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Clinical Case Report of Expansive Laminoplasty for Cervical Myelopathy Due to Both Disc Herniation and Developmental Cervical Spinal Canal Stenosis in Older Adolescents

Hua Zhou, MD, PhD, Yu Sun, MD, Fengshan Zhang, MD, Gengting Dang, MD, and Zhongjun Liu, MD

Abstract: Reports on adolescent patients with cervical myelopathy who underwent anterior cervical discectomy and fusion are scarce. However, to our knowledge, no cases of expansive laminoplasty for cervical myelopathy associated with progressive neurological deficit after a series of conservative treatment, caused by both disc herniation and developmental cervical spinal canal stenosis, have been reported.

From January 2006 to July 2012, we retrospectively studied 3 patients in late adolescence presenting with cervical myelopathy who underwent expansive unilateral open-door laminoplasty at our hospital. The outcomes after the surgery were evaluated according to the Japanese Orthopedic Association scores.

Symptoms presented by these patients were due to both disc herniation and developmental cervical spinal canal stenosis. No major complications occurred after the surgical procedures. The median follow-up time was 66 months (range 36–112 months). The Japanese Orthopedic Association scores after surgery showed a significant increase. Long-term outcomes after surgery were satisfactory according to the evaluation criteria for the Japanese Orthopedic Association scores. However, the ranges of motion of the cervical spine decreased, especially the ranges of motion on flexion after surgery showed a significant decrease.

Expansive laminoplasty is helpful for older adolescent patients with cervical myelopathy due to both disc herniation and developmental cervical spinal canal stenosis, presenting with progressive neurological deficit after long conservative treatment.

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Abbreviations: ACDF = anterior cervical discectomy and fusion, ASD = adjacent segment disease, CT = computed tomography, JOA = Japanese Orthopaedic Association's, MRI = magnetic resonance imaging.

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From the Department of Orthopedics (HZ, YS, FZ, GD, ZL), Peking University Third Hospital; and Beijing Key Laboratory of Spinal Diseases (HZ, YS, FZ, GD, ZL), Beijing, China.

Correspondence: Zhongjun Liu, Department of Orthopedics, Peking University Third Hospital, Haidian District, Beijing, China (e-mail: liuzj@medmail.com.cn).

Yu Sun, Department of Orthopaedics, Peking University Third Hospital, Haidian District, Beijing, China (e-mail: sunyuor@vip.sina.com).

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INTRODUCTION

Cervical myelopathy with herniated discs is considered a degenerative process and many cases are diagnosed in older patients.¹ However, patients presenting in late adolescence with cervical myelopathy without any underlying disease are rare.² Neurological deficit symptoms, including intractable radicular pain, limb weakness, and cervical myelopathy rarely occur, and conservative treatment is recommended in most cases. In the majority of adolescent patients, surgical treatment for cervical myelopathy due to herniated discs is rarely recommended because herniated discs could be spontaneously absorbed under the natural course of microvascular blood supply to the juvenile intervertebral disc.³

Cervical spinal canal stenosis had been established as an important risk factor in patients with multilevel cervical myelopathy. Laminoplasty could result in a wide spinal canal; therefore, open-door laminoplasty might be a preferred method in treating multilevel cervical myelopathy with spinal canal stenosis in the absence of kyphosis.⁴ Laminoplasty could maintain cervical lordosis if the invasion of the facet joint was minimal.⁵ Cervical laminoplasty prevents fusion and allows for preservation of an acceptable range of motions, so surgeons recommended laminoplasty for cervical myelopathy with spinal canal stenosis in younger patients. It was suggested that laminoplasty might be an effective surgical solution for cervical myelopathy due to both disc herniation and developmental cervical spinal canal stenosis in late adolescent patients.

To our knowledge, very few cases are reported in the Medical English literature about unilateral open-door laminoplasty in late adolescent patients with cervical myelopathy. Therefore, we report 3 adolescent patients with cervical myelopathy due to both disc herniation and developmental cervical spinal canal stenosis, who underwent unilateral open-door laminoplasty.

