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The Spine Journal ■■ (2014) e1–e7

THE SPINE JOURNAL

Case Report

Revision surgery after cervical laminoplasty: report of five cases and literature review

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Received 17 June 2013; revised 10 October 2013; accepted 26 November 2013

Abstract

BACKGROUND CONTEXT: Revision surgery after laminoplasty is rarely performed, and there are few reports of this procedure in the English literature.

PURPOSE: To evaluate the reasons why patients underwent revision surgery after laminoplasty and to discuss methods of preventing the need for revision surgery. A literature review with a comparative analysis between previous reports and present cases was also performed.

STUDY DESIGN: Case report and literature review.

PATIENT SAMPLE: Five patients who underwent revision surgery after laminoplasty.

OUTCOME MEASURES: Diagnosis was based on the preoperative computed tomography and magnetic resonance imaging findings. Neurologic findings were evaluated using the Japanese Orthopedic Association score.

METHODS: A total of 237 patients who underwent cervical laminoplasty for cervical spondylotic myelopathy from 1990 to 2010 were reviewed. Patients with ossification of the posterior longitudinal ligament, renal dialysis, infection, tumor, or rheumatoid arthritis were excluded. Five patients who underwent revision surgery for symptoms of recurrent myelopathy or radiculopathy were identified, and the clinical courses and radiological findings of these patients were retrospectively reviewed.

RESULTS: The average interval from the initial surgery to revision surgery was 15.0 (range 9–19) years. The patients were four men and one woman with an average age at the time of the initial operation of 49.8 (range 34–65) years. Four patients developed symptoms of recurrent myelopathy after their initial surgery, for the following reasons: adjacent segment canal stenosis, restenosis after inadequate opening of the lamina with degenerative changes, and trauma after inadequate opening of the lamina. One patient developed new radiculopathy symptoms because of foraminal stenosis secondary to osteoarthritis at the Luschka and zygapophyseal joints. All patients experienced resolution of their symptoms after revision surgery.

CONCLUSIONS: Revision surgery after laminoplasty is rare. Inadequate opening of the lamina is one of the important reasons for needing revision surgery. Degenerative changes after laminoplasty may also result in a need for revision surgery. Surgeons should be aware of the degenerative changes that can cause neurologic deterioration after laminoplasty. © 2014 Elsevier Inc. All rights reserved.

Keywords: Laminoplasty; Revision surgery; Lamina closure; Adjacent degeneration; Cervical spine; Myelopathy; Radiculopathy

FDA device/drug status: Not applicable.

Author disclosures: ***HS:*** Nothing to disclose. ***MK:*** Nothing to disclose. ***HM:*** Nothing to disclose. ***EI:*** Nothing to disclose. ***TK:*** Nothing to disclose. ***AO:*** Nothing to disclose. ***YU:*** Nothing to disclose. ***YT:*** Nothing to disclose.

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http://dx.doi.org/10.1016/j.spinee.2013.11.048

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Introduction

Because open-door laminoplasty was first reported by Hirabayashi et al. [1], this technique has been widely used for cervical decompression in patients with compressive cervical myelopathy involving three or more levels. Currently, cervical myelopathy resulting from cervical spondylosis or ossification of the posterior longitudinal ligament (OPLL) is commonly treated by laminoplasty. The aim of laminoplasty is to expand the spinal canal while preserving the posterior structures of the cervical spine and to achieve stability and prevent postlaminectomy membrane formation. Although some patients may experience short-term postoperative symptoms such as C5 nerve root palsy [2] or axial pain [3], laminoplasty for compressive myelopathy resulting from cervical spondylosis or OPLL generally has stable results with good long-term resolution of symptoms [4,5]. Few reports have focused on mid- and long-term revision surgery after cervical laminoplasty. The aim of this study was to review our patients who underwent revision surgery after laminoplasty to evaluate the reasons for reoperation and to review the literature and discuss methods of preventing the need for reoperation.

Materials and methods

We reviewed all patients who underwent revision surgery after cervical laminoplasty between 1990 and 2010. Patients with OPLL, renal dialysis, trauma at the time of the initial surgery, tumor, rheumatoid arthritis, and infection were excluded.

