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REVIEW ARTICLE

Surgical Treatment of Cervical Spondylotic Myelopathy: Review Article

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ABSTRACT

Background: Cervical Spondylotic Myelopathy (CSM) develops insidiously as degenerative changes of the cervical spine that impact the spinal cord. Unfortunately, CSM is a form of spinal cord injury in older patients that often experience delayed treatment. This summary evaluates the pathophysiology, natural history, diagnosis, and current management of CSM. Frequently, patients do not appreciate or correlate their symptomatology with cervical spine disease, and those with radiographic findings may be clinically asymptomatic. Providers should remember the classic symptoms of CSM: poor hand dexterity, new unsteady gait patterns, new onset and progressive difficulty with motor skills. magnetic resonance imaging is required in patients with suspected CSM, but computerized tomography myelography is an alternative in patients with implants as contraindications to magnetic resonance imaging. The management of those with CSM has continued to be a controversial topic. In general, patients with incidental findings of cervical cord compression that are asymptomatic can be managed conservatively. Those with daily moderate-severe disease that significantly affects activities of daily living should be treated operatively.

Keywords: Cervical Spondylotic Myelopathy, Laminoplasty, Laminectomy.

INTRODUCTION

A clinical chronic illness known as cervical spondylotic myelopathy is typically associated with an intervertebral disk degenerative disease [1].

The most prevalent spinal cord degeneration in elderly patients is cervical spondylotic myelopathy, which is brought about by growing spinal canal stenosis and ensuing compression of the nerve roots [2].

When conservative therapy fails to relieve a patient's cervical spondylotic myelopathy, surgery is usually recommended. Anterior cervical fusion and decompression for multiple The complicated process of treating cervical spondylotic myelopathy carries a risk

of lengthy recovery periods and other side effects such dysphagia, internal graft displacement, and trigeminal nerve palsy **[2].**

The two main posterior cervical surgical approaches for treating cervical spondylotic myelopathy are laminoplasty and laminectomy, either with or without fusion, to remove compressive factors, provide the cord adequate room, and decompress the spinal cord [3].

In the beginning, laminectomy which is typically accompanied by further fusion was thought to be the best course of action for treating cervical spondylotic myelopathy [4].

Nevertheless, there are several drawbacks to this procedure, including segmental instability, kyphosis following laminectomy, and subsequent neurological decline that results in a shortened indication.

First described in 1982, laminoplasty is thought to be a successful mean of preserving anatomical cervical reduction. The ligamentum flavum covering the spinal cord and posterior laminar bone is preserved after laminoplasty [5].

The benefits of laminoplasty include less instability, less constriction of the dura due to extradural scar development, preservation of motion, and avoidance of fusion-related problems. However, Laminoplasty is contraindicated in patients with Cervical spondylotic myelopathy and >13° of kyphosis and severe neck pain **[6]**.

Surgical treatment:

Surgical decompression, lordosis restoration, and stability. If there is a considerable functional impairment, this can be done. There are several different cord decompression techniques that can be used, both anterior and posterior approaches. The position of compression (either anterior or posterior), the number of stenotic levels, and cervical alignment all influence the appropriate technique [7].

Surgical treatment procedures are:

Anterior decompression: A posterior operation can repair cervical kyphosis of greater than 10 degrees, anterior decompression is the cornerstone of treatment for many patients with single- or two-level disc disorders, and anterior pathology (soft discs and disc osteophytes complexes) are among the indications for anterior decompression [7].

Oblique corpectomy, anterior median cervical corpectomy and fusion (ACCF), and anterior cervical discectomy and fusion (ACDF) can all be used to accomplish this [7].