MATERIALS AND METHODS

This study was approved by the Ethical Committee of Peking University Third Hospital and all the participants signed informed consent on admission, before their data were archived in the hospital database and used for research purposes. From January 2006 to July 2012, 3 older adolescent patients with cervical myelopathy underwent expansive laminoplasty at our hospital. All patients were boys, and the median age at the time of surgery was 17 years (range 16–17 years). All patients were high school students, spending 8 to 10 hours a day in sitting position, with their neck flexed. The median duration of preoperative symptoms was 24 months (Table 1). The major symptom at onset was unilateral upper limb weakness and mild sensory disturbance. Conservative treatment could not alleviate the upper limb weakness and mild sensory disturbance. Progressive neurological deficit symptoms developed, which were

TABLE 1. Characteristics and Clinical Outcomes of the Patients

No	Age	Gender	Duration	Herniated Disc	Torg–Pavlov Ratio (%)					Follow-Up	JOA Score		ROM on Flexion		ROM on Extension	
					C3	C4	C5	C6	C7		Pre	Post	Post	Pre	Post	
1	16	Male	36 Mo	C45	65.8	53.3	56.5	58.2	61.6	112 Mo	13	17	14.7	9.3	29.3	23
2	17	Male	24 Mo	C34	63.9	63.2	59.1	71.3	64.4	66 Mo	13.5	16.5	16.1	11.3	49.2	40
3	17	Male	15 Mo	C34, C56	68.0	71.0	71.8	65.8	68.7	36 Mo	10	16	15.9	7.4	37.4	37

JOA = Japanese Orthopaedic Association, Mo = Months, ROM = range of motion.

associated with gait disturbance. All patients underwent imaging (radiographic, computed tomography [CT], and magnetic resonance imaging [MRI]) before surgery.

The severity of myelopathy was evaluated according to the Japanese Orthopedic Association's (JOA) scoring system. Surgical outcomes were assessed based on the recovery rate evaluated by Hirabayashi's system.⁶ The recovery rate was calculated using the following formula: (postoperative score – preoperative score) / (17 – preoperative score) × 100%. Surgical procedures performed on C3–7 had been described previously.^{7,8} All patients were asked to wear a cervical collar for 2 to 4 weeks after surgery. The patients were followed up at 3, 6, 12, and 24 months postsurgery. The median follow-up time was 66 months (range 36–112 months).

We compared preoperative and postoperative dynamic radiograms of the patients who underwent expansive laminoplasty. The range of motion before and after surgery was measured using the dynamic lateral radiograms of the cervical spine.⁹

Case Report

A 17-year-old boy had intermittent numbness in the left hand at the age of 15. Conservative therapy could not alleviate the symptoms. The patient presented with progressive neurological deficit, resulting in gait disturbance, and was transferred to our hospital. The laboratory investigation results were normal. Radiographic examination of the cervical spine showed a developmental cervical spinal canal stenosis (Figure 1A), and CT examination showed sclerosis of the vertebral body edge and facet joint (Figure 2A and B). The T2-weighted MRI revealed posterior cord compression from C3 to C7 with a C3–4 herniated disc (Figure 3A and B). In addition, the T2-weighted MRI showed focal high signal intensity of the cervical cord at the C3–4 (Figure 3A and B). The patient underwent unilateral open-door laminoplasty with the preservation of the unilateral paraspinous muscle ligament complex. At 5 years follow-up, the patient had no neurological deficit symptoms.

