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Comparison of Early Surgical Outcome between Unilateral Open-Door Laminoplasty and Midline Splitting Laminoplasty

Hyun-Chul Baek, M.D., Suk-Hyung Kang, M.D.,
Sang Ryong Jeon, M.D., Sung-Woo Roh, M.D., Seung-Chul Rhim, M.D.

Department of Neurological Surgery, University of Ulsan College of Medicine, Asan Medical Center, Seoul, Korea

Objective : Various techniques of cervical laminoplasty have been developed to decompress the spinal canal in patients with multilevel cervical spondylotic myelopathy. This study compared the early surgical outcomes between unilateral open-door laminoplasty and midline splitting cervical laminoplasty.

Materials and Methods : From March 2004 to August 2005, we performed cervical laminoplasty in 34 patients with cervical myelopathy. Of these patients, 24 were treated by unilateral open-door laminoplasty (open-door group) and 10 by midline splitting cervical laminoplasty (splitting group). The mean duration of follow up was 9.2 months in the open-door group and 15.8 months in the splitting group. We retrospectively analyzed neurological outcomes using the Japanese Orthopedic Association (JOA) score, and compared the radiological changes between the two groups.

Results : Postoperative JOA score and recovery rate were 13.29±4.01 and 56.28±44.91% in the open-door group and 15.75±0.88 and 72.69±19.99% in the splitting group. There was no statistical difference between the two groups ($p>0.05$). Regarding the radiological assessment, the increase of postoperative axial canal area was 63.23±23.24% in the open-door group and 42.30±14.96% in the splitting group ($p<0.05$).

Conclusion : There was no statistical difference in the neurological outcome when the early surgical outcomes of the open-door group and the splitting group were compared. However, the open-door group showed wider cervical spinal canal areas than the splitting group.

KEY WORDS : Cervical vertebrae · Myelopathy · Surgical procedure · Outcome · Spinal canal.

Introduction

Various techniques of cervical laminoplasty have been developed to decompress the spinal canal in patients with multilevel cervical canal stenosis caused by ossification of the posterior longitudinal ligament (OPLL) or cervical spondylosis[1,4,5,7,8,17]. Among the various surgical techniques, unilateral open-door type and midline splitting type are most commonly used[12,14].

The aim of the surgery is to achieve wide posterior decompression of the cervical spine, while maintaining its stability by retaining anterior, middle, and most of the posterior columns of the cervical spine[4,7,17].

We conducted comparison analysis of early surgical outcomes between unilateral open-door laminoplasty and midline splitting laminoplasty. Among the factors that may influence the surgical outcome, such as age, duration of symptoms and the severity of myelopathy, we have focused on the pre- and post-operative neurological status and radiological findings[2,9,11,15].

Materials and Methods

Patient selection and clinical parameters

From March 2004 to August 2005, we performed cervical laminoplasty in 34 patients with cervical myelopathy due to multilevel cervical spondylotic myelopathy or OPLL.

Preoperative diagnoses were OPLL (26 patients) and cervical spondylotic myelopathy (8 patients). Twenty-four patients were treated by unilateral open-door laminoplasty (open-door group) and 10 patients by midline splitting laminoplasty

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• Address for reprints : Seung-Chul Rhim, M.D., Department of Neurological Surgery, University of Ulsan College of Medicine, Asan Medical Center, Pungnap-dong, Songpa-gu, Seoul 138-736, Korea Tel : +82-2-3010-3550, Fax : +82-2-476-6738, E-mail : scrhim@amc.seoul.kr

Table 1. Summary of the JOA Scale grades for cervical myelopathy*

Variable	Grade
I) motor function	
a) upper extremity	
i) unable to feed oneself	0
ii) unable to handle chopsticks; able to eat w/ a spoon	1
iii) handles chopsticks w/ much difficulty	2
iv) handles chopsticks w/ slight difficulty	3
v) normal	4
b) lower extremity	
i) unable to stand & walk by any means	0
ii) unable to walk w/o a cane or other support on a level	1
iii) walks independently on a level surface but needs support on stairs	2
iv) capable of fast walking but clumsy	3
v) normal	4
II) sensory function	
a) upper extremity	
i) apparent sensory loss	0
ii) minimal sensory loss	1
iii) normal	2
b) lower extremity	
i) apparent sensory loss	0
ii) minimal sensory loss	1
iii) normal	2
c) trunk	
i) apparent sensory loss	0
ii) minimal sensory loss	1
iii) normal	2
III) bladder function	
a) urinary retention &/or incontinence	0
b) sense of retention &/or dribbling &/or thin stream	1
c) urinary retardation &/or pollakiuria	2
d) normal	3

