Cervical laminoplasty in patients with spinal canal stenosis and myelopathy. A case series.

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Abstract

Introduction: Cervical spinal stenosis causes spinal cord compression and degenerative changes, which clinically translate into neurological dysfunction of the upper extremities and gait impairment. MRI reveals this degeneration as a white cord at one or more levels. Open-door laminoplasty is a surgical technique for multilevel stenosis with neurological symptoms in patients who retain cervical lordosis. The objective of this study was to determine the incidence of degenerative myelopathy due to cervical stenosis in our hospital and to perform a functional assessment of patients who underwent surgery for myelopathy and were treated with open-door laminoplasty.

Methods: In a descriptive, cross-sectional study in the Traumatology and Orthopedics Service of the Alcívar Hospital from 2021 to 2024, 5 patients with cervical myelopathy were treated, of which 4 underwent the open-door laminoplasty procedure, which was analyzed with the mJOA and Nurick functional scales.

Results: Anterior cervical fusion first ensures increased cervical lordosis and a stable spine when necessary. Mini titanium plates are handy to keep the door open. When spinal cord degeneration has been present for a long time, there may be immediate improvement and then worsening of neurological symptoms, as we observed in a patient with a two-year history of spinal cord degeneration. Whenever cervical stenosis is present, we also find lumbar stenosis. Three of our patients had both, but the lumbar stenosis remained asymptomatic.

Discussion: The results are consistent with the literature, where surgical intervention is reserved for complex or displaced fractures. Postoperative functional assessment was favorable, supporting the effectiveness of appropriate surgical selection.

Conclusions: Cervical laminoplasty represents a safe and effective posterior approach technique for achieving adequate canal opening with multilevel stenosis and decompressing the spinal cord.

Keywords:

Cervical myelopathy, canal stenosis, laminoplasty.

Abbreviations

MCD: Degenerative cervical myelopathy
NMR: Nuclear magnetic resonance.

Additional information

No supplementary materials are declared.

Acknowledgments

Not applicable.

Authors' contributions

Hugo Ernesto Villarroel Rovere: Conceptualization, research, writing – original draft, resources, software, supervision.

María Dolores Delgado Zambrano: Conceptualization, research, writing—original draft, resources, software, supervision.

Manuel Enrique Betancourt Castillo: Methodology, Data curation, Formal analysis, Funding acquisition, Project management, Validation, Visualization, Writing – review and editing.

Adrián Ernesto Villarroel Pérez: Conceptualization, Research, Writing – original draft.

All the authors read and approved the final version of the manuscript.

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Availability of data and materials

The datasets used and analyzed during the present study are available from the corresponding author upon reasonable request.

Introduction

Degenerative cervical myelopathy (DCM) involves spinal cord dysfunction caused by severe stenosis of the cervical spinal canal that compresses the spinal cord. A common condition often requires surgical intervention [1-3]. Cervical myelopathy results from osteoarthritic degeneration of the intervertebral disc, which leads to vertebral body remodeling, disc disease with osteophytes, facet hypertrophy and instability, thickening of the yellow ligament, calcification of the posterior common vertebral ligament, and spondylolisthesis. All these changes progressively narrow the spinal canal, compress the spinal cord, cause ischemia, and initiate a degenerative process in the cord [4-5]. This ischemic degeneration in the medulla includes demyelination, gliosis, microcystic cavitation, degeneration of the medial gray and white matter, Wallerian degeneration of the ascending and descending tracts, and atrophy of the dorsal and ventral horns [2] (Figure 1).

Degenerative myelopathy caused by cervical stenosis presents clinically with neurological and imaging changes. Neurological symptoms and gait abnormalities can affect the upper and lower limbs [6, 7]. On MR images, myelopathy or spinal cord degeneration appears as a white area; MRI is also functional for measuring the spinal canal and assessing the degree of stenosis.

According to the modified Japanese Orthopedic Association (MJOA) score, 20–62% of patients with cervical stenosis and myelopathy had decreased scores after 3–6 years of follow-up. 2 Currently, international guidelines recommend surgery for moderate (mJOA = 12–14) to severe (mJOA = ≤ 11) deterioration of any progressive disease [8, 9].

