

# Surgical Results of en Bloc Open-door Laminoplasty

Seok Won Kim, M.D.,<sup>1</sup> Seung Meung Lee, M.D.,<sup>1</sup> Ho Shin, M.D.,<sup>1</sup> Hyun Sung Kim, M.D.<sup>2</sup>

*Department of Neurosurgery,<sup>1</sup> College of Medicine, Chosun University, Gwangju, Korea*

*Department of Neurosurgery,<sup>2</sup> Mok-po Hankook Hospital, Mokpo, Korea*

**Objective :** The purposes of this study are to evaluate the efficacy of en bloc open-door laminoplasty and to investigate the validity of various factors as prognostic indicators in patients with multisegmental spondylotic myelopathy and ossification of posterior longitudinal ligament(OPLL).

**Methods :** The authors reviewed 43 cases in whom laminoplasty were performed for cervical myelopathy between January 2000 and December 2002. Clinical symptoms and results were evaluated using the Japanese Orthopaedic Association(JOA) scale. The recovery rate was calculated and then assessed for prognostic factors such as preoperative JOA scores, ages, history of previous trauma, duration of symptoms and signal change in cord on T2-weighted magnetic resonance image.

**Results :** In cervical stenosis, canal widening of antero-posterior diameter and dimension after laminoplasty is 4.16mm, 87.43mm<sup>2</sup> and in OPLL is 6.20mm, 117.61mm<sup>2</sup>. In all cases there wasn't neurologic deterioration, mild postoperative complications developed in seven cases. Four patient had a limitation of range of neck motion and the other one showed kyphotic change and another two showed C5 radiculopathy. The recovery rate of JOA score in cervical stenosis and OPLL was 62% and 68% respectively. Duration of symptoms, the severity(preoperative JOA score), and signal change in cord on T2-weighted magnetic resonance image had close relationship to the clinical outcomes.

**Conclusion :** Unilateral en bloc laminoplasty is simultaneous expansile and decompressive method. And preoperative JOA score, symptom duration and high signal intensity on T2-weighted magnetic resonance image can be used to predict prognosis.

**KEY WORDS :** En bloc open-door laminoplasty.

## Introduction

Multiple spondylotic myelopathy and ossification of the posterior longitudinal ligament developed from cervical spondylosis due to disc space narrowing, bony spur formation, and ligament hypertrophy are likely to bring about myelopathy and radiculopathy. They require surgical treatment including anterior decompression, laminectomy, and cervical laminoplasty. Among these methods, cervical laminoplasty is done using several techniques, which were reported to render the similar result<sup>3)</sup>. The preoperative prognostic factors affecting the clinical outcome are the patient's age, severity and duration of neurologic symptoms, and presence of injury<sup>5,6)</sup>. This study was performed to analyze surgical outcomes and the factors affecting the surgical outcomes by evaluating some patients treated for cervical laminoplasty.

## Materials and Methods

Among those cervical spondylotic myelopathy patients who had been treated with cervical laminoplasty from January 2000 to December 2002 at our institute we evaluated the records of 43 patients. All patients underwent laminoplasty using bony union according to the method by Hirabayashi.<sup>15)</sup> Those with ossification of the posterior longitudinal ligament were treated with laminoplasty by placing hydroxyapatite as the spacer to prevent neurological symptoms after surgery due to natural growth of the posterior longitudinal ligament. They were followed up for an average of 12.5 months. Cervical computed tomography(CT) was checked in all patients by postoperative 6 months to evaluate bony union and spinal canal expansion. They included more men than women with 29 men and 14 women. Cervical spondylotic

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• Address for reprints : Seok Won Kim, M.D., Department of Neurosurgery, College of Medicine, Chosun University, 588 Seoseok-dong, Dong-gu, Gwangju 501-717, Korea Tel : +82-62-220-3120, 3126, Fax : +82-62-227-4575, E-mail : chosunns@hanmail.net

myelopathy was present in 31 patients, and ossification of the posterior longitudinal ligament in 12. Their ages ranged from 37 to 76 years, with an average age of 54 years. The Japanese Orthopaedic Association scale was used to evaluate the preoperative and postoperative clinical findings in all patients. The evaluation was made before surgery and by postoperative 1 month, 3 months, and 1 year.