RESULTS

The dynamic lateral radiograms of the cervical spine before surgery showed physiologic lordosis with normal ranges of motion. All of these patients had developmental cervical spinal canal stenosis assessed with spinal canal-to-vertebral body ratio (Torg-Pavlov ratio, Table 1). Patients presented no serious complications related to surgery. Neurological deficits significantly improved within 2 weeks after surgery. Grip weakness and sensory disturbances improved after surgery. In addition, the radiographic examination revealed that the

physiologic lordosis had improved. Range of motion in the cervical spine was preserved after surgery, and none of the patients had adjacent segment disease (ASD) or cervical kyphosis (Figure 1D–F). CT scan revealed that the spinal canal had been expanded after the surgery, and no broken shaft or sinking lamina was noticed (Figure 2C and D). An MRI showed no further spinal cord compressions and high signal intensity of the spinal cord decreased gradually (Figure 3C and D). The JOA scores after surgery showed a significant increase. Long-term outcomes after surgery were satisfactory according to the evaluation criteria for the JOA scores (Table 1). However, the ranges of motion in the cervical spine decreased, and especially the ranges of motion on flexion after surgery showed a significant decrease (Table 1).

DISCUSSION

Cervical disc herniation in adolescent patients is typically a benign process with minimal symptoms, which usually resolve spontaneously.¹⁰ The therapeutic method should be selected after considering the natural history.¹¹ Surgical decompression should be performed only in cases presenting with persistent neurological deficits or progressive neurological deterioration, after an adequate course of conservative treatment. In the reported cases, because long-term conservative treatment was ineffective and did not prevent progression of neurologic deteriorations, it was necessary to perform surgical decompression for the cervical myelopathy.

Several reports indicate that anterior cervical discectomy and fusion (ACDF) in children is a safe procedure with good clinical results.¹¹ In adolescent patients, a shorter segment fusion is ideal to prevent kyphotic alignment in flexion and to decrease cervical movement.¹² Although ACDF in young patients with cervical myelopathy could reduce segmental kyphosis and decompress the spinal cord at the responsible segments,¹² surgeons should consider that the cervical spine in young patients would continue to grow.¹³ Hyper-mobility of the segment above the fused vertebra was found more frequently in patients aged <30, and those patients had a higher incidence of developing ASD.¹⁴ Cervical arthroplasty for cervical myelopathy could preserve the motion of the cervical spine, potentially reducing the risk of ASD.¹⁵ However, it was not a viable option in patients with cervical myelopathy due to both disc herniation and developmental cervical spinal canal stenosis.

In late adolescent patients, ASD should be avoided because it usually requires another surgical intervention. At the same time, it is important to preserve the motility in the cervical spine for a good quality of life. Cervical expansive laminoplasty is usually performed in patients with multiple-level spinal cord compression¹⁶ or with canal stenosis,¹⁷ and the favorable



FIGURE 1. A 17-year-old boy presented with numbness of the hand and gait disturbance. (A) Straightening of the physiologic lordosis and developmental cervical spinal canal stenosis. (B–C) Normal ranges of motion in the cervical spine. (D–E) At 2 years follow-up after surgery, physiologic lordosis has improved and the range of motion in the cervical spine is preserved.



FIGURE 2. Computed tomography reveals sclerosis of vertebral body (lower edge) and joint facets without bony spurs. (A–B) Patient underwent unilateral open-door laminoplasty. (C) Open door laminoplasty with no broken shaft and no sinking of the lamina shaft. (D) Image shows that the spinal canal has expanded at 3 months follow-up after surgery.