*Cumulative normal grade in a healthy individual is 17. Recovery Rate (%) = (postoperative score−preoperative score) / (17−preoperative score) × 100

Table 2. Comparison between open-door group and splitting group in preoperative status

	Open−door group (n=24)	Splitting group (n=10)	*p* value
Age (years)	55.5	56.2	0.925
Symptom duration (months)	17.58	18.8	0.985
JOA scores	9.21	10.9	0.332
Number of levels of lesion	4.92	4.70	0.485
Axial canal area (mm^2)	167.32	158.04	0.326
AP canal diameter (mm)	9.97	10.51	0.526

*The numeric is average value

(splitting group). The average duration of the postoperative follow-up was 9.6 months in the open-door group and 15.9 months in the splitting group.

The Japanese Orthopedic Association (JOA) scale and recovery rate (RR) were used to evaluate the severity of the cervical myelopathy and the postoperative outcome (Table 1)[14].

Table 3. Comparison between open-door group and splitting group in postoperative status

	Open−door group (n=24)	Splitting group (n=10)	*p* value
JOA scores	13.29	15.75	0.157
Recovery rate (%)	56.28	72.69	0.390
Axial canal area (mm^2)	273.06	222.61	0.001
(post ACA − pre ACA) / pre ACA ×100 (%)*	63.24	42.30	0.014
AP canal diameter (mm)	16.59	15.83	0.566

*pre ACA : preoperative axial canal area, post ACA : postoperative axial canal area

Fig. 1. Intraoperative photograph of miniplate augmented unilateral open−door laminoplsty : The laminae on left side are elevated and fixed by titanium miniplates and screws (Walter Lorenz®, Florida, USA).

Fig. 2. Intraoperative photograph of midline splitting laminoplasty : The split spinous processes are split and spread in the midline. They are fixed by hydroxyappatite spacers (Apaceram®, PENTAX Corp. Tokyo, Japan).

The recovery rate was calculated by following formula.

Recovery rate (%) = [Postoperative JOA score - Preoperative JOA score/(17-Preoperative JOA score)] × 100

The duration of symptoms, length of lesion, and patients' age and sex were also analyzed.

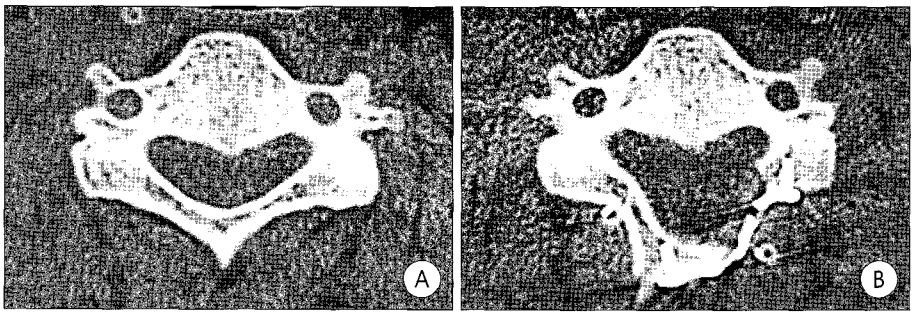

Fig. 3. A : Preoperative axial computed tomography scans showing cervical stenosis, B : postoperative axial computed tomography scans showing canal widening after miniplate augmented unilateral open-door laminoplasty.

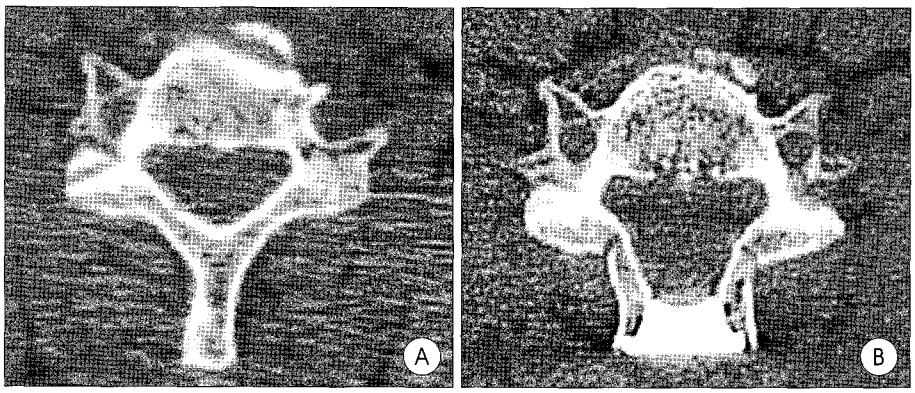

Fig. 4. A : Preoperative axial computed tomography scans showing cervical stenosis, B : postoperative axial computed tomography scans showing canal widening after midline splitting laminoplasty fixed by hydroxyappatite spacer.