Surgical techniques

We used two bilateral open-door laminoplasty techniques. Some patients underwent bilateral open-door laminoplasty with interpositional bone grafting (Fig. 1, Left). The other patients underwent bilateral open-door laminoplasty without interpositional bone grafting, with sutures placed between the ligamentum flavum and the facet capsule to keep the lamina open (Fig. 1, Right, white arrows). Patients with cervical spondylotic myelopathy were randomly assigned to undergo one of these procedures.

We reviewed a total of 237 patients who underwent laminoplasty from 1990 to 2010 and identified five patients who underwent revision surgery. The follow-up period was 2 years or longer in 85.2% (202/237) of these patients. Four patients underwent revision because of recurrent myelopathy symptoms, and the other patient underwent revision because of new radiculopathy symptoms. All revision procedures used the posterior approach (revision laminoplasty or laminectomy in the patients with myelopathy and foraminotomy in the patient with radiculopathy).

We retrospectively reviewed the clinical records and X-ray, computed tomography, and magnetic resonance image findings of the patients who underwent revision surgery. The age, sex, interval between initial surgery and revision surgery, neurologic deficit, surgical technique used, and reason for revision surgery were recorded for each patient.

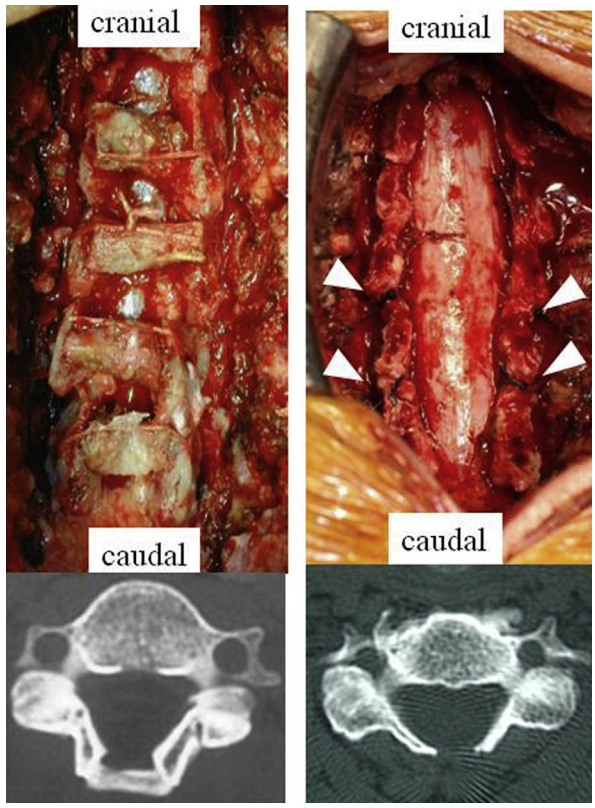

Fig. 1. Our surgical techniques. (Left) Bilateral open-door laminoplasty with interpositional bone grafting. (Right) Bilateral open-door laminoplasty without interpositional bone grafting. Sutures were placed between the ligamentum flavum and the facet capsule (white arrows).

Cases

Patient characteristics

The mean age at the time of the initial surgery was 49.8 (range 34–65) years. The mean interval between the initial surgery and the revision surgery was 15.0 (range 9–19) years. The four patients with recurrent myelopathy underwent laminoplasty or laminectomy during their revision surgery, and the patient with radiculopathy underwent foraminotomy. All patients experienced resolution of symptoms after their revision surgery. The clinical data at the time of the initial surgery are shown in Table 1. The details of revision surgery are shown in Table 2.

Case 1

A man with upper and lower limb numbness and gait disturbance underwent C3–C7 laminoplasty at 34 years of age. His symptoms resolved after surgery. After a traffic accident

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Table 1
Patient characteristics at the time of the initial surgery

Case	Age	Sex	Level	Preoperative JOA score	Postoperative JOA score
1	34	M	C3–C7	Unknown	16
2	65	M	C4–C6	Unknown	Unknown
3	57	F	C3–C7	14	17
4	54	M	C3–C7	14	No data
5	39	M	C3–C7	7	13

JOA, Japanese Orthopedic Association; M, male; F, female.