C-spine plain radiography, computed tomography, and magnetic resonance image were taken before surgery in those patients showing neurological symptoms among those with multiple spondylotic myelopathy with at least 3 levels affected. Those patients who had multiple spondylotic myelopathy with less than 2 levels affected and treated with anterior approach were excluded from this study.

Statistical analysis was done using the factors that might have affected surgical outcomes including the gender, age at the time of surgery, duration of neurological symptoms, diameter of the spinal canal before surgery, and presence of injury before surgery. It was done using SPSS by comparing the data using Pearson's chi square test, and significance was determined at P values less than 0.05. The rate of recovery was calculated to evaluate the surgical outcomes using the following formula by Hirabayashi.

The rate of recovery(%)=(postoperative score-preoperative score/total score-preoperative score) × 100.

The diameter of spinal canal was measured at the most narrow portion of the spinal canal on CT. Table 1 shows the data obtained from the patients before surgery.

### Operation technique

The technique by Hirabayashi was used, but we performed bony union using 0.8~1cm bone fragments obtained using a drill from the spinous process from the open site. We using the posterior midline approach in those patients with cervical spondylotic myelopathy in which when the spinous processes were exposed, they were removed using a drill at the base by minimizing bone loss. A gutter was made at the medial margin of the facet through the cancellous portion, but not through the inner cortex on the side of the "open-door" hinge. A gutter on the contralateral side was similarly made, except that it

Table 1. Preoperative patient profile

	Patients (43 cases; male 29, female 14)	
	Cervical stenosis(31 cases)	OPLL(12cases)
Duration of symptoms (mons.)	14.3 ± 10.7	16.4 ± 9.3
Canal diameter (mm)	9.8 ± 1.3	9.1 ± 1.6
JOA* score	11.2 ± 2.5	11.1 ± 2.3
Presence of trauma related to symptoms	6.6%	17 (%)