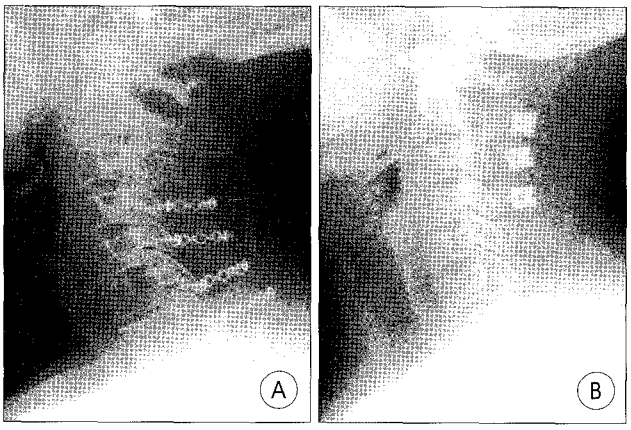

Fig. 5. Postoperative plain X-ray in (A) miniplate augmented unilateral open-door laminoplasty and (B) midline splitting laminoplasty fixed by hydroxyappatite spacer.

We also analyzed the length of lesion, pre- and post-operative minimal axial canal area, and anterior-posterior (AP) length of the cervical canal. All measuring processes were performed using the picture archiving and communication system (PACS) which was analysed by digital imaging and communication in medicine (DICOM Version 3.0).

Operative methods

The two operative procedures, unilateral open-door laminoplasty and midline splitting laminoplasty, were performed by two different surgeons in our department according to their own preference.

In the open-door group, modified Hirabayashi unilateral open-door laminoplasty augmented by miniplates was performed. The level of operation included one to two segments above and below the lesion. If C2 was uppermost, dome-like laminoplasty was performed. The laminae were fixed by titanium miniplates and screws (Walter Lorenz®, Florida, USA). Bilateral foraminotomy using a high speed drill was also carried out simultaneously. All bone work was done under microscope.

In the splitting group, the spinous processes were split at the midline using a high speed burr. After the gutters were made on both laminalateral mass junctions, the hemilaminae were separated at the midline and elevated. The split spinous processes were fixed by hydroxyappatite spacers (Apaceram®, PENTAX Corp. Tokyo, Japan) (Fig. 1, 2).

Statistical analysis

Parametric statistical analysis was performed using Student's t-test or the Mann-Whitney U test (SPSS 12.0, $p<0.05$).

Results

The preoperative JOA score was 9.21±4.5 in the open-door group and 10.9±3.9 in the splitting group ($p>0.05$). The mean duration of symptoms in the two groups was 17.6±23.4 months for the open-door group and 18.8±36.3 months for the splitting group ($p>0.05$). The mean number of levels affected was 4.92 and 4.70 ($p>0.05$), preoperative axial canal area (mm^2) was 167.32 and 158.04 ($p>0.05$) and preoperative AP canal diameter (mm) was 9.97 and 10.51 ($p>0.05$) for the open-door group and the splitting group respectively (Table 2).

The average duration of hospitalization was 15.8 days in the open-door group and 16.5 days in the splitting group. The mean operation time was 264 minutes in the open-door group and 237 minutes in the splitting group.

Postoperatively, transient C5 root palsy developed in 2 patients in the open-door group and axial neck pain was observed in 8 patients in the open-door group and 1 patient in the splitting group. The axial neck pain was evaluated based on that the numeric rating scale for pain was higher than five at last follow-up.

Postoperative JOA score and recovery rate were 13.29±4.01 and 56.28±44.91% in the open-door group, and 15.75±0.88 and 72.69±19.99% in the splitting group. However, there was no statistical difference between the two groups ($p>0.05$).

