



A Clinical and Radiographic Comparison between Cervical Degenerative Stenosis and Ossification of the Posterior Longitudinal Ligament after Single, Open-Door Instrumented Laminoplasty

Fengbin Yu¹, Fei Huang¹, Hui Zhu¹, Degang Tao¹, Jianbo Jin¹ and Lian Cen^{2*}

¹Department of Orthopaedic Surgery, East China University of Science and Technology, China

²Department of Product Engineering, East China University of Science and Technology, China

Abstract

There are few large series evaluating the operative results of laminoplasty for the treatment of multilevel Cervical Degenerative Stenosis (CDS) and Ossification of the Posterior Longitudinal Ligament (OPLL). The purpose of this study was to compare the clinical and radiographic differences between patients with CDS and those with OPLL after posterior, single open-door instrumented laminoplasty. From 2012 and 2016, 88 patients with either multilevel CDS (n=55) or segmental OPLL (n=33) were treated with posterior, single open-door instrumented laminoplasty. When compared to the CDS patients, the OPLL patients had more Estimated Blood Loss (EBL) (360 + 66 ml vs 220 + 48 ml) and longer operative time (145 + 12 min vs 115 + 13 min) than those with CDS (p<0.001). The extent of the loss of sagittal cervical range of motion after laminoplasty was greater in the OPLL group (19 + 5 degrees vs 10 + 3 degrees; p<0.001). Both groups had marked improvement in the Japanese Orthopedic Association (JOA) score after surgery (p<0.001). There were no significant differences in the pre- and postoperative JOA scores or recovery ratio between the two groups (p>0.05). The rate of complications also did not differ between the two groups (p>0.05). Our study showed that the EBL, operative time, and loss of cervical range of motion were greater in the OPLL group. We speculated that tissue properties associated with OPLL might be responsible for the differences between the two groups.

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*Correspondence:

Lian Cen, Department of Product Engineering, East China University of Science and Technology, China,
E-mail: liancen1978@sina.com

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Introduction

Progressive spinal canal narrowing caused by Cervical Degeneration Stenosis (CDS) or Ossification of the Posterior Longitudinal Ligament (OPLL) can lead to compression of the spinal cord, and cervical stenotic myelopathy [1-2]. Conservative therapy is often inadequate, requiring eventual operative intervention [3]. The optimal operative treatment for multilevel CDS remains controversial. Laminoplasty is an attractive option when no cervical kyphosis exists, as previously reported [4-7].

Few large series have evaluated the operative outcomes in patients with CDS or with OPLL [8]. The aim of this study was to compare the operative outcome in patients with OPLL and CDS treated with posterior, single open-door, instrumented laminoplasty and fixation with titanium mini plates.

Materials and Methods

Patient demographics

We reviewed retrospectively 88 patients with CSM caused by either multilevel CDS or segmental OPLL. Patients underwent single open-door, instrumented laminoplasty with fixation using titanium mini plates between April 2012 and August 2016. Indications for laminoplasty included: (1) lesions involving 3 levels, (2) lateral cervical X-ray films with no cervical kyphosis deformity, and (3) neurologic deterioration caused by trauma or progression of disease not responding to conservative treatment. All anticoagulation therapy was stopped two weeks before operation. Similar to CDS patients, OPLL patients maintained their sagittal motion after laminoplasty. Patients

with a history of prior cervical surgery, those who underwent fusion for pre-existing segmental instability or extension of the laminoplasty to T-1, and those with mixed OPLL or continuous OPLL were not included in this study.

The 88 patients were divided into two groups, those with multilevel CDS and those with segmental OPLL. The CDS group included 36 men and 19 women (mean age: 62.6 years; range: 48–78 years). The OPLL group included 23 men and 10 women (mean age: 61.2 years; range: 46–82 years). All five levels (C3–C7) were treated in each group. There were no significant demographic differences between the two groups.