Posterior decompression:Indications of posterior decompression include multilevel compression with kyphosis of < 10 degrees **[8].**

Contraindications of posterior decompression includefixed kyphosis of > 10 degrees is a contraindication to posterior decompression because this will not adequately decompress spinal cord as it is "bowstringing" anterior **[8].**

The advantages of the posterior approaches over the anterior:Laminectomy, laminectomy and fusion, and laminoplasty are examples of posterior-based procedures that each have a unique set of benefits. First off, posterior surgeries are often less complicated technically than anterior corpectomies since an indirect decompression is carried out, especially in multilevel patients with significant stenosis or OPLL that needs to be respected. As a result, none of the difficulties relating to using graft carpentry to rebuild the anterior column arise. Second, compared to a multilayer anterior decompression, posterior decompression enables the surgeon to quickly decompress many segments. When treating patients who are incapacitated and require an expedited decompressive operation, this could

be crucial. Third, cord decompression is possible with motion-preserving posterior procedures like laminoplasty, which avoid the need for fusion and the associated risks. Fourth, laminoplasty, one of the posterior techniques, allows decompression of segments at future risk in a single operation without significantly raising patient morbidity because fusion is not always required. Laminotomy, laminectomy with fusion, and laminoplasty are the available techniques for this [8].

Laminectomy:

Before anterior cervical spine surgery became popular, the most widely used method of decompression for multilevel myelopathy was laminectomy. However, because of its many drawbacks and the availability of more effective options, laminectomy by itself has currently been reduced to a relatively limited role in the treatment of cervical myelopathy [7].

If the cord becomes draped over the kyphosis, it may result in recurrent myelopathy. One of its potential problems is post-laminectomy kyphosis, which can happen following laminectomy (Fig. 1). Although estimates vary, the true incidence of post-laminectomy kyphosis in the adult population is unknown. In addition to deformity, kyphosis may cause neck pain due to muscular exhaustion. In comparative research, following a laminectomy, 34% of patients experienced postoperative kyphosis or swan neck deformity, while 7% experienced this after a laminoplasty. Iatrogenic spondylolisthesis may arise from a severe facetectomy performed in conjunction with a laminectomy, which may cause pain and affect neurologic function. Post-laminectomy membranes can develop after surgery and have the potential to cause deformity, instability, and dynamic compression of the spinal cord over time. If a patient needs a second posterior operation even though there is no symptomatic post-laminectomy membrane, the exposed dura along the laminectomy's length may make the revision procedure challenging and dangerous to be carried out [7].

A modified method called skip laminectomy was created with the goal of reducing postoperative kyphosis while simultaneously limiting posterior muscle stress and neck pain [9].

Using this method, a typical laminectomy of the lamina between the stenotic levels is paired with a partial laminectomy of the lower neighboring vertebra to decompress two successive stenotic disc levels. Therefore, laminectomy of C4 and C6 can accomplish a C3-7 decompression, with partial laminectomies and flavum resection at other levels. The muscle attachments to the spinous processes at the "skipped" lamina (C3, C5, and C7 in this example) remain preserved, which aids in maintaining sagittal alignment and limiting post-laminectomy kyphosis [9].

Laminectomy with fusion (figure 2):

A posterior fusion can be added to avoid some of the disadvantages associated with laminectomy alone. Currently, lateral mass screws are usually used for fusion in conjunction with laminectomy. Although using simply local autograft bone has been shown to produce positive results, autologous bone graft from the iliac crest is usually advised to increase fusion rates [9].

The indications of laminectomy with fusion are:Axial neck discomfort: if one goal of surgery is to manage the spondylotic neck pain with fusion, this approach is favored in multilayer myelopathic patients with severe neck pain (e.g., from facet arthropathy). Preservation of sagittal alignment: laminectomy and fusion may also be chosen

in patients who are not too kyphotic to be decompressed posteriorly, since it better preserves sagittal alignment than laminoplasty (e.g., neutral to slightly kyphotic alignment). It restricts both instability and repetitive microtrauma since the fusion may keep the latter from developing and restrict recurrent microtrauma to a healing cord, both of which have been linked to worse neurologic outcomes [9].