15 years later, he gradually developed recurrence of his upper and lower limb numbness and gait disturbance. Computed tomography myelography showed inadequate opening of the lamina and canal stenosis at C5–C6 (Fig. 2A and B). He underwent repeat C5–C6 laminoplasty (Fig. 2C–E).

Case 2

A man with upper limb numbness and dysfunction underwent C4–C6 laminoplasty at 65 years of age. Ten years later, he gradually developed the inability to walk or urinate without assistance. Magnetic resonance imaging showed adjacent canal stenosis at C3–C4 and C6–C7 (Fig. 3, Left and Right). He underwent laminoplasty at C3 and C7.

Case 3

A woman with upper and lower limb numbness underwent laminoplasty at 57 years of age. Her symptoms resolved after the initial surgery. Eighteen years later, she developed numbness of both upper limbs and clumsiness. Magnetic resonance imaging showed cervical stenosis at C6–C7 because of inadequate opening of the lamina and buckling of the ligamentum flavum (Fig. 4A and C). She underwent revision laminectomy (Fig. 4B and D).

Case 4

A man with upper limb numbness and muscle weakness underwent C3–C7 laminoplasty at 54 years of age (Fig. 5, Left). Sixteen years later, he gradually developed trunk and lower limb numbness and became unable to walk. Magnetic resonance imaging showed adjacent canal stenosis at T1–T2 (Fig. 5, Middle and Right). He underwent laminectomy at T1.

Case 5

A man with upper and lower limb numbness and inability to walk without a cane underwent C3–C7 laminoplasty at 39 years of age. His symptoms resolved after the initial surgery. Sixteen years later, he developed numbness of his right forearm and thumb. His symptoms did not improve with conservative treatment, and he underwent C4–C5 and C5–C6 foraminotomy.

Discussion

Over the past 10 years, many spine surgeons have reported stable results with good clinical outcomes after laminoplasty. In this study, we reviewed five patients who underwent revision surgery after laminoplasty, which has rarely been reported.

Case selection

This study focused on revision surgery after laminoplasty for cervical spondylotic myelopathy. Patients with OPLL have different characteristics and may have different reasons for requiring revision surgery. For example, Hori et al. [6] reported progression of OPLL thickness in 21.8% of 55 patients who underwent laminoplasty and were followed up for at least 5 years. We therefore consider that revision surgery in patients with OPLL who underwent laminoplasty should be studied separately.

Reasons for revision surgery

We performed revision surgery because of symptoms indicating recurrent myelopathy or new-onset radiculopathy. We consider that the reasons for recurrence of symptoms after laminoplasty fall into three categories, as described by Liu et al. [7]: technique related, inadequate treatment, and disease progression. Our modification of the etiologies of laminoplasty failure based on these categories is shown in Table 3. Two of our patients were in the technique-related category, with symptoms resulting from inadequately opened laminae. The other three patients were in the disease progression category, with symptoms resulting from adjacent canal stenosis or foraminal stenosis. None of the patients were in the inadequate treatment category because they all experienced resolution of their symptoms after the initial surgery.

Table 2
Patient characteristics at the time of the revision surgery

Case	Time since initial surgery (y)	Reason for revision	Level	Surgery	Preoperative JOA score	Postoperative JOA score
1	15	Lamina closure, trauma	C5–C7	Laminoplasty	9	15
2	9	Adjacent degeneration	C3–C4, C6–C7	Laminoplasty	3	9
3	19	Lamina closure, degeneration	C4–C5, C6–C7	Laminectomy	13	17
4	16	Adjacent degeneration	T1–T2	Laminectomy	8	No data
5	16	Foraminal stenosis	C5–C6, C6–C7	Foraminotomy	13	16

JOA, Japanese Orthopedic Association.

