully elevated en bloc from the caudal to the cranial side to expose the dura sac. The osteotomy was performed by a micro saw and custom-made thin osteotome to decrease the bone loss of laminae.

After discectomy under direct visualisation, the laminae, spinous processes, LF, supraspinal ligaments, and interspinal ligaments were reattached to the original site. First, thread was used to suture the detached LF, then the spinous processes were fixed by the threads passing through the bony holes on both sides of the cutting line; finally, the supraspinus ligaments were sutured to accomplish the reconstruction. External braces were used for four weeks after the operations. Patients began to walk with a brace ten days after surgery.

Follow-up was made at two, four, and six months, and one, two, four, and five years after surgery. The assessment of clinical results during the follow-up was completed independently by two experienced neurologists (X. Liu and J. Li). Ordinary and dynamic roentgenograms in the standing position were performed to monitor the alignment and stability of lumbar spine. The Cobb angles of sagittal alignment of lumbar spine were measured twice respectively by two doctors (Y. Zheng and L. Gong), and the average angles were used for statistical analysis. X-rays and/or CT scans were used to assess the fusion of the laminae. Bony fusion was defined as disappearance of the osteotomy-line of laminae and having a callus formation at the cut edges of the laminae. MRI was used to observe the epidural scar and exclude recurrence of disc herniation.

Fig. 1 The osteotomy range of hemilaminoplasty. **a** Posterior view. **b** Cross-sectional view

Statistical analysis

The SPSS version 12.0 software package (SPSS, Inc., Chicago, IL) was used for statistical analysis. In the event of statistical significance, a *t* test was performed. A level of significance was set at $p < 0.05$.

Results

Mean incision length, operation time, blood loss, follow-up period, postoperative JOA score, recovery rate, VAS of low back and leg pain, and Cobb angle of groups A and B are shown in Table 2.

There was no significant difference in preoperative JOA score, VAS of low back pain, VAS of leg pain, and Cobb angle between groups A and B. There was no significant difference in the operation time and blood loss between groups A and B. The VAS of low back pain, VAS of leg pain, JOA score, and Cobb angle in both of the two groups were significantly improved from the preoperative after surgery (Table 3). The postoperative Cobb angle and recovery rate of group A was significantly better than that of group B ($p < 0.05$), while the postoperative VAS of back and leg pain of group B was much higher than that of group A ($p < 0.05$).

All reattached laminae and spinous processes achieved bony fusion. The time of laminae fusion ranged from 1.5 to 3.5 months (mean, 2.1 ± 1.1 months). There was neither postoperative instability nor adhesion between dura and reattached laminae observed in group A (Fig. 2). Epidural adhesion was observed in 19 cases (54.3%) in group B.

Discussion

The importance of laminoplasty in keeping normal sagittal alignment has already been proven in many studies [4, 7, 10]. Yeh et al. [10] found that laminectomy is associated

Table 3 The pre- and follow-up results of the hemilaminoplasty (A) and fenestration (B) groups

	Characteristic	Pre-op	Post-op	<i>P</i> value
Group A	JOA scores	10.4±1.3	19.4±1.3	0.002*
	VAS of low back pain	7.8±2.1	1.4±0.4	0.001*
	VAS of leg pain	8.6±1.7	2.1±0.5	0.001*
	Cobb angle (°)	10.1±2.0	59.2±1.9	0.000*
Group B	JOA scores	11.3±2.1	17.6±2.3	0.001*
	VAS of low back pain	8.2±1.3	2.2±1.0	0.001*
	VAS of leg pain	8.7±2.1	3.2±0.6	0.002*
	Cobb angle (°)	11.1±1.0	45.2±2.8	0.000*

* $P < 0.05$

with worsened alignment at the thoracic–thoracolumbar region, while laminoplasty reduces this risk in children. Hida [4] reported follow-up results of more than two years using transverse placement laminoplasty. His reports demonstrated that, compared to laminectomy, the sagittal alignment had been well conserved by laminoplasty. In our study, the patients in both groups reacquired lumbar spinal lordosis by the latest follow-up. However, patients in the hemilaminoplasty group retained better lumbar lordosis than those in the fenestration group. The postoperative Cobb angle and recovery rate of group A was significantly higher than those of group B. As facet joint was restored and posterior bony elements were completely reconstructed, no postoperative instability and malalignment in the sagittal plane translation or rotation was observed in any patients of the hemilaminoplasty group according to the follow-up X-rays.