Operative technique (C3–C7)

A standard, posterior midline approach was used to expose the cervical lamina from the inferior edge of C2 to the superior portion of T1, and laterally to the medial aspect of the facet joints. A high-speed burr was used to remove the posterior cortex at the junction of the lateral mass and lamina. The lamina was opened on the side with the greatest compression or more neurologic symptoms. The other side was left with a thin shell of bone as a hinge to open the lamina. Once the opening and hinging of each lamina was performed, the C2-3 and C7-T1 interspinous ligaments were resected. After adequate decompression, the dura was typically pulsatile, indicating satisfactory decompression. When the “open door” had been mobilized adequately, the posterior elements were stabilized with a titanium mini plate at each level. A soft collar was used to maximize patient comfort in the first few days after operation.

Outcome assessment

Perioperative data collected included Estimated Blood Loss (EBL), operative time, and complications. The operative outcome was assessed using the Japanese Orthopedic Association (JOA) scoring system and the recovery rate. The recovery rate was calculated as follows: $(\text{postoperative JOA score} - \text{preoperative JOA score}) / (17 - \text{preoperative JOA score}) \times 100\%$. Preoperative and final follow-up dynamic lateral radiographs in patients with CDS (Figure 1A) and OPLL (Figure 1B) were evaluated to evaluate the cervical Range of Motion (ROM). Cervical ROM was calculated by measuring the Cobb angles of C2–C7 on lateral radiographs during flexion and extension according to the technique described by Adams and Logue [9]. The data were collected and reviewed by an independent, experienced, academic spine surgeon.

Ethical approval

The institutional committee for medical ethics approved the design of the study.

All the patients participated voluntarily at the follow-up.

Statistical methods

Statistical analyses were performed using SPSS (Mac Version 18.0) (SPSS Inc., Chicago, IL, USA). Student's t-test was used to evaluate mean data, and Pearson's chi-squared test was used to evaluate categorical data. P value <0.05 was considered statistically significant. Continuous data are presented as standard + standard deviation.

Results

Mean duration of follow-up for the 88 patients was 20 ± 5 months for CDS and 21 ± 5 months for OPLL ($p=0.66$); the range of follow-up was 18 to 28 months. The EBL and operative time for the CDS group were $220 + 48$ ml (range: 150 ml to 330 ml) and $115 + 13$ mins (range:

98 min to 155 min), respectively. In contrast, the EBL and operative times for the OPLL group were greater at $360 + 66$ ml (range: 260 ml to 510 ml) and $145 + 12$ mins (range: 110 min 173 min), respectively, ($p<0.001$ each). In the CDS group, the average preoperative JOA score was 8.1 ± 1.5 (range: 6–11) and increased to 12.6 ± 1.5 (range: 10–16) at the final follow-up ($p<0.001$); the recovery rate of the JOA score was $38\% \pm 18\%$. Similar values were present in the OPLL group; the average preoperative JOA score was 8.3 ± 1.3 (range: 6–11) and increased to 12.7 ± 1.5 (range: 10–15) at the last follow-up ($p<0.001$), the recovery rate of the JOA score was $39\% \pm 16\%$. The preoperative and postoperative JOA scores and the recovery rates did not differ between the two groups ($p > 0.60$ each).

The sagittal ROM (degrees) from C₂ to C₇ was similar in the two groups before operation (CDS group, 39 ± 4 , range 33 to 45; OPLL group, 38 ± 4 , range 24 to 46; $p=0.20$). In contrast, the loss of cervical ROM after laminoplasty was greater in OPLL patients (from 38 ± 4 to 21 ± 3 , mean 17 ± 5) than among CDS patients (from 39 ± 4 to 30 ± 3 , mean 10 ± 3) ($p<0.001$).

Only one patient (in the CDS group) developed a temporary C-5 nerve root palsy on the hinge side that resolved within 3 months. Three patients in the CDS group and 2 in the OPLL group experienced postoperative axial symptoms which all resolved within 1 year. No cerebrospinal fluid leak, wound infection, wound hematoma, or reoperation occurred in either group overall. There was no difference in the rate of complications between the two groups ($p=0.60$).