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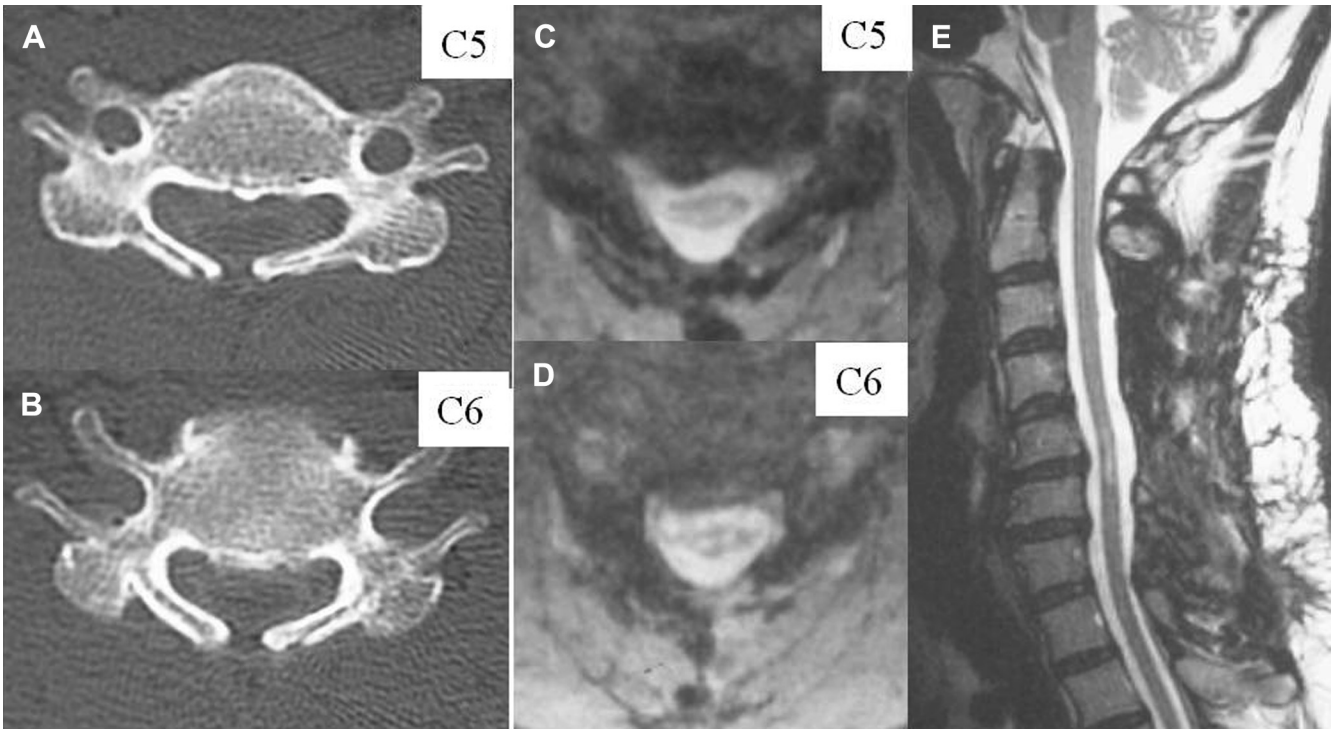

Fig. 2. A patient with inadequate opening of the lamina. (A, B) Inadequate opening of the lamina at C5–C6. (C–E) After revision surgery.

Prevention of the need for revision surgery

Technique-related issues

Two patients had inadequately opened laminae and needed revision surgery because of lamina closure. The reported incidence of lamina closure after laminoplasty ranges from 1.5% to 34% [4,8–10]. Although Wang et al. [8] recommended using a 4-mm decrease in anteroposterior spinal canal diameter to define lamina closure, there is currently no consensus regarding this definition. We think that this lack of consensus is the reason for the wide range in the reported incidence of this complication. These reports were based on single-door laminoplasty techniques such as the method by Hirabayashi et al. [1] and included both asymptomatic and symptomatic cases. The incidence of lamina closure after bilateral open-door laminoplasty remains unclear. However, it is very important to avoid this complication to prevent the need for revision surgery. Some surgical techniques can reduce the incidence of lamina closure, such as interpositional bone grafting, implantation of mini plates, and use of suture anchors [11–15]. We think that interpositional bone grafting is effective for the prevention of lamina closure because none of our patients who underwent this procedure needed revision surgery. Matsumoto et al. [9] reported lamina closure after single-door laminoplasty with suture anchors, indicating that use of suture anchors may not prevent lamina closure. Further research is needed to clarify the incidence of myelopathy after lamina closure using bilateral open-door laminoplasty.

Fig. 3. A patient with adjacent segment stenosis. (Left) Canal stenosis at C3–C4 and C6–C7. (Right) Axial view of C3–C4.

