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Review Article

# DIFFERENT CERVICAL LAMINOPLASTY TECHNIQUES

*AS DIFERENTES TÉCNICAS DE LAMINOPLASTIA CERVICAL*

Francisco Alves de Araújo Júnior[1,2], Jurandir M. Ribas-Filho[1], Osvaldo Malafaia[1], Aluízio Augusto Arantes Júnior[3], Guilherme Henrique Weiler Ceccato[2], Pedro Helo dos Santos Neto[2]

Authors' affiliation: [1]Evangelical Mackenzie College of Paraná, Curitiba, PR, Brazil; [2]Mackenzie Evangelical University Hospital, Curitiba, PR, Brazil; [3]Clinical Hospital, Federal University of Minas Gerais, Belo Horizonte, MG, Brazil

**ORCID**
Francisco Alves de Araújo Júnior - https://orcid.org/0000-0002-3404-6555
Jurandir Marcondes Ribas Filho - https://orcid.org/0000-0002-5251-7672
Osvaldo Malafaia - https://orcid.org/0000-0002-1829-7071
Aluízio Augusto Arantes Júnior - https://orcid.org/0000-0002-9475-7420
Guilherme Henrique Weiler Ceccato - https://orcid.org/0000-0002-6986-1795
Pedro Helo dos Santos Neto - https://orcid.org/0000-0002-4720-8605

**Correspondence**
Francisco Alves de Araujo Júnior
Email: faraujojr@gmail.com

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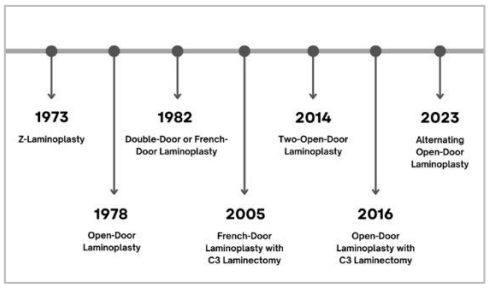
**Image**




Cervical laminoplasty timeline

**Central Message**
Cervical laminoplasty is one of the standard techniques for the treatment of spondylotic cervical myelopathy. Over the years, several types of laminoplasty have been described. Open-door and French-door laminoplasty are the most widely used and studied in the literature and based on them, technical variations have been described, including the use of endoscopy. This review intent to describe the laminoplasties used at the moment.

**Perspective**
Cervical laminoplasty has several technical variations. All approaches appear to be

safe and with few complications. Regardless of the technique used, the preservation of muscle insertion in the spinous processes of C2 and C7 allows for less postoperative neck pain. However, more studies are still needed to determine whether one technique may be superior to another.

**Author´s contribution**
Conceptualization: Francisco Alves de Araújo Júnior
Methodology: Francisco Alves de Araújo Júnior, Aluízio Augusto Arantes Júnior
Project administration: Guilherme Henrique Weiler Ceccato
Writing – original draft preparation: All authors
Writing – review & editing: All authors

**ABSTRACT -** ***Background***: Cervical laminoplasty is one of the standard techniques for the treatment of spondylotic cervical myelopathy. It was developed by Japanese orthopedists in the 1970s as an alternative to laminectomy. Over the years, several types of laminoplasty have been described. Open-door and French-door laminoplasty are the most widely used and studied in the literature and based on them, technical variations have been described, including the use of endoscopy. ***Objective***: To review the laminoplasty techniques described in the literature. ***Methods***: A literature review was conducted on the Pubmed and Scielo platforms in January 2024. Initially, 66 articles were selected that addressed something related to types of laminoplasty technique in their title. The abstracts of these articles were read and those that addressed a review on the subject or that described a new type of laminoplasty or technical variation of open-door or French-door were selected. ***Results***: A total of 20 articles were considered for study. ***Conclusions***: After the advent of open-door and french-door laminoplasty, some variations emerged, such as two-open-door laminoplasty, alternating open-door laminoplasty and those associated with C3 laminectomy.
**HEADINGS –** Laminoplasty. Spondylosis. Spinal cord compression. Spinal stenosis.