Discussion

Several surgical approaches are used to treat multilevel CSM, because the optimal approach has not been defined. The anterior approach to the cervical spine allows direct decompression of the ventral pathology and corrects kyphotic deformities. Fusion-related problems [10,11], complications related to the anatomic approach [12], and potential adjacent-level disease [13] make a posterior approach more attractive. Cervical, single open-door laminoplasty decompression is achieved by expansion of the posterior arch without removal of the posterior spinal element. This operative approach preserves segmental motion and avoids the potential disadvantages associated with laminectomy alone or laminectomy with fusion [14–16]. Cervical; single open-door laminoplasty has been the most common alternative method for patients with multilevel CSM.

A commonly encountered problem in single open-door laminoplasty is the so-called “spring-back” phenomenon, which consists of reclosure of the open door lamina? A variety of techniques have been used to stabilize the bony posterior elements, including suture and wiring of the spinous process to the facet joint, insertion of a spacer within the opening, or placement of a mini plate with screw fixation [17–20]. Among these techniques, mini plate and screw fixation with or without bone allograft has achieved the best improvement in patient function, with no hardware failure, and few associated complications [18–20]. Our patients had good outcomes, similar to the literature [18–20].

Our outcomes may be similar for the following reasons. Compared with other techniques of laminoplasty, the use of mini plates at each level provides stability to the posterior elements. This stability can not only promote healing of greenstick fractures on the hinge side but also maintains the position of the open door, maximizing cervical mobility and allowing patients to move and exercise their necks sooner.

Nerve root palsy after laminoplasty occurred in only 1 of 78 patients (1.3%), which is much less than that the rate of 5% to 12% reported in the literature [21]. This observation may explain our low rate of opening of the posterior elements. Although several mechanisms for the development of nerve root palsy have been proposed [21-22], increased stretching of the nerve root with cord drift-back is still the most widely accepted theory. If true, minimizing the possibility of cord drift-back could decrease the risk of nerve root palsy. In our study, opening of the posterior elements was 8 mm to 10 mm, slightly less than that reported by O'Brien and colleagues [18]. This amount of opening appeared to be sufficient, because the return of dural pulsations during operation indicated that adequate decompression had been achieved.

The overall incidence of axial neck pain in our two groups was 6%, which is on the low end of the incidence of 6% to 60% reported in the literature [23]. Stable fixation, avoiding facet joint disruption, reattachment of the muscles, and early cervical mobilization may be responsible for our low incidence of axial symptoms.

In this study, the mean EBL for the OPLL group was nearly 1.5 times greater than that of the CDS group. It is our impression that in the OPLL group there appeared to be more perforating vessels passing through the lamina and cervical muscles. These vessels had a tendency to bleed, even after coagulation. The same was true when operating below the lamina, especially at the C3-C4 level. We speculate that OPLL might lead to an increase in the density of these blood vessels in the cervical region related to the vascular inflammation associated with OPLL; such changes would result in more blood loss during the open door laminectomy.

Even when a laminoplasty is performed without fusion, a loss of cervical ROM usually occurs [24-25]. Possible reasons for loss of ROM include injury to the facet joint with spontaneous fusion of the hinged side, alterations in tissue elasticity after the extensive posterior exposure, and prolonged postoperative immobilization. We used only one operative technique and had identical immobilization times in the two groups. We speculate that the more prominent loss of neck motion in the OPLL group was caused by the increased osteoblast activity occurring as part of the development of OPLL. This increased bone deposition lead to undesired intersegmental fusion of the hinged side. Progression of OPLL after single open-door laminectomy may also be responsible in part for the greater loss of cervical ROM in the OPLL group. We chose specifically to follow patients from 18 to 248 months after operation to mitigate the potentially confusing factor of progression of OPLL. Our patients experienced less EBL and greater ROM than reported by Meyer et al. [8]. The reasons for these differences may be multi factorial, including the relatively small number of patients (n=88), racial differences, and shortcomings inherent to a retrospective study.

In summary, our data suggest that instrumented single open-door laminoplasty was associated with clinically important improvement in neurologic symptoms and function and fewer complications in both the CDS and OPLL groups. EBL, operative time, and loss of cervical ROM were greater in patients with segmental OPLL than those with multilevel CDS. We speculate that the inflammatory component of OPLL may cause vascular changes responsible for these differences.

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