Inadequate treatment (residual symptoms)

We think that coexistent foraminal stenosis, marked anterior cord compression because of osteophytes, disc abnormalities, and cervical kyphosis may contribute to residual symptoms [7,16]. Although this study did not include any patients who received inadequate initial treatment, this may be

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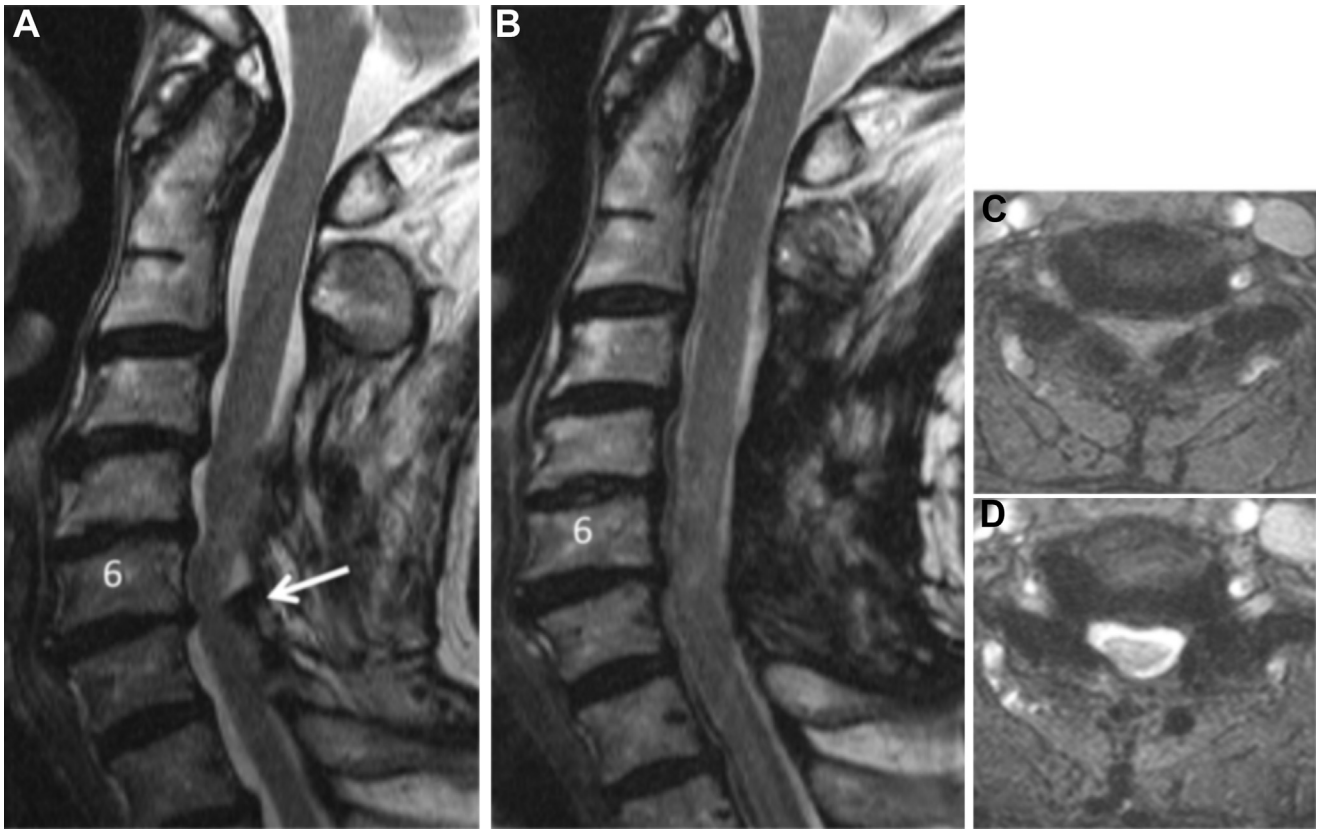

Fig. 4. A patient with inadequate opening of the lamina and buckling of the ligamentum flavum (white arrow). (A, C) Canal stenosis at C6–C7. (B, D) After laminectomy.

because of the difficulty in clearly diagnosing residual symptoms caused by these factors after laminoplasty.