***RESUMO - Introdução***: A laminoplastia cervical é uma das técnicas-padrão para o tratamento da mielopatia cervical espondilótica. Foi desenvolvida por ortopedistas japoneses na década de 1970 como alternativa à laminectomia. Ao longo dos anos, vários tipos de laminoplastia foram descritos. A de porta aberta e porta francesa são as mais utilizadas e estudadas na literatura e a partir delas foram descritas variações técnicas, incluindo o uso da endoscopia. ***Objetivo***: Rever as técnicas de laminoplastia descritas na literatura. ***Métodos***: Foi realizada revisão de literatura nas plataformas Pubmed e Scielo em janeiro de 2024. Inicialmente foram selecionados 66 artigos que abordavam algo relacionado aos tipos de técnica de laminoplastia em seu título. Os resumos desses artigos foram lidos e selecionados aqueles que abordavam revisão sobre o tema ou que descreviam um novo tipo de laminoplastia ou variação técnica de porta aberta ou porta francesa. ***Resultados***: Foram considerados para estudo um total de 20 artigos. ***Conclusões***: Após o advento da laminoplastia *open-door* e de *french-door*, surgiram algumas variações, como a laminoplastia *two-open-door*, a laminoplastia *open-door* alternada e as associadas à laminectomia C3.
**PALAVRAS-CHAVE** – Laminoplastia. Espondilose. Compressão da medula espinhal. Estenose espinal.

## INTRODUCTION

The surgical approach to the cervical spinal canal can be performed either by the anterior route, with discectomy and/or corpectomy, both associated with fusion or posterior access with isolated decompression of the spinal canal, laminoplasty or laminectomy with fusion.[1-3] The posterior approach ends up being a choice in cases of spinal canal stenosis and multi-level degenerative diseases, especially in those cases where the cervical lordosis is preserved.[1,3,4]

Laminectomy was the main technique used in these cases, but it had some complications such as instability, kyphosis and the possibility of neurological deterioration.[4-6] To preventing such complications, orthopedic surgeons developed a way of enlarging the diameter of the spinal canal while preserving the posterior arch of the vertebrae in the 1970s: laminoplasty.[7,8] Since then, laminoplasty has been accepted as one of the standard techniques for posterior decompression of the cervical spinal canal.[3,9-11]

Over the years, various laminoplasty techniques have been described with the aim of better preserving cervical mobility, less aggression on the muscles, less postoperative neck pain and, consequently, a better quality of life for patients[12–19].

Therefore, the aim of this study was to discuss the various laminoplasty techniques described in the literature and their differences.

## METHODS

A literature review was carried out on the Pubmed and Scielo platforms, using the descriptor "*cervical laminoplasty*", with the filters "*clinical trial*", "*meta-analysis*", "*review*" and "*systematic review*", in April 2024.

Initially, 66 articles were selected that addressed something related to types of laminoplasty technique in their title. The abstracts of these articles were read and those that addressed a review on the subject or described a new type of laminoplasty or technical variation of open-door or French-door were selected.

In the end, 20 articles were used to review on the different types of laminoplasty.

## RESULTS

Figure 1 resume the cervical laminoplasty timeline. It was identified seven types of laminoplasty, since 1973. Next, the authors describe the main characteristics of the techniques.

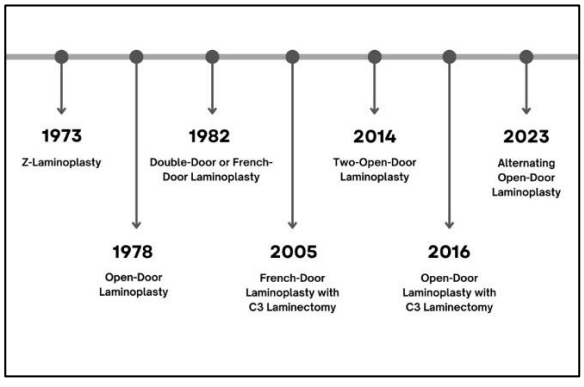



**FIGURE 1** – Cervical laminoplasty timeline

## DISCUSSION

### The first laminoplasty

The first laminoplasty was described by Oyama in 1973 as "*Z-shaped expansive laminoplasty*". The blades were cut in a "Z" shape and elevated and sutured in the midline (Figure 2). The posterior spinal canal was reconstructed to avoid scar formation over the dural surface, preventing the invasion of scar tissue, which was believed to be a cause of late neurological deterioration.[20]