JOA : Japanese Orthopaedic Association(JOA) scale

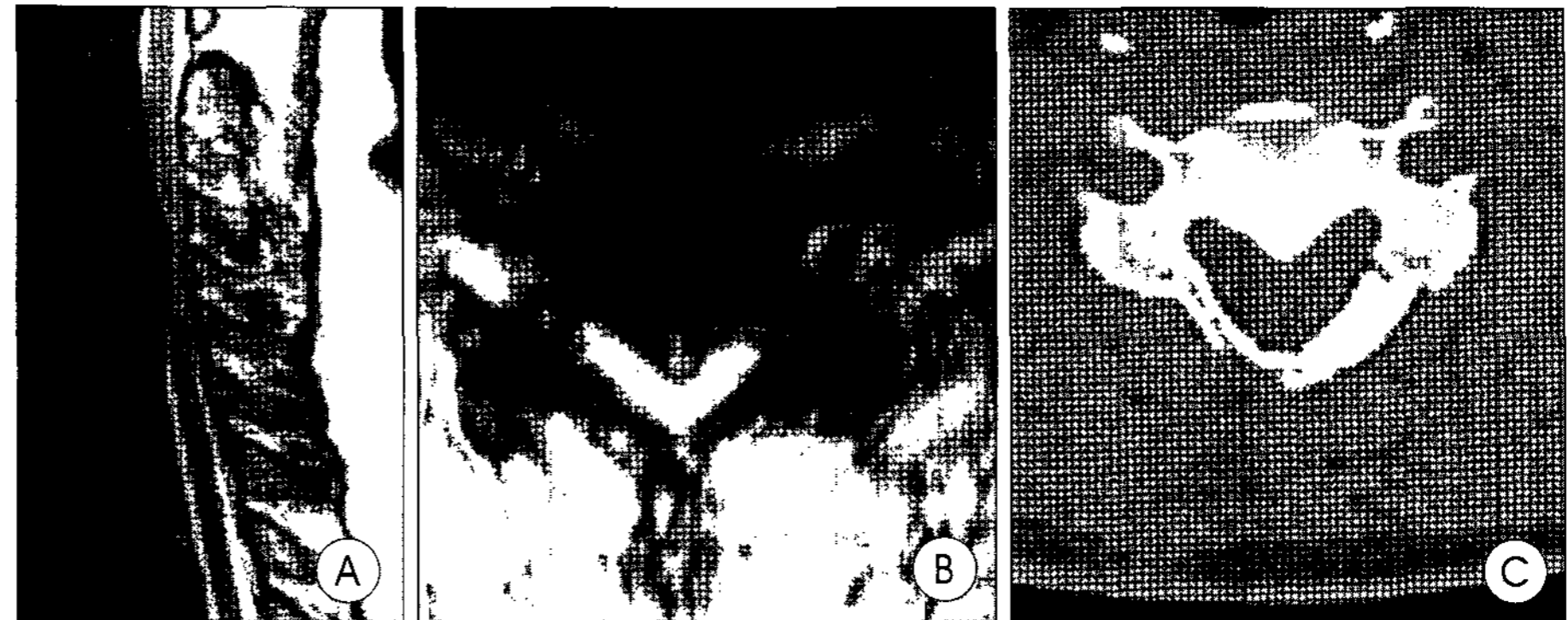


Fig. 1. A, B : On preoperative T2-weighted magnetic resonance images showing continuous type ossification of posterior longitudinal ligament from C3 to C6. The anterior pressure on the spinal cord and dural sac is clearly seen from C3 to C6. C : Six months after the operation, computed tomography scan shows osseous union of the laminoplasty and the well-maintained, enlarged expansion of the spinal canal.

penetrated the inner cortex. Laminectomy was done completely in the side affected by neurological symptoms, foraminotomy was also performed when radiculopathy was present, and a hinge gutter was created in the opposite side. It was performed to include one more disc top and bottom portions of the site affected by spondylosis diagnosed on preoperative radiography. After laminectomy and, the entire posterior arch was carefully lifted toward the hinged side. Then, the spinous processes already removed were cut into the desired size (0.8~1cm). To stabilize the open site, the bone fragments were secured using nonabsorbable suture or 20~22 gauge wire. However, those patients with ossification of the posterior longitudinal ligament were fitted with a trapezoid shaped-hydroxyapatite piece formed using a rongeur or burr as the spacer instead of spinous process into each cervical disc to prevent the recurrence of neurological symptoms. Black silk was passed through the spinous process and the hole already created using a burr by tying both ends. The patients were instructed to walk within 2 days of operation and placed on the Philadelphia brace for 4 to 6 weeks (Fig. 1).

### Results

In those patients with cervical spondylotic myelopathy, the average number of posterior arch used was 5.2, the average time of surgery was 2 hour and 20 minute, and the average

**Table 2.** Surgical result of laminoplasty

	Patients (43cases; male 29, female 14)	
	Cervical stenosis(31cases)	OPLL(12cases)
Average of laminoplasty level	5.2	5.8
Average of operative time	140min	160min
Average of bleeding	350cc	370cc
Average of cord diameter widening	A-P diameter: 4.16mm 87.43mm <sup>2</sup>	A-P diameter: 6.2mm 117.61mm <sup>2</sup>