Disease progression

Three of our patients experienced neurologic deterioration because of degenerative changes. One of these patients developed symptoms of radiculopathy 16 years after his initial surgery. When he visited his family doctor complaining of right upper limb pain, he had signs of C6 nerve root compression, but this was not immediately recognized as radiculopathy because his doctor believed that the cervical canal would be wide open after laminoplasty. This case teaches that careful neurologic examination is very important for determining the cause of symptoms. After foraminotomy, his numbness resolved. The other two patients experienced recurrence of myelopathy symptoms caused by adjacent canal stenosis. In Case 3, the initial laminoplasty was at C4–C6, and new stenoses occurred at C3–C4 and C6–C7 because of buckling of the ligamentum flavum. This patient's range of motion at C4–C6 was only 2° after the initial surgery, and we think that the new stenoses occurred because of increased mechanical stress at the adjacent segments. In Case 4, the initial laminoplasty was at C3–C7, and new stenosis occurred at T1–T2 because of buckling of the ligamentum flavum. This patient's range of motion at C6–C7 was 0° before revision surgery, and we think that the new stenosis occurred because of increased mechanical stress at the adjacent segments. Few previous reports have described adjacent canal stenosis after laminoplasty [17–19]. In these previously reported patients, the age at the time of the initial surgery was 59, 62, and 56 years, and the time from the first laminoplasty to the revision surgery was 3, 2, and 11 years, respectively. The authors considered that the adjacent canal stenosis was caused by biomechanical changes attributable to elevation of the lamina or unintended fusion after drilling in the proximity of the facet joints. In Case 2, intraoperative assessment showed facet joint ankylosis with a markedly reduced range of motion from C4 to C6. Although this complication seems to be quite rare, careful attention to prevention of intersegmental fusion may play a role in preventing degenerative changes of the adjacent levels.

Techniques for revision surgery

We think that the choice of procedure for each patient should be based on the location of compression, the general condition of the patient, the sagittal alignment of the cervical spine, and the preference of the surgeon. In this study, we selected the posterior approach in all cases because of the location of compression. Komura et al. [16] performed revision surgery by anterior cervical decompression and fusion using a fibular strut. They selected the anterior approach

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Fig. 5. A patient with adjacent segment stenosis. (Left) Magnetic resonance imaging before the initial laminoplasty. There was no stenosis at T1–T2. (Middle) Canal stenosis at T1–T2. (Right) Axial view of T1–T2.

Table 3
The etiologies of revision surgery after laminoplasty

1) Technique-related issues (new symptoms at early onset)
a) *Complication of laminoplasty*
— C5 motor paresis
— Hematoma
— Dislocation of grafted bone
b) *Surgical skill*
— Cord compression because of lamina closure
— Nerve root or cord compression because of hinge fracture
2) Inadequate treatment (residual preoperative symptoms)
a) *Remained foraminal stenosis*
b) *Large anterior cord compression*
c) *Cervical kyphosis (local or global)*
3) Disease progression (new symptoms at late onset)
a) *Within laminoplasty levels*
— Spondylosis
— OPLL
— Herniated disc
— Buckling flavum
b) *Adjacent segment disease*
— Facet arthrosis (zygapophysis or Luschka)
— Herniated disc
— Osteophytic or spondylotic change
— OPLL
— Buckling flavum
— Junctional kyphosis

OPLL, ossification of the posterior longitudinal ligament.

because their patients had multilevel anterior compression and intervertebral instability.

Limitations of this study

This study had a small sample size. However, revision surgery after laminoplasty is rarely performed, and it is very difficult to study a large group of patients who have undergone this procedure. A multicenter study would be required to adequately evaluate this complication. This was also a retrospective study, and some patients could not be followed up. As patients with recurrence of symptoms may have presented to other surgeons, it is possible that we were unaware of some cases of revision surgery. We were therefore unable to calculate the precise rate of revision surgery.

In summary, this review evaluated patients who underwent revision surgery after laminoplasty. Revision surgery after laminoplasty is rarely performed. The factors related to the need for revision surgery were inadequately opened laminae and degenerative changes. Interpositional bone grafting may help to prevent long-term or delayed recurrence of stenosis and symptoms. It is important to be aware of these factors associated with revision surgery.

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