Surgical treatment of CSM by Laminoplasty:

Laminoplasty is the term for the procedure of reconstructing the laminar arch from the posterior direction to increase the amount of space available for the spinal cord. Numerous methods are similar in that they preserve part or all the posterior components while enlarging the cervical canal. Changes have been made to the locations of the lamina or spinous processes' incisions as well as the methods used to keep the canal open. There have been suggestions for more recent methods that could shorten surgery times and increase patient safety, for using titanium mini-plates and ceramic spacers [12].

Indications:Ossification of the posterior longitudinal ligament (OPLL)**.** Multi-level cervical spondylosis (more than 3 levels) **[13].**

Contraindications:

Cervical kyphosis: If the kyphosis is greater than 10 degrees, posterior decompression should not be performed because the spinal cord will not be sufficiently decompressed, "bowstringing" the anterior spinal cord due to insufficient space for posterior cord drift. Therefore, although a lordotic posture is desirable, laminoplasty can be performed in a straightened spine.

Patients with severe axial neck discomfort should be fused because their facets will improve and their pain will be reduced. This is a relative contraindication.

Spinal diseases, such as cervical disc disease or traumatic vertebral body fracture with canal compression, are best treated with an anterior technique.

Ligamentum flavum osseossification (OLF).

Fifth, epidermal fibrosis.

The affected segment's instability.

A prior cervical posterior surgery [13].

Positioning of the Patient:The patient is put in a prone position with the head slightly flexed and fixated with Mayfield to the operating table, then shoulders are taped down, and the table is inclined cranially upward in a reverse Trendelenburg posture (**Fig. 3**) **[14].**

Approach: Midline markers include the spinous processes of C2 and C7, as well as the external occipital protuberance (Inion). Usually starting from C2 to C7, make a straight midline incision of the proper length. Then, follow the central plane along the nuchal ligament and down to the spinous processes. Always maintain your position in the midline; a cautious dissection of the nuchal ligament in the midline reduces bleeding from the muscles. The midline can be made more visible by bilaterally retracting the skin and subcutaneous tissues using Gelpi or Adson retractors. First, locate the conspicuous spinous processes C6 or C7. Next, move cranially to avoid missing the midline **(Fig. 4) [14].**

Lamina Exposure: Using a tiny Cobb elevator or a cautery, expose the ends of the spinous processes and then separate the bilateral paracervical muscles from the lateral sides of the spinous process and the laminae, being careful not to pierce the facet joint capsules **(Fig. 5)** [14].

Laminoplasty techniques: Examples of these techniques are:

Plasty laminoplasty: **Oyama et al**. and Susumu Hattori first described this method in 1973. The laminae are thinned, and the

spinous processes are eliminated first in this operation. They narrow out to the intersection of the laminae and facet. Lateral troughs are executed. The thinned laminae are now cut with a (Z) [14].

A diamond drill bit and high-speed drill can be used for this. The thinned laminae sections may then be divided, and the canal may be opened or widened following the completion of the (Z) cut. To keep the enlarged channel in place, the laminae can then be fastened with wire or suture **(Fig. 6)** [14].

Hirabayashi expansive open door laminoplasty**:** In 1977, Hirabayashi and associates provided a description of the extensive open-door laminoplasty. The laminae and spinous processes are visible in this approach. There is no damage to the supraspinous or interspinous ligaments. Whichever levels need to be enlarged will determine which ligaments need to be cut between C2 and C3, or between C7 and T1. This helps to get the door open. At the intersection of the laminae and facets, a first trough is made on the open side using a high-speed drill [14].

Drilled down to the ligamentum flavum is the first trough. Drilling through the laminae can be done completely or it can leave a very thin layer of laminae, particularly at the cranial side. Then, a 1- or 2-mm Kerrison punch is used to remove this thin rim and the related ligament. Then, using a high-speed drill, a second trough is created in the closed or opposing side **(Fig. 7)** [14].

It is careful not to cut all the way through, merely thin the lamina on this side. In relation to the open side, this second trough is sliced a little more laterally. The lamina is then gently lifted off the spinal cord and the canal is widened by extending the opening on the open side. Using a Penfield dissector or curette, the surgeon can carefully widen the incision, and an aid can use a Kocher or similar tool to gently twist the laminae towards the closed side [14].