OPLL : Ossification of posterior longitudinal ligament

**Table 3.** Preoperative and postoperative JOA score and recovery rate

factor	JOA score				
	Cervical stenosis		OPLL		
	Pre-op	Post-op	Pre-op	Post-op	
Moto	upper extremity	2.7	3.6	2.6	3.8
	lower extremity	2.4	3.1	2.4	3.3
Sensory	upper limbs	0.7	1.4	0.7	1.3
	lower limbs	1.2	1.7	1.3	1.6
	trunk	1.7	1.9	1.7	1.8
Bladder		2.5	2.9	2.4	3.1
Total score		11.2	14.6	11.1	14.9
Recovery rate (%)		62		68	

JOA : Japanese Orthopaedic Association Scale(JOA)

**Table 4.** Relationship between prognostic factors and recovery rate in all patients

Factor	All patients	Cervical stenosis	OPLL
	P-value		
Age	0.178	0.168	0.183
Duration of symptom	0.035	0.019	0.026
Canal diameter	0.029	0.038	0.019
Sex	0.234	0.321	0.224
Trauma history	0.321	0.452	0.349

OPLL : Ossification of posterior longitudinal ligament

amount of bleeding was 350mL. When 0.8~1.0cm bone fragments were used, the spinal canal was expanded by an average of 4.16mm in longitudinal diameter and 87.43mm<sup>2</sup> in cross section. In those patients with ossification of the posterior longitudinal ligament, the average number of posterior arch used was 5.8, the average time of surgery was 2hour and 40minute, and the average amount of bleeding was 370mL. When hydroxyapatite spacers were used, the spinal canal was expanded by an average of 6.2mm in longitudinal diameter and 117.61mm<sup>2</sup> in cross section (Table 2).

In those patients with cervical spondylotic myelopathy, the average JOA score was 11.2points before surgery but improved to 14.6points after surgery, showing a 62% improvement. In those patients with ossification of the posterior longitudinal ligament, the average JOA score was 11.1points but improved to 14.9points after surgery, showing a 68% improvement. Lower extremity movement was recovered better than upper extremity movement. No patient showed worsening after

surgery. More than a 40% improvement was seen even in 2patients older than 70years of age (Table 3).

Although symptomatic improvement was not related with age in all patients, it was closely related with the preoperative duration and severity of neurological symptoms (Table 4). In other words,

the rate of recovery was better in those patients who had the symptoms for less than a year, compared with those who had them for more than a year. It was inversely related with the degree of spinal stenosis in which a poor prognosis was seen in those patients with the canal diameter of less than 8mm before surgery. Nonetheless, it was not significantly different according to the gender and presence of injury before surgery. Despite the fact that we could not confirm statistical significance using the small number of patients, the rate of recovery was related with cervical curvature. It was better in those patients with lordotic curve compared with those with kyphosis. The 3 patients who showed an enhancement on T2-weighted MRI showed least improvement with less than 10% improvement.

## Discussion

Cervical spondylotic myelopathy progresses with degenerative changes such as spinal stenosis, induces spondylosis in some cases, and is responsible for spondylosis in most patients older than 55years. Currently, four causes are known to cause cervical spondylotic myelopathy including pathological cause (compression due to bony spur formation), progressing spinal stenosis, vascular cause and motor cause<sup>1,7)</sup>. Among these causes, the first one is most important in which the primary factors inducing spinal symptoms involves a decrease of more than 30% of spinal canal and spondylosis when the spinal canal is less than 6mm. These static factors can be evaluated by evaluating the effective area in the spinal canal using CT or MRI<sup>8,9)</sup>. Pathologically, the mechanism involved in symptomatic expression is different according to the site affected in which degeneration of gray mater is induced at the center of the spinal canal, anteriomedial portion degeneration of the posterior column especially of the corticospinal tract at the top of the lesion, and demyelination (especially the corticospinal tract) of the lateral column below the lesion<sup>11)</sup>.