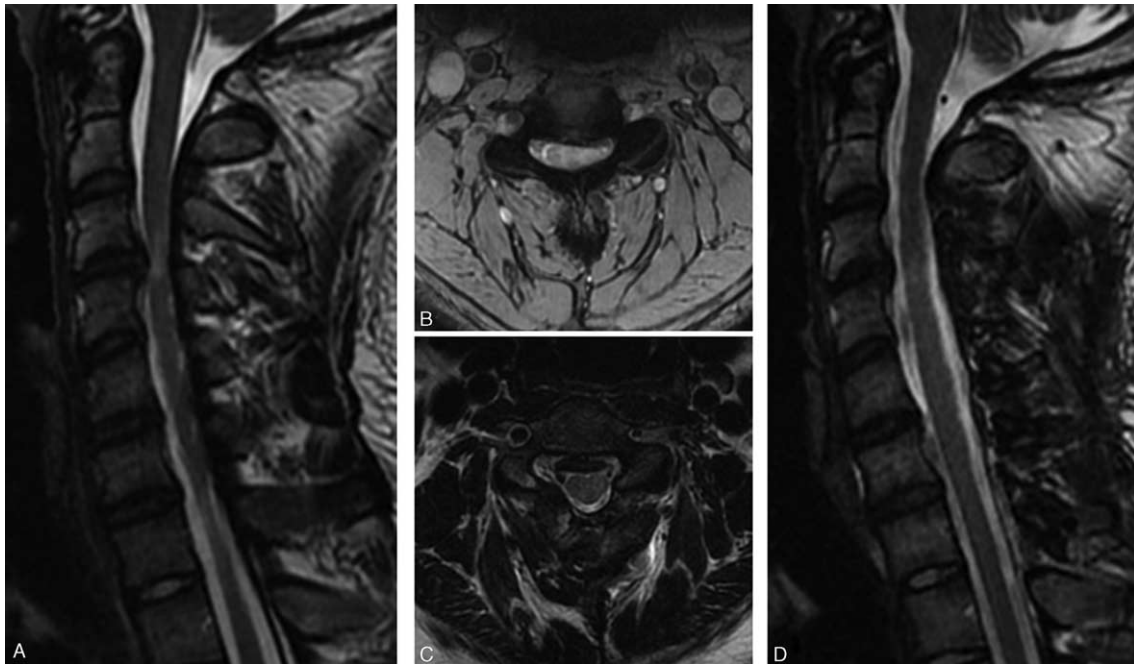


FIGURE 3. The T2-weighted magnetic resonance imaging (MRI) shows the posterior cervical cord compression from C3 to C7 and a C3–4 disc herniation (A–B). In addition, the T2-weighted images in axial MRI show the focal high signal intensity at the C3–4 (A). The patient underwent unilateral open-door laminoplasty. After surgery, the MRI shows no further compression of the spinal cord and the high signal intensity of the spinal cord decreased gradually after 2 years (C–D). MRI = magnetic resonance imaging.

surgical results have been usually obtained in adults.⁴ However, the results have not been confirmed in late adolescent patients. Laminoplasty is a nonfusion surgical techniques performed on the cervical spine. ASD is not a common complication after expansive laminoplasty, if one paid attention to preserve the joint facets in the cervical spine, which would minimize the stress placed on adjacent motion segments.⁵ Sato et al¹⁸ have reported that laminoplasty for calcified intervertebral disc herniation at the cervical–thoracic junction had an excellent outcome in a 13-year-old girl at 5 years follow-up after surgery. The unilateral open-door technique could decrease the incidence of progressive spinal deformity and maintain stability.¹⁹ Cervical laminoplasty has a more favorable outcome when compared with cervical laminectomy in preserving a physiologic range of motion.²⁰ Cervical laminoplasty allows for preservation of the posterior elements, and this might enhance the spinal stability and prevent kyphosis.²¹ In our opinion, unilateral open-door laminoplasty is more suitable for late adolescent patients due to both disc herniation and developmental cervical spinal stenosis. Based on the increase in JOA scores, we can conclude that neurologic function significantly improved in the patients after surgery. The long-term postoperative outcomes were satisfactory according to the evaluation criteria based on the JOA scores. In addition, the high signal of the spinal cord gradually disappeared 2 years after the unilateral open-door laminoplasty. Over the median 5 years follow-up, none of the patients presented with ASD and cervical kyphosis, and all attained a favorable range of cervical motion, although the range of motion decreased slightly, especially on flexion. These results are different than those published by other researchers.²¹ Possible reasons for these differences are that the cases were few and the patients were younger, and very few cases of adolescents with cervical myelopathy that needed surgery have been reported.

In conclusion, expansive laminoplasty is helpful for older adolescent patients with cervical myelopathy due to both disc herniation and developmental cervical spinal canal stenosis, if conservative treatments could not prevent deterioration of neurologic symptoms.

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