It is important to avoid letting the block of laminae slide and quickly snap back into place as this could cause a spinal cord injury. By stitching across the spinous processes and the facet capsule on the closed side, the door can be kept open **(Fig. S1)** [14].

Numerous adjustments for leaving the door open have been detailed. These include the use of ceramic spacers that are fastened in situ between the lamina and the facet joints (Hatori's approach) or titanium mini-plates, anchor screws, and bone graft (from the spinous process) **(Fig.S2)** [14].

According to several studies, anterior decompression followed by fusion and laminectomy both exhibit decompression effects that are nearly identical to ELAP's [14]. Despite the development of various technological changes, including the insertion of spacers, plates, and bone grafts, this straightforward yet inventive technique continues to be the most practical option for treating compressive myelopathy surgically. It serves as the foundation for all other treatments as well. With a shorter operating period, less bleeding, and a lower incidence of problems than other modified procedures, ELAP is far safer and simpler, which lessens the impact of surgery on the patients **[15].**

French door laminoplasty: The canal is hinged on one side and opened on the other in an open-door expansive laminoplasty. In essence, this caused the canal to expand asymmetrically. By opening the door in the middle, the French door laminoplasty produces a symmetrical aperture in the canal. It is important to note that no technique has been shown to be better than another. Each side has a trough drilled at the laminae/facet intersection, typically C3–C7. Using a high-

speed drill, take care not to drill through the laminae completely when doing this. Next, a fine Kerrison punch and a high-speed drill are used to cut the laminae in the midline [16].

The canal is then widened by lifting the laminae off the spinal cord in the midline. Suture through the facet capsules and the laminae can then be used to secure the laminae in an open posture. The canal is left open in this initial description (**Fig. S3)** [17].

There have been descriptions of modifications to reconstruct the protecting arch and bridge the gap in the open laminae. Wire can be utilized to secure resected spinous process pieces between lamina, or ceramic spacers can be employed [18].

Numerous modifications exist for French door laminoplasty, such as the Kurokawa modification that keeps the door open or the Tomitta modification that modifies the midline cut.

Kurokawa modification: In this modification of the French door laminoplasty, the dorsal aspect of the spinous processes is removed and used as grafts. The spinous processes/laminae are cut in the midline using a high-speed drill. The spinous process is split open and held open with bone grafts that are wired in place **(Fig. S4) [19].**

Tomita modification: In this modification, the spinous process/laminae are split with a wire-saw. This has been termed the T-saw laminoplasty **(Fig. S5) [21].**

Figure (1): Post laminectomy kyphosis. Several factors contribute to this kyphosis: 1) an anterior cervical discectomy without cage replacement at C6-7 in the remote past that healed in kyphosis; 2) severe disc degeneration atC5-6 and C7-T1; 3) iatrogenic spondylolisthesis at C4-5; and 4) multilevel laminectomy **[10].**