Those patients with spondylosis would show changes in the cervical area on radiographic study and operation is indicated when neurological symptoms progress for more than a year or severe pain is present. The anterior approach is used when the lesion is present in the anterior portion or the nu-

number of affected site is less than two level. The posterior approach (laminectomy and laminoplasty) is used in patients with congenital stenosis or those with more than three level affected. However, lesions in the anterior portion could progress, there is a possibility of progressive kyphosis and subluxation, the laminectomy membrane can be formed, pain could increase, and the duration of recovery is long with the latter approach, especially laminectomy. In order to reduce these drawbacks, Hirabayashi et al.<sup>4)</sup> proposed the use of cervical laminoplasty in 1978, and many different techniques have been introduced afterwards. However, the rate of recovery was reported to be similar (64~75%).

Artificial bone such as hydroxyapatite are used more frequently in patients with ossification of the posterior longitudinal ligament due to continued growth of this ligament<sup>10,17)</sup>. Nakano et al.<sup>14)</sup> reported excellent outcomes using hydroxyapatite as the spinous process spacer when performing laminoplasty. Although limited, we also used hydroxyapatite as the spinous process spacer in patients with ossification of the posterior longitudinal ligament and obtained similar outcomes. Laminoplasty would show direct and indirect decompression effect by expanding the posterior portion and is used to protect the spinal cord since the posterior arch is preserved. However, cervical motion (especially extension) is limited in about 30~70%, and cervical curvature is maintained in the lordotic state since kyphosis can not be expected because of posterior movement after surgery and correction cannot be achieved. Similar to other studies, a satisfactory outcome was seen in 33 (76%) out of 43 patients in this study, showing laminoplasty to be effective.

Although many factors could affect the treatment outcome, Fujiwara et al.<sup>3)</sup> reported that the important factors are the duration of symptoms before surgery, patient age, and the degree of stenosis. Other factors proposed are the preoperative JOA score, presence of injury, and enhancement on T2-weighted MR image. Most authors reported that prognosis is poor after surgery in patients older than 70 years<sup>2,16,18)</sup>. However, the rate of recovery in this study was 64% and 43% (JOA score) in patients older than 70 years. We found that prognosis was better as the symptomatic duration was short, the preoperative JOA score was higher, and the severity of spinal stenosis was mild. We also encountered an enhancement on T2-weighted MR image in some patients, which signified the presence of reversible lesions or irreversible changes due to edema in the spine. Although we could not tell the difference, we found that these patients showed least improvement of less than 10% improvement. Thus, surgeons should pay careful attention when surgery is indicated and when the patient is counselled before surgery.

The possible complications after laminoplasty include axial

pain (posterior neck, scapula) and transient radiculopathy. Axial pain seen frequently, probably because of motion limitation<sup>12)</sup>. It was seen in 16(37%) out of 43 patients in this study, who had been placed under neck exercise in conjunction with the rehabilitation department. Seen in 3 of our patients, transient radiculopathy is due to C5 root palsy in most patients, occurs by postoperative 1 day and is recovered spontaneously by postoperative 3 months. Although the exact cause is unknown, it is probably due to root traction coming from the posterior displacement of spinal cord<sup>13)</sup>. According to the literature study, neurological worsening after surgery is seen in 38.5%, postoperative growth of ossified lesion in 70%, and postoperative kyphotic angle increase in 8%<sup>11)</sup>. However, these complications were not seen in any of our patients during the follow-up period.

## Conclusion

Laminoplasty is a technique used for spinal decompression without causing secondary instability for the treatment of multiple spondylotic myelopathy maintaining cervical curvature. It was especially effective in patients with ossification of the posterior longitudinal ligament by using hydroxyapatite as the spacer. Not only clinical outcomes but also radiological outcomes were excellent with this technique. It was effective and safe without resulting in many complications. We found that the preoperative JOA score, severity of spinal stenosis, and duration of clinical symptoms are the important prognostic factors. We believe that laminoplasty should be performed regardless of age before irreversible neurological changes would occur.

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