Open-door cervical laminoplasty, described by Hirabayashi [8], is a technique that can perform multilevel (> three levels) posterior decompression of the spinal canal while maintaining spinal alignment and mobility [9]. Cervical laminoplasty was developed as an alternative to laminectomy to avoid complications [4], providing favorable results in terms of neurological decompression and preservation of spinal stability [5]. The goal is to expand the laminar arch, allowing direct and indirect spinal canal decompression [6]. The ideal indications for open-door laminoplasty are multilevel myelopathy (usually involving three or more segments), preserved lordosis, signs of myelopathy, and minimal or no axial spondylotic pain [6, 7]. Contraindications include cervical spine instability, kyphotic deformity, monosegmental or bisegmental anterior compression, and predominant radicular symptoms in cases of neuroforaminal stenosis.

This study aimed to determine the incidence of degenerative myelopathy caused by cervical stenosis, conduct a final functional and improvement assessment of patients who underwent surgery for cervical myelopathy, and develop a flowchart or protocol for treating and managing cervical myelopathy at our hospital.

Figure 1. Spinal cord disorders.

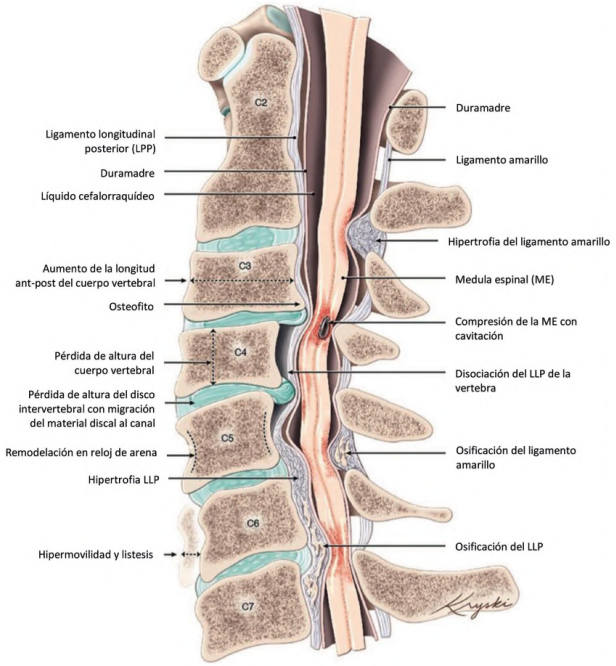


Image showing pathological changes in the cervical spine and spinal cord abnormalities in degenerative cervical myelopathy . Taken from Diana Kryski , Kryski Biomedia https://www.kryski.com".

Materials and methods

A retrospective observational study was conducted at the Orthopedics and Traumatology Service of Alcívar Hospital over three years, from July 2021 to June 2024. During this period, five patients with cervical degenerative myelopathy were treated. Among these patients, three underwent the open-door cervical laminoplasty technique after performing anterior fusion with two or three self-supporting intersomatic Spacers to achieve greater stability or improve cervical lordosis. All of these patients underwent:

1. AP, lateral, and functional X-rays of the cervical spine.
2. CT scan of the spine and MRI of the cervical spine.
3. MRI images were measured to determine canal stenosis.
4. Scales were used to score the degree of myelopathy and neurological deficit.
5. A minimum follow-up of 1 year was performed, and the final functional results were assessed.

A. Classification used

The scale developed by Japanese surgeons, who have advanced the study and classification of this condition, was utilized to evaluate the severity of myelopathy and neurological deficits. In 1972, Nurick (Table 1) established a classification system for the clinical diagnosis of cervical myelopathy, which was divided into six stages. This system helps us categorize patients to determine their subsequent treatment and postoperative progress. The Japanese Orthopedic Association (Table 2) has assessed motor function in the upper and lower limbs, sensitivity, and sphincter control. Owing to this comprehensive approach, it is regarded as the most complete method for evaluating a myelopathic patient.

A. Preoperative invasion rate of the anterior spinal canal [11]

On axial T2-weighted MR image of the most compressed cervical segment before surgery, three horizontal lines (A, B, C) are drawn on this image, representing the anterior margin of the spinal canal, the level of anterior spinal cord compression, and the posterior margin of the spinal canal, respectively. (Figure 2). It is calculated as AB/AC × 100%.