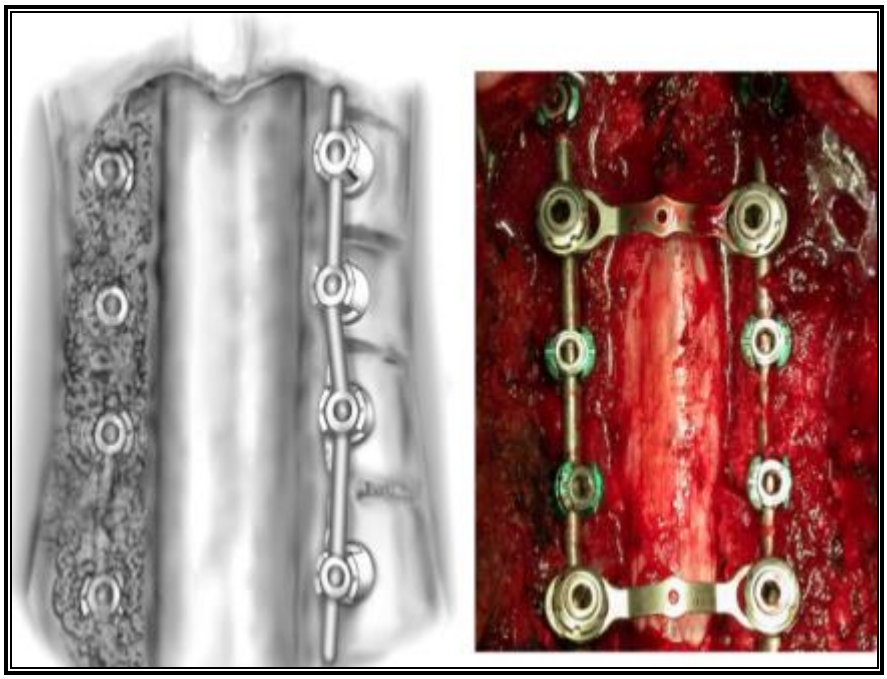

Figure (2): Laminectomy with fusion. **[11].**

Figure (3): Intraoperative photograph of the prone position for laminoplasty procedure **[15]**

