

Clinical Study

# Where should a laminoplasty start? The effect of the proximal level on post-laminoplasty loss of lordosis

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## Abstract

**BACKGROUND CONTEXT:** Open-door laminoplasty is a useful operation in the surgical management of cervical myelopathy with favorable outcomes and relatively low complications. One potential undesirable outcome is a decrease in cervical lordosis postoperatively. It is unknown whether the most proximal level undergoing laminoplasty affects the magnitude of loss of lordosis.

**PURPOSE:** This study aimed to compare the loss of cervical lordosis postoperatively in patients for whom the most proximal level undergoing laminoplasty is C3 versus C4.

**STUDY DESIGN/SETTING:** A retrospective radiographic review at an academic center was carried out.

**PATIENT SAMPLE:** A total of 65 patients at a single institution who underwent plated open door laminoplasty for cervical myelopathy by multiple surgeons over a 5-year period were included.

**OUTCOME MEASURES:** The primary outcome was change in cervical lordosis, which was the difference in C2–T1 Cobb angle between the postoperative and preoperative films.

**METHODS:** Patients were divided into two groups based on the most proximal vertebral level undergoing laminoplasty. There were 49 patients who underwent laminoplasty beginning at C3, whereas 16 patients underwent laminoplasty beginning at C4. The C2–T1 Cobb angle was measured on the preoperative film and on the final postoperative follow-up film. The difference between these values was calculated for each patient, and the mean of the differences for the C3 group was compared with that of the C4 group.

**RESULTS:** When C3 was the proximal plated laminoplasty level, loss of lordosis averaged 9°. In contrast, when C4 was the proximal plated level, loss of lordosis was significantly less and averaged only 3° ( $p=.047$ ). In the group as a whole, mean preoperative lordosis was 18° compared with 11° postoperatively, for an overall 7° loss of lordosis.

**CONCLUSIONS:** Starting the laminoplasty at C4 led to significantly less loss of lordosis than starting at C3. When the pattern of spinal cord compression does not require laminoplasty at C3, consideration should be given to making C4 the most cephalad laminoplasty level rather than C3 to better preserve lordosis. © 2016 Elsevier Inc. All rights reserved.

## Keywords:

Cervical myelopathy; Cervical spine; Cervical spine surgery; Complications; Kyphosis; Laminoplasty; Lordosis; Sagittal alignment; Sagittal balance

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## Introduction

One of the original impetuses for the development of laminoplasty was to avoid post-laminectomy kyphosis and its attendant problems, including deformity, neck pain, and residual or recurrent myelopathy. Although severe kyphosis of the magnitude seen after multilevel laminectomy is not common after laminoplasty, studies have nevertheless demonstrated that loss of lordosis can occur even after laminoplasty [1]. Loss of lordosis is typically not a desirable outcome with any type of cervical surgery, whereas maintaining lordosis has beneficial effects. For example, cervical lordosis has been associated with posterior spinal cord migration away from anterior impinging structures following laminoplasty [2], and also with improved neurologic recovery [3].

Although high preoperative T1 slope and flexion greater than extension range of motion have been described as risk factors for kyphosis developing after laminoplasty [1,4], intraoperative factors may contribute as well. Because detachment of the C2 cervical extensor attachments has been associated with worse axial pain and range of motion [5–7], attempts are made to preserve those attachments whenever possible. However, when a laminoplasty is performed at the C3 level, some degree of muscle detachment off of C2 is almost always unavoidable to obtain the exposure necessary to be able to open C3 on C2. This need for muscle detachment occurs because the distal portion of the C2 lamina is dorsal to, overlaps, and partially blocks the proximal portion of the C3 lamina. In contrast, although laminoplasty at the C4 level requires at least some dissection of the C3 muscular attachments, it can generally be performed without disturbing the C2 insertions. In such cases, if it is necessary to decompress the C3–C4 and C2–C3 disc levels, then a laminectomy—either partial or complete—of C3 can be performed in association with a C4 laminoplasty, because the lamina of C3 can be removed working from distal to proximal underneath the C2 attachments with minimal disruption to them. Given that disruption of cervical extensor muscles at C2 has been associated with worse cervical alignment [8], we examined whether limiting proximal muscle dissection by starting the laminoplasty at C4 versus C3 could potentially reduce post-laminoplasty loss of lordosis.

## Methods

All patients at a single institution undergoing plated open door laminoplasty for cervical myelopathy by multiple surgeons over a 5-year period were reviewed. Patients with a diagnosis of cervical myelopathy, with symptoms including weakness, gait disturbance, and loss of coordination, as well as evidence of compression on magnetic resonance imaging (MRI) or computed tomography myelogram that could explain their symptoms, were included in the study. Patients with prior spine surgery or plain radiographs showing dynamic listhesis or preoperative kyphosis exceeding 13° from C2 to C7 were excluded. The location and number of levels treated surgically

## EVIDENCE & METHODS

### Context

The authors sought to evaluate the impact of proximal level of laminoplasty on postoperative cervical lordosis. This was a retrospective review of 65 patient records derived from a single center.

### Contribution

The authors report significantly less loss of lordosis for laminoplasties that stopped at C4 as opposed to C3. The significance of this finding, as encountered in the authors' reported p-value (0.047) is borderline given the limited number of patients included in this study.

### Implications

While providing some potentially useful information, it must be appreciated that the design of this study limits the capacity for broad translation, particularly due to the number of patients considered within both cohorts. The results may be confounded by selection and indication bias (patients with less extensive spondylotic involvement may be less prone to loss of lordosis) as well as measurement bias. Given the limitations associated with this work, this study should be considered as presenting Level IV evidence.

—The Editors

were considered based on MRI or computed tomography myelogram. If the proximal extent of stenosis was no further cephalad than the C3–C4 disc level, a laminoplasty of C4 could be performed along with a laminectomy of C3 to achieve adequate decompression while limiting detachment of the C2 muscle insertions. Patients were divided into two groups based on the most cephalad level involved in the laminoplasty. There were 49 patients who underwent laminoplasty beginning at C3, whereas 16 patients underwent laminoplasty beginning at C4. Preoperative sagittal radiographic measurements included C2–C7 and C2–T1 Cobb angles (defined as the measurement of the angle between the upper end plate of one vertebral body to the lower end plate of a more distal vertebral body [9], but the inferior end plate of C2 was used for increased consistency) in a neutral lateral position, C2 plumb (measured by dropping a vertical line from the center of the C2 vertebral body, and measuring the horizontal distance from that line perpendicularly to the center of the T1 vertebral body), and C2–C7 Cobb angles in flexion and extension. The Figure below demonstrates the Cobb angle measurement.

Postoperative radiographs were analyzed to determine the difference between the postoperative and preoperative lordosis. To determine the change in lordosis, preoperative C2–T1 Cobb angle was subtracted from postoperative C2–T1 Cobb angle. Comparisons were made to evaluate the impact of the most cephalad level included in the laminoplasty as well as the presence of a C2 dome laminectomy on change in lordosis.

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