B. Surgical technique

Open-door laminoplasty is performed directly if the patient has good cervical lordosis and stability. If there is mild spinal instability or moderate loss of lordosis (not kyphosis), it is performed in two surgical stages: first, anterior fusion; then, laminoplasty.

First surgical stage:

1. Prone position.
2. Anterior approach from the right side of the neck.
3. An image intensifier is used to locate the involved arthritic segments.
4. A self-supporting cage filled with bank bone graft at three levels was placed.
5. Anterior fusion with recovery of cervical lordosis was achieved.

Second surgical stage:

1. Prone position with Mayfield-type head fixation.
2. Longitudinal incision from C2 to T1 and skeletonization.
3. High-speed milling was performed at the bilateral laminoarticular junctions, which were incomplete on the hinge side and complete on the side to be opened.
4. The yellow ligaments and dural adhesions were sectioned, hemostasis was monitored, and the osteoligamentous complex was opened.
5. The 2 mm titanium mini-plates were placed to maintain the opening.
6. Canal opening is sufficient when the spinous processes are at the level of the articular masses and the laminae are parallel to the posterior wall.

Table 1. Cervical myelopathic involvement scale , Nurick [10].

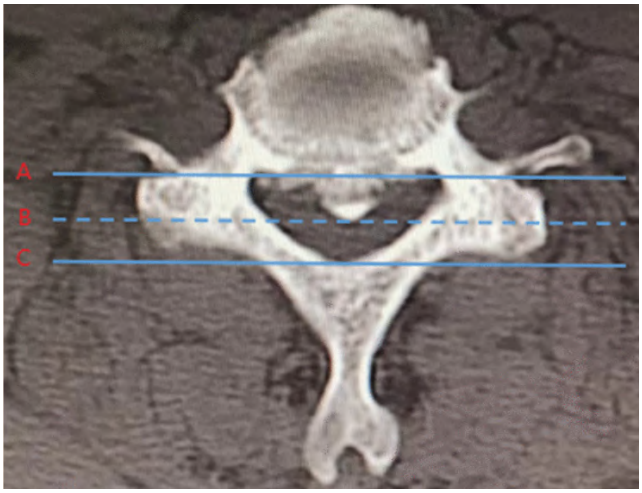
Grade 0	Radicular signs and symptoms. No evidence of spinal cord involvement.
Grade 1	Signs of spinal cord involvement, but without gait disturbance.
Grade 2	Mild difficulty walking that does not interfere with work activity.
Grade 3	Difficulty walking that interferes with work activity.
Grade 4	Need assistance walking.
Grade 5	Wheelchair or bedridden.

Table 2. Modified Japanese Orthopedic Association (mJOA) evaluation system.

Points	**Motor function of upper extremities.**
0	Unable to feed himself
1	Unable to use a knife/fork, but can use a spoon.
2	He has great difficulty using cutlery.
3	Uses cutlery with little difficulty.
4	No changes.
Points	**Motor function of lower extremities**
0	Unable to walk
1	Needs assistance walking on flat ground.
2	You need to use the handrail when using stairs.
3	Instability
4	No changes.
Points	**Sensory deficit of upper extremities**
0	Severe/Pain
1	Mild.
2	No deficit
Points	**Sensory deficit of the trunk**
0	Severe/Pain
1	Mild.
2	No deficit
Points	**Sensory deficit in lower extremities**
0	Severe/Pain
1	Mild.
2	No deficit
Points	**Bladder function**
0	Null
1	Severe urinary difficulty (occasional retention).
2	Mild urinary difficulty (polyuria, urinary urgency).
3	No alterations

0-17 points.

Figure 2. Kuhn classification.



Preoperative anterior spinal canal invasion rate11 = AB/AC × 100%.