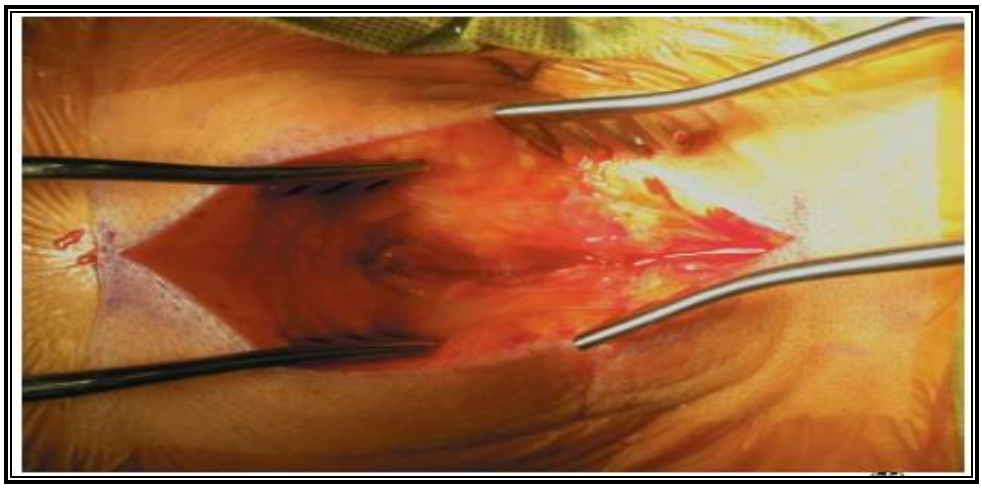

Figure (4): Posterior approach to cervical laminoplasty **[15].**

Figure (5): Lamina exposure. **[14**

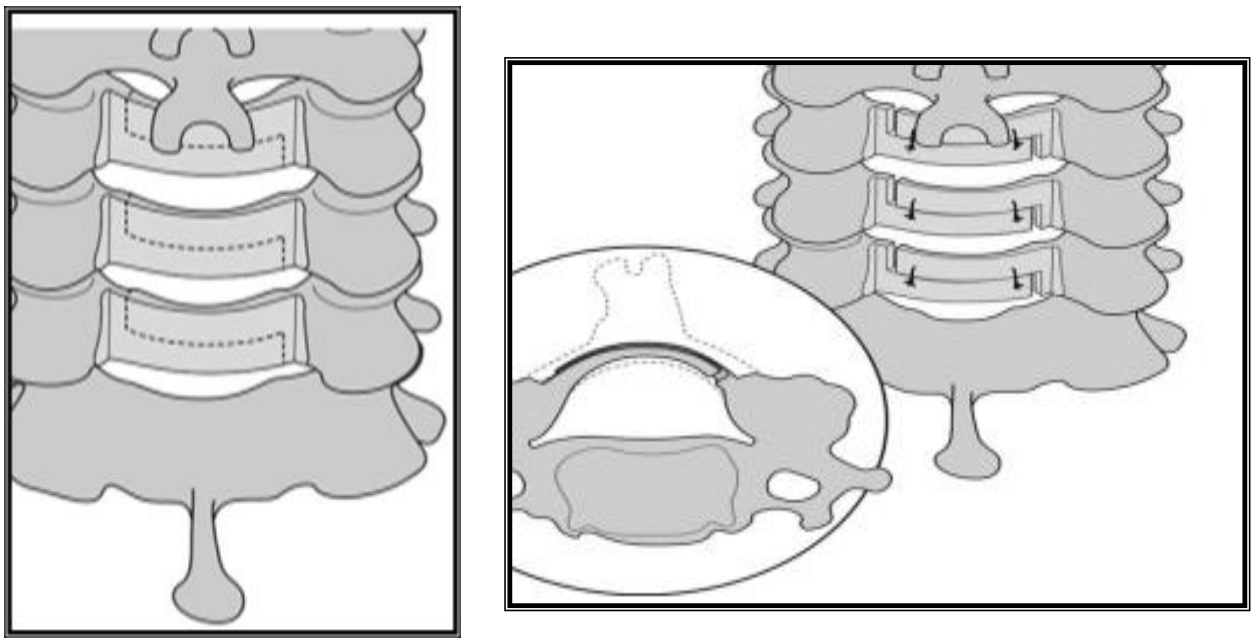

Figure (6): plasty-laminoplasty. **[14]**

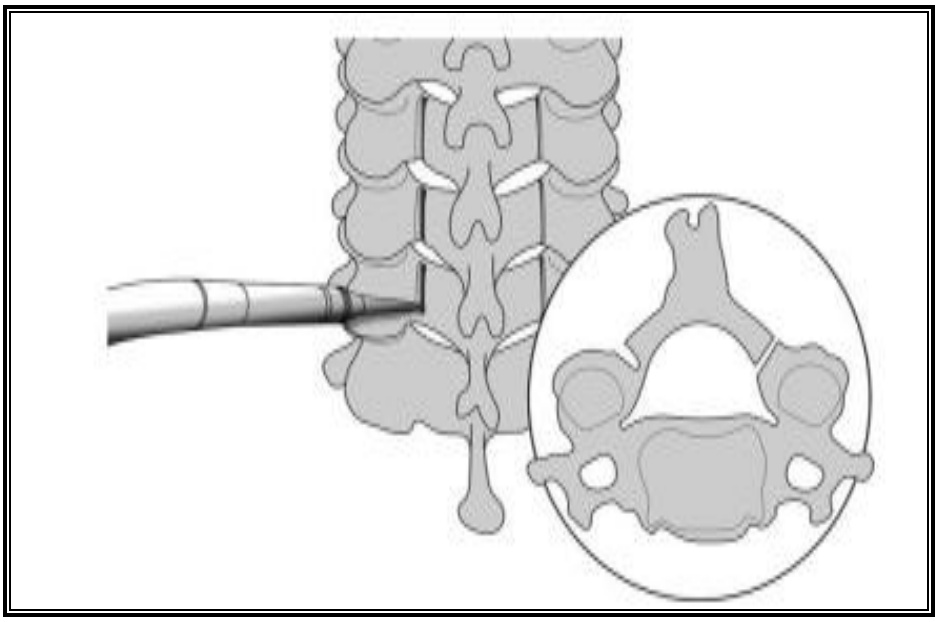

Figure (7):drilling the complete trough on the open-door side, and a second trough is drilled on the closed side. Care must be taken not to drill all the way through the lamina. **[**30**]**

Advantages of laminoplasty:

The spinal cord's decompression left unchecked, leaving the spondylotic protrusion pressing against the neural tissue. When surgeons use the anterior route for CSM, the most dangerous portion of the operation is known to be the removal of the osteo-cartilaginous protrusions encroaching on the already weakened neural tissue.