The mechanical role of interspinous ligaments and supraspinous ligaments is to provide a tethering or tension constraint during anterior flexion and support for lumbar muscles in all body positions. They may be useful in maintaining posterior stability and avoiding kyphosis deformity in some content. In our technique, only the interspinous ligaments and supraspinous ligaments of the affected side were injured, while the contralateral part of the ligaments were conserved. Moreover, as the inferior half of the spinous process of the superior vertebra and superior half of the spinous process of the inferior adjacent vertebra were osteotomised, we could preserve interspinous ligaments and acquire bony fusion of the spinous processes. The bony fusion may be more helpful in conserving the posterior stability of the spine than healing of the interspinous ligament by fibrosis, but this issue warrants further biomechanical investigation.

Postoperative epidural fibrosis is also one of the most common reasons of failed back syndrome after lumbar disc herniation. It can cause progressive neurological deficit and pain after laminectomy [8]. Postoperative epidural fibrosis rates in MRI after lumbar discectomy range from 20–62.5%

Table 2 Surgery and follow-up outcome of the hemilaminoplasty (A) and fenestration (B) groups

Characteristic	Group A	Group B	<i>P</i> value
Operation time (min)	50±5.6	43±3.5	0.088
Blood loss (ml)	70±12.5 ml	64±10.1	0.114
Follow-up (months)	34.2±2.5	31.1±3.2	0.101
Postoperative JOA	19.4±1.3	17.6±2.3	0.042*
Recovery rate of JOA (%)	95	87	0.028*
VAS of low back pain	1.4±0.4	2.2±1.0	0.041*
VAS of leg pain	2.1±0.5	3.2±0.6	0.037*
Postoperative Cobb angle (°)	29.2±1.9	21.2±2.8	0.023*

* $P < 0.05$

Fig. 2 A 23-year-old female with LDH at the L5/S1 level. **a** The preoperative CT showed the protruded disc was located on the left side of the L5/S1 level. **b,c** The four-year follow-up CT showed that the laminae of L5 and S1 on the left side (*red arrow*) were fused. **d** LF was conserved (*black arrow*) and no epidural fibrosis was observed

in literature. In our study, epidural adhesion was not observed in group A, while it was observed in 54.3% cases in group B. Although patients in both of the two groups had good neurological recovery and pain relief after surgery, the recovery rate of JOA scores and level of pain relief of the hemilaminoplasty group were significantly better than those of the discectomy group. Although many materials and drugs have been used to prevent such complications, some of them may cause infection and none have a reliable outcome. Until now, the LF and laminae are still the most valuable materials to avoid epidural adhesion. Ozer et al. [6] reported a short-term result of a new technique for preserving the ligamentum flavum during lumbar discectomy. They found that the postoperative fibrosis can be efficiently avoided by preserving LF. Aydin et al. [2] reported that the LF preserving technique is useful in achieving a favourable long-term outcome and makes the re-operation easier and safer. Also, laminoplasty has already been proven to be a valuable method to prevent the laminectomy membrane for the treatment of intradural tumour and lumbar spinal canal stenosis [4, 5, 9]. By our technique, both laminae and LF can be anatomically reconstructed quite well after discectomy, and no epidural adhesion was observed during the follow-up. We also thought it might be more powerful to prevent epidural

fibrosis than those methods which only preserve LF or laminae.

The fusion time of laminae after laminoplasty ranges from 1.9 to five months in literature. Yücesoy and Ozer [11] reported that bony fusion of the cutline of laminae was seen in only one third of patients who were monitored for more than two years by using inverse laminoplasty. Wiedemayer et al. [9] reconstructed the laminar roof with miniplates to the anatomical site in 79 cases (laminae). In his follow-up results, 11.3% of laminae achieved unilateral fusion and 2.6% had no osseous bridging of the bilateral osteotomy sites. In our results, the time for laminae fusion was 2.1 months on average, and fusion rate of laminae in our cohort was 100%, which is higher than that of the laminoplasty technique reported in literature. Reasons for this may be: (i) the less invasive of paraspinal muscles and bony structure of hemilaminoplasty makes the vertebral segment more stable, which is an important factor for laminae fusion; and/or (ii) comparing with laminoplasty, hemilaminoplasty can provide an additional cancellous interface between the cut-line of spinous processes.

There are some disadvantages to this technique. First, it requires experience working on the laminae osteotomy to avoid injury of the nerve roots and dural mater. Also, it requires more surgery time for osteotomy and reconstruc-

tion of the laminae and spinous processes, especially for an inexperienced surgeon. And finally, after surgery, the patients need to wear an external brace for a relative long time (one month). It may be better to use some internal instrumentation, such as titanium miniplates, to reduce the period required for wearing the brace.

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