C. Representative case of the surgical technique

A 52-year-old male patient with a two-month history presented with cervicalgia, paresthesia, and muscle weakness in both the upper and lower extremities. His symptoms began after a fall from his height with direct trauma to the posterior cervical region. He has bladder dysfunction, Nurick grade 4, an MJOA score of 9, and decreased muscle strength (3/5) in the left C5 and C6 territories. An examination revealed left patellar hyperreflexia, positive Hoffman's, and positive Trommer's signs. The functional radiographs revealed instability at C4-C5. MRI reveals canal stenosis at three levels, C3–C4, C4–C5, and C5–C6–C7, and medullary degeneration (white matter changes) at two of these stenotic levels. The first surgical stage involved anterior cervical fusion with augmentation of lordosis using two cages and intersomatic support. The second stage involved an open-door laminoplasty (Figures 3 and 4).

Results

The analysis of the cases is detailed in Table 3 and Table 4.

Discussion

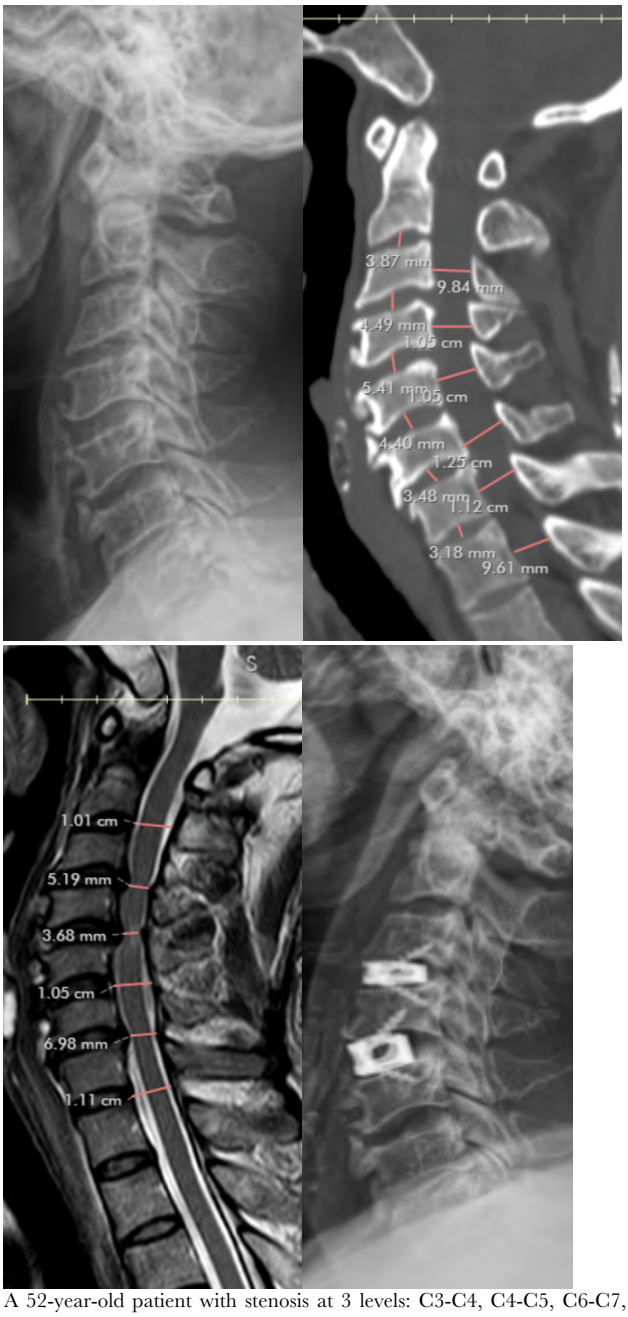
In the surgical treatment of cervical myelopathy caused by spinal stenosis, the choice of approach and technique must be carefully considered: anterior approach (corpectomy) or posterior approach (laminectomy or laminoplasty). The decision depends on several factors: clinical signs, type of cervical curvature (lordosis, rectification, or kyphosis), number of levels to be treated (one, two, or multiple), site of compression (anterior, posterior, or circumferential), and the surgeon's personal preference and experience. Typically, the anterior approach is indicated when kyphosis is present with few levels of compression. Conversely, the posterior approach is often preferred in patients with lordosis and compression at multiple levels.