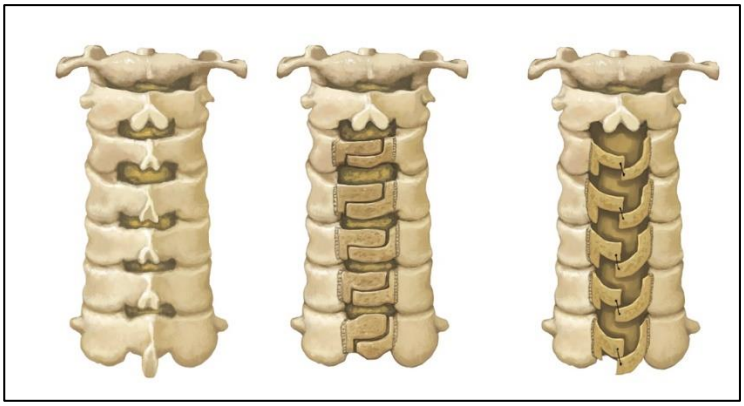


**FIGURE 2** – Z-laminoplasty

### Open-door laminoplasty

In 1978, Hirabayashi[7,8] developed an epoch-making laminoplasty, the open-door expansive laminoplasty, which consists of a total laminotomy on one side and the making of a hinge on the opposite side by drilling the outer cortex of the laminae (Figure 3). Among the advantages he advocated were several levels of the spinal cord can be decompressed simultaneously, earlier mobilization of patients, post-operative kyphotic deformity of the cervical spine can be avoided and mobility of the cervical region maintained.[7,8] In their study, it was observed that most patients achieved good results, with an improvement in the JOA scale score of 66% over a 4.5-year follow-up. The diameter of the spinal canal increased by an average of 5 mm. Two patients showed worsening in the post-operative period and it was identified that the laminoplasty did not remain open. After these cases, the authors began to apply sutures between the ligamentum flavum and the deep muscles around the facets on the hinge side and this was enough to maintain decompression of the spinal canal.[7]

Subsequently, studies have shown that fixing the laminae with titanium plates is more effective in preventing post-operative complications, such as neurological damage and axial pain.[21]

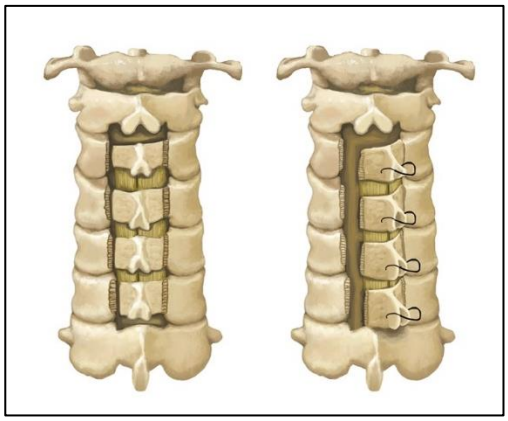


**FIGURE 3** – Open-door laminoplasty

**French-door laminoplasty**

French-door laminoplasty, also described as double-door, consists of performing a longitudinal osteotomy of the spinous processes, in the midline, dividing it in half, and making the hinge on the blades bilaterally (Figure 4). Spacers, which can be autologous, homologous or synthetic bone grafts, are placed between the flaps of the spinous processes to keep the spinal canal open. The final design of the laminoplasty resembles a French window, hence its name. This technique was described in 1982 by Kurokawa[22]