In the radiological evaluation, the increase of postoperative axial canal area was 63.23±23.24% in the open-door group and 42.30±14.96% in the splitting group, demonstrating a statistically significant difference between the two groups ($p<0.05$) (Table 3), (Fig. 3, 4, 5). The postoperative axial computed tomography showed that the majority of hinges remained patent in both groups.

In summary, there was no difference in the neurological outcome between the two groups, but open-door surgery resulted in wider axial canal area than the splitting surgery.

Discussion

There are many methods of performing cervical laminoplasty. The main goal of laminoplasty is a wide spinal canal decompression with preservation of the posterior elements for maintaining the stability of the cervical spine. Cervical laminoplasty is the method of choice in decompression of the cervical spine in multiple-level disease (e.g. cervical spondylotic myelopathy and OPLL). Among the various methods of cervical laminoplasty, unilateral open-door type and midline-splitting type are the most useful[12,14]. This study was designed to compare the surgical outcome of unilateral open-open door surgery to that of midline splitting surgery.

The factors that influence surgical outcome are age, duration of symptoms and the severity of myelopathy, etc[2,9,11,15]. In comparative analysis of preoperative status, there was no significant difference in the patients' profile and disease severity between the two groups. In terms of postoperative results, there was no significant difference in neurological outcome between the two techniques.

Naito et al.[12] suggested that there were no significant differences in clinical results between two surgical methods. Yue et al.[19] also showed that no difference in neurological outcome was observed for the two surgical techniques except that there was a higher incidence of minor complications in the unilateral open-door technique. Patel et al.[13] found that there was no statistical difference in recovery rates based on different laminoplastic techniques.

A review of the literature revealed postoperative recovery rates ranging from 50% to 80%[14]. Steinmetz et al.[16] found that the mean recovery rate after unilateral open-door laminoplasty was approximately 60% and after midline splitting laminoplasty the mean recovery rate was approximately 50%. Similar neurological outcomes were observed in this study and both surgical techniques achieved favorable neurological outcomes.

The minimal extent of the spinal canal must be widened to obtain good results remains unclear, although the relationship between the degree of spinal canal expansion and clinical results after laminoplasty have been investigated. Hukuda et al.[6] found no relationship between these two factors. Kimura et al.[10] suggested that the optimal enlargement of the stenotic canal by laminoplasty is an increase of 4-5 mm in AP diameter. In this study, the majority of the patents showed a definite increase in axial canal area. Comparing the two groups however, the open-door technique achieved a wider axial canal area. To minimize the difference in measurments using PACS, we repeated measurments three times and took the average value. Since the two techniques were performed by two different surgeons, the different laminoplasty opening size could affect the expansion of postoperative axial canal area. In the splitting group, a 10 mm spacer was used but the anchoring positions on the spinous processes were slightly different.

Wang et al.[18] suggested that significant differences in postoperative increase in axial canal area were found between the two techniques when the door was opened by more than 12 mm, while no significant differences were detected when the door was opened by less than 12 mm. In other words, unilateral open-door laminoplasty achieved a wider axial canal area if the laminoplasty opening size was more than 12 mm. Therefore, postoperative axial canal area could be affected by the opening size of laminae in this study.

The postoperative minimal axial canal area was 214.2 mm^2 in the open-door group and 181.0 mm^2 in the splitting group. Hamburger et al.[3] reported that patients with a postoperative axial canal area more than 160 mm^2 achieved a better outcome and recommended an operation plan to achieve this target area. Considering the analyzed results, an effective canal widening was achieved in both the open-door and the splitting surgical techniques.

Conclusion

Unilateral open-door or midline splitting cervical laminoplasty seem to be effective surgical methods for multilevel spondylotic myelopathy. Comparison of early surgical outcome for unilateral open-door laminoplasty and

for midline splitting laminoplasty revealed no statistical difference in neurological outcome, but wider postoperative spinal canal expansion was observed radiologically in patients who had undergone unilateral open-door laminoplasty. Consequently, unilateral open-door laminoplasty achieved more effective canal widening.

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Commentary

The authors undertook a comparative study on two currently and most widely used cervical laminoplasty techniques and delivered brief reassuring results. As shown in the previous reports, both treatments were equally effective, and thus they failed to show any significant differences in clinical outcome between two laminoplasty methods, although the extent of canal widening shown in the postoperative radiograph is significantly high in the open-door group. It is rather disappointing that the authors did not describe the features of developing postoperative axial pain in detail.

Youn-Kwan Park, M.D.
Department of Neurosurgery, Korea University