Laminoplasty is a surgical technique used primarily when multilevel spinal cord compression maintains lordosis in the cervical spine. Unlike laminectomy, which involves complete removal of the vertebral lamina, it was developed to decompress the spinal cord without entirely removing the bony structures. Laminoplasty aims to avoid complications associated with laminectomy [9].

In laminoplasty, the opening is created on the side where symptoms are most prominent. The 'door' is kept open via sutures tied to the spinous process and facet capsule. Later studies described the use of suture anchors in the lateral mass and translaminar screws [12]. Currently, plates are generally preferred because of their ease of application and ability to provide immediate, stable fixation [13]. One postoperative complication is axial pain, which can be prevented by performing the opening alternately [14]. In our cases, we made the opening on the side that presented the most significant symptoms and fixed it with 2 mm titanium miniplates secured with 7 mm screws.

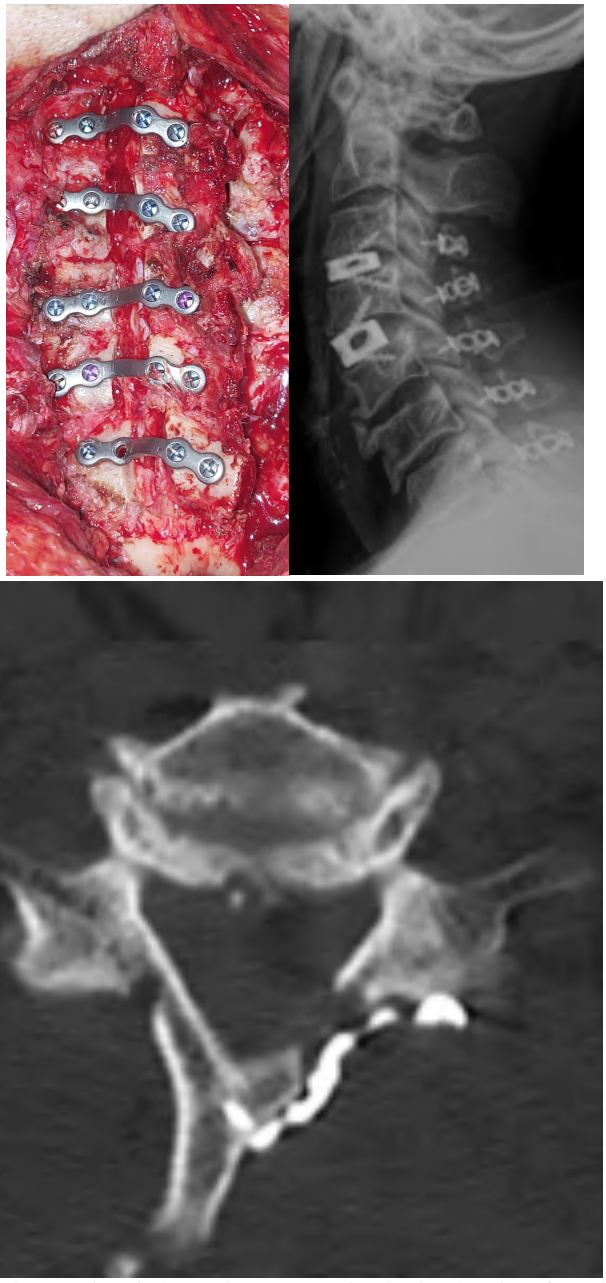
When cervical kyphosis is severe and rigid, anterior corpectomy should be considered. However, in cases where the degree of loss of cervical lordosis is moderate or mild and not rigid, two or three cages may be placed in cases of multilevel intercorporeal stenosis. An anterior approach can increase lordosis, which is then followed by posterior laminoplasty. The same method can be applied when the spine is unstable; we stabilize the spine with intercorporeal cages and then perform laminoplasty via the posterior approach. These last two scenarios were present in three of our cases.

Figure 3. Representative images of the case .



A 52-year-old patient with stenosis at 3 levels: C3-C4, C4-C5, C6-C7, myelopathy at 2 levels and instability in functional radiographs at C4-C5 level, underwent fusion with cages in the first surgical stage. interbody to stabilize and increase cervical lordosis. Graphic document from the Alcívar Hospital.