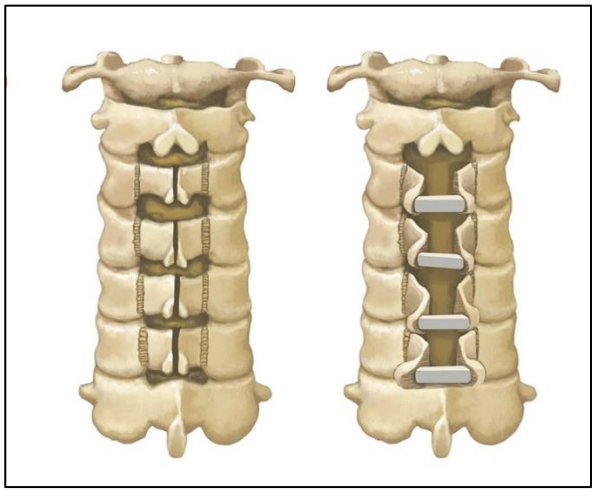


**FIGURE 4** – French-door laminoplasty

The great advantage defended by the author is that French-door laminoplasty allows symmetrical decompression of both sides of the spinal canal. One of the disadvantages of this technique is the greater chance of dural laceration and spinal cord injury, especially in extreme cases of canal stenosis, such as in patients with ossification of the posterior longitudinal ligament.[11,22]

Some authors consider this laminoplasty to be technically difficult due to the sectioning of the spinous process. Tomita et al.[23] described the use of a Gigle saw to section the spinous processes and considered the method to be safe and effective, not observing dural injury in a single case.[23]

**Open-door vs. French-door: which one is the best?**

Nakashima et al.[24] compared the two laminoplasty techniques (open-door and French-door) in a randomized study involving 92 patients with MCE and concluded that there was no difference between them in terms of neurological recovery or perioperative complications. However, the average reduction in post-operative cervical lordosis was significantly greater in patients who underwent open-door laminoplasty. Therefore, they suggest that French-door laminoplasty is preferable to open-door laminoplasty for maintaining cervical alignment.

Luo et al.[25] did a meta-analysis comparing the two techniques and showed that the channel expansion was significantly greater with open-door compared to French-door. There were no significant differences between the two procedures in operative time, intraoperative blood loss, postoperative complications, C5 root palsy, axial pain, postoperative cervical lordosis, postoperative cervical range of motion, as well as improvement in the JOA score. Thus, it has not yet been possible to conclude that one of these procedures is superior to the other.

Another meta-analysis comparing the two techniques showed that open-door laminoplasty presented more adverse events than French-door and the score on the JOA scale was better in the latter, so the authors considered that French-door is more effective and safer.[26]

Chen et al.[27] suggest, in its meta-analysis, that both methods can achieve good postoperative results. However, less intraoperative bleeding and a lower incidence of postoperative axial symptoms were found in patients undergoing French-door laminoplasty.

**Variations of open-door laminoplasty**

Arantes Júnior et al. [28] idealized the two-open-door technique, where an opening is made in the C3 and C4 laminae on one side and C5 and C6 on the opposite side (Figure 5). This makes it possible to perform bilateral C4-C5 foraminotomy, avoiding C5 root neuropraxia, and also promotes three arthrodesis points between: 1) the C3 lamina and the C2 spinous process; 2) the C4 and C5 laminae; and 3) the C6 lamina with the C7 spinous process. Their study included 86 patients with a five-year follow-up. There was an increase in the diameter of the spinal canal (from 11 mm to 17 mm), not one case of instability and 88% functional improvement on the Nurick scale.

**FIGURE 5** – Two-open-door laminoplasty

Huang et al.[29] also described a variation of the open-door technique that is very similar to Arantes. They approached from C3 to C7 and made alternating openings: in C3, C5 and C7 the opening of the lamina was on the left and in C4 and C6 the right (Figure 6). These authors performed this procedure in a single 74-year-old patient and there was an improvement in the mJOA score (preoperative score of 8 pts/14$^{th}$ postoperative day: 12 points/after five years of segment: 14 points), absence of neck pain and preserved cervical stability.

**FIGURE 6** – Alternating-side cervical laminoplasty

To avoid segmental fusion and reduce the incidence of postoperative neck pain, Suh et al.[13] developed a variation of open-door laminoplasty in which the cranial portion of the posterior arch of each vertebra was resected in the shape of a wedge to avoid impact between neighboring laminae. The authors compared their technique with that of Hirabayashi in a randomized study and concluded that wedge resection provided less postoperative neck pain and greater preservation of cervical mobility.

**Laminoplasty associated with C3 laminectomy** (Figure 7)

The literature reports that there may be a decrease in cervical mobility after open-door laminoplasty, mainly due to interlaminar fusion between the C2-C3 and/or C3-C4 segments, which may cause limited mobility and interference with quality of life.[30]

From this principle, Lee et al.[12] performed C3 laminectomy associated with laminoplasty at the other levels. The study included 59 patients, retrospectively, with a three-year follow-up. Fourteen patients underwent C3 laminectomy + open-door laminoplasty at the other levels, and in none of these cases was there any sign of fusion between C2-C3 and/or C3-C4, while 42.2% of the patients who underwent laminoplasty, including C3, had interlaminar bone fusion. Therefore, the authors concluded that C3 laminectomy associated with open-door laminoplasty seemed to prevent interlaminar bone fusion in the segments. This resulted in better preservation of cervical mobility, without the development of focal kyphosis or instability (Figure 5).

Chen et al.[31] compared the clinical results of C3 laminectomy in French-door laminoplasty vs. classic French-door laminoplasty and observed that C3 laminectomy can reduce operative time, preserve cervical mobility, and reduce the incidence of postoperative neck pain. A similar finding had been found by other authors years earlier.[32]

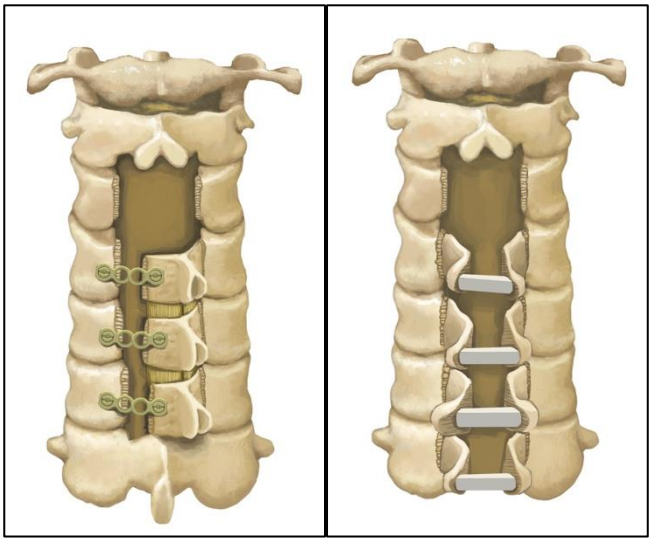


**FIGURE 7** – C3 laminectomy with open-door laminoplasty (left) and french-door laminoplasty (right)

**Decreased muscle injury**

Some technical details have been studied to preserve the paravertebral muscles to reduce postoperative axial pain. Meta-analysis studies have shown that there is a significant reduction in the incidence and severity of axial symptoms and an improvement in cervical mobility, especially by preserving the muscle attachment in the spinous processes of C2 and C7.[15,19] Lin et al.[17] developed a technical variation of the French-door where preserved the muscle insertion in the spinous process of C2 and C7 and performed laminectomy of C3 and laminoplasty in C4, C5 and C6. The authors compared this technique with the traditional French-door technique and observed spinal cord decompression and neurological recovery similar to those of the conventional technique, in addition to allowing a lower incidence of postoperative neck pain and improvement of the angle of movement of the cervical spine without causing instability.

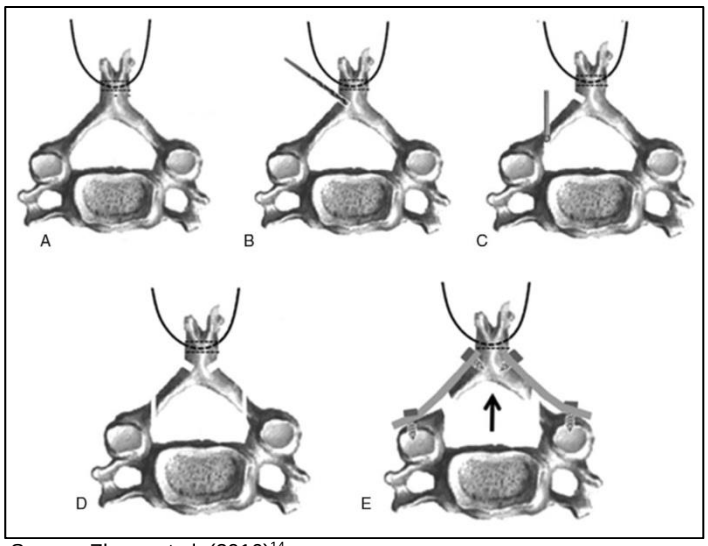
There is a description of a minimally invasive technique of open-door laminoplasty. Benglis et al.[33] conducted a study on 6 cadavers using tubular access through two small incisions at the level of C4 and C6. By moving the cranial tube and caudally, it is possible to access the other levels and proceed to laminoplasty, The great advantage of this technique was the smaller muscle lesion because they are not detached from the midline.