Figure 4. Surgical results.



In the second surgical procedure, an open-door laminoplasty is performed from C3 to C7, and the opening is secured with five 2-mm titanium miniplates . Graphic document from Alcívar Hospital.

Table 3. Patients with degenerative cervical myelopathy who underwent opening laminoplasty .

	Case # 1	Case # 2	Case # 3	Case # 4
Age	52 years old	67 years old	82 years old	70 years
Sex	Man	Man	Man	Women
Number of levels affected by stenosis	3 levels	4 levels	3 levels	3 levels
Signal hyperintensity in MRI/T2 Spinal Cord white (myelopathy)	Yeah	Yeah	Yeah	Yeah
Time evolution symptoms neurologist .	2 months	3 years	2 years	1 year
Hoffman sign, Trommer sign, and gait disturbances	Yeah	Yeah	Yeah	Yeah
Functional RX	Unstable	Stable	Stable	Stable
Nurick presurgical	4	3	4	3
presurgical meeting	9	6	12	12
Loss of cervical lordosis	No	Mild	Mild	No
Instability	Yeah	No	No	No
Anterior fixation	2 levels	3 levels	3 levels	No
Previous intersomatic				
Door laminoplasty open	Yeah	Yeah	Yeah	Yeah
Interval between approaches	6 days	9 days	6 days	No
Presurgical canal invasion rate	53%	55%	66%	48%
Postsurgical canal invasion rate	15%	22%	21%	14%
Complications	None	None	None	None
Improvement early	Yeah	Yeah	Yeah	Yeah
Date	August 31 , 2023	October 14 , 2023	01/07/2021	04/16/2024

Table 4. Patients with degenerative cervical myelopathy who underwent opening laminoplasty .

mJAO postoperative	**Case 1**	**Case 2**	**Case 3**	**Case 4**
3 months	12	13	13	14
6 months	15	14	15	16
12 months	16	14	16	16
Nurick postoperative	**Case 1**	**Case 2**	**Case 3**	**Case 4**
3 months	1	2	1	1
6 months	1	2	2	1
12 months	1	3	1	1

Compared with laminectomy and fixation, the latter has lower complication rates, fewer days of hospitalization, and better clinical and functional results; patients with cervical lordosis and spinal stability can benefit from laminoplasty [15, 16]. Only one of our patients underwent laminoplasty, leading to a faster hospital stay and quicker improvement. In contrast, the other three patients experienced more extended hospital stays of up to 10 days because the surgery had to be performed in two stages.

When the preoperative canal occupancy rate is ≥ 60%, anterior cervical corpectomy and fusion are associated with better postoperative JOA scores and higher rates of neurological recovery. If the degree of preoperative spinal stenosis is < 60%, posterior laminoplasty appears to be both practical and safe [17]. In our cases, the average stenosis rate was 58%, and we applied a combined approach: the anterior approach with interbody fixation and posterior open-door laminoplasty.

Fehlings et al. [18, 19] evaluated patients with cervical myelopathy following decompression, with assessments in both the short and long term. Patients with severe myelopathy (0–11 mJOA and Nurick 5) showed an improvement of 4.91 points in the mJOA score and 1.74 points in the Nurick score. Patients with moderate mJOA scores (12–14 points) improved by 2.58 on the mJOA and 1.51 on the Nurick. Some patients initially improved but then worsened due to irreversible histological damage that could not be reversed by decompression. Patients with mild mJOA scores (15–17 points) improved by 1.29 on the mJOA scale and 1.54 on the Nurick scale [20]. In our series, one patient initially experienced significant neurological improvement but deteriorated considerably over 3–6 months. This patient had experienced neurological symptoms for more than two years without treatment.

Conclusions

Laminoplasty is a safe and effective option for treating multilevel cervical spinal stenosis. It provides significant benefits in decompressing the spinal cord while preserving spinal stability. Proper patient assessment and selection of the most appropriate surgical technique are essential to achieving optimal outcomes and reducing the risk of complications.

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Statements

Ethics committee approval and consent to participate

This method is not required for clinical cases.

Consent to publication

The authors have written permission from the patients to publish.

Conflicts of interest

The authors have no conflicts of interest.

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