Wang et al.[16] developed a bilateral laminotomy technique associated with longitudinal separation of the spinous process, preserving part of the paravertebral musculature. Subsequently, the lamina was fixed to the lateral mass of the same vertebra, thus enlarging the vertebral canal. This method was applied only in the posterior arch of C6 and in the other segments, open-door laminoplasty was performed. These authors observed a significant increase in the area of the spinal canal, did not have a single case of complication, and there was postoperative functional improvement, but postoperative neck pain was not evaluated in the study (Figure 7).

**Endoscopic laminoplasty**

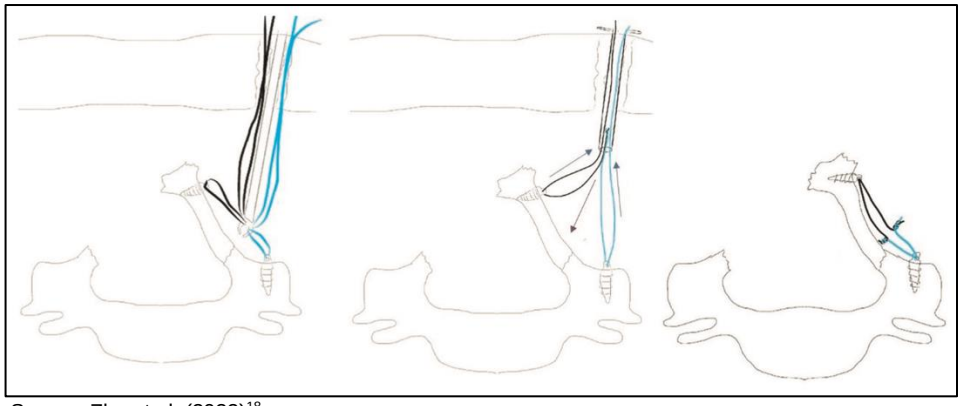
With the advent and expansion of endoscopic spine surgery, new laminoplasty

techniques have been described, with promising results.[14,18] Zhang et al.[14] operated on 45 patients with an endoscopic laminoplasty technique and observed clinical improvement according to the mJOA scale, an increase in the diameter of the vertebral canal by 1 to 3 mm, and no collapse of the laminoplasty. They performed bilateral endoscopic laminotomy associated with traction of the posterior arch of the vertebra, decompressing the vertebral canal. Then, the blades were fixed to the lateral mass with titanium plates (Figure 8). Zhu et al.[18] reported the case of a patient with stenosis of the cervical vertebral canal between C3 and C6 who applied a biportal endoscopic technique and underwent open-door laminoplasty, including fixation of the blades with sutures to prevent their closure (Figure 9). There was clinical improvement in the immediate postoperative period, and MRI of the cervical spine showed effective decompression of the spinal cord.




Source: Zhang et al. (2016)[14]

**FIGURE 8** – Schematic of the endoscopic laminoplasty described by Zhang et al. (2016)[14]



Source: Zhu et al. (2022)[18]

**FIGURE 9** – Schematic of the endoscopic laminoplasty described by Zhu et al. (2022)[18]

## CONCLUSION

Cervical laminoplasty has several technical variations. All approaches appear to be safe for the patient and have few complications. Regardless of the technique used, the preservation of muscle insertion in the spinous processes of C2 and C7 allows for less postoperative neck pain. However, more studies are still needed to determine whether one technique may be superior to another.

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