An increase in spinal canal size with little loss of spinal stability. Instability following decompressive laminectomy may be the primary cause of deterioration when the spinal cord has myelomalacia due to prolonged spondylotic compression,

especially if it is linked to epidural adhesions (postlaminectomy membrane).

More cautious and exacting hemostasis is frequently required following anterior surgery for CSM and OPLL. However, hemostasis is not a major issue after laminoplasty.

For decompressing nerve roots, laminateoplasty may be combined with other treatments. For nerve root decompression, foraminotomy may be used [22].

Complications:

Wound complications:There is a large incidence of wound complications and poor healing presumably due to the increased tension created by the mass effect of elevating the posterior structures. It is for this reason that it is commonly that the more pronounced spinous processes are debulked prior to wound closure **[23].**

Nerve root palsy (specifically C5):A motor dominant C5 root palsy may result after laminoplasty in 5–11% of cases. This usually occurs on postoperative day two or three and is not commonly seen immediately postoperatively. C5 is most often involved, although C6, C7, and rarely C8 root palsies have been described. It begins with deltoid weakness and shoulder pain. These motor root palsies are not unique to laminoplasty. This complication has also been reported after laminectomy and fusion or anterior decompression and fusion procedures for the same pathology [24]. Although the cause of C5 palsy is unknown, it is most likely due to traction on the nerve during the dorsal migration of the spinal cord and the nerve's straight, small foramen. Some studies have linked intraoperative nerve root trauma, undiagnosed preoperative foraminal stenosis, and intrinsic spinal cord alterations that existed prior to surgery to postoperative C5 palsy [23]. A mechanical tethering of the nerve root in the foramina put the C5 root under stretch and caused the palsy in post-lapinoplasty patients evaluated with CT myelograms that showed a mean posterior drift of 3mm at the level of C5. However, this theory does not fully explain why C5 palsy may also occur after an anterior decompression [25]. Non-steroidal anti-inflammatory medications and physical therapy may be used to manage the pain. After surgery, motor palsy typically returns to normal or very normal within a year [23].

Axial neck pain:Following a laminoplasty, patients may report having axial neck pain. Because it is not consistently documented in the literature, its true occurrence is unknown. The surgical dissection and manipulation around the facet joints could be the cause. After surgery, the discomfort normally starts soon after and goes away in a year or two. It is crucial to recognize preoperative neck pain when choosing cases for laminoplasty and to forego laminoplasty in these situations [26].

Although the precise cause of the postoperative neck pain is unknown, it could be caused by denervation, injury to the nuchal muscles, or rigidity of the facet joints. While prior axial discomfort is frequently persistent or amplified, new midline neck pain is comparatively uncommon. For patients who have little to no axial pain, laminoplasty is therefore the best option [26].

Delayed neurological deterioration: Closing the door or losing the expansion results in delayed neurological degeneration. Computed tomographic scanning may reveal this; it could be the consequence of insufficient fixation of the exposed laminae or a fracture of the hardware (titanium mini plates). Moreover, spinal cord damage could result from a fracture of the laminoplasty's hinged side, which could intrude on the spinal cord.

Computed tomographic scanning may reveal this issue. If this problem materializes, laminectomy can be necessary. The risk of a hinge fracture can be reduced with careful surgical technique [27].

Loss of motion:Usually, there is some loss of motion even after laminoplasty. The etiology could be complex;however, it could be linked to changes in tissue elasticity following a significant posterior exposure or facet joint injury with spontaneous fusion. Extended immobility following surgery could be a factor in the issue [28]. In a long-term study of open door laminoplasty, Wada et al. [29] found that patients who were immobilized in a collar for just three weeks lost 27% of their range of motion (37.1 degrees preoperative to 27.1 degrees postoperative), while patients who were immobilized for two to three months lost 71% of their range of motion (40.2 degrees preoperative to 11.6 degrees postoperative). Even with early mobilization, a normal expectation is a 30% loss of preoperative range of motion in the C2-7 motion arc.

Declaration of interest

The authors report no conflicts of interest. The authors along are responsible for the content and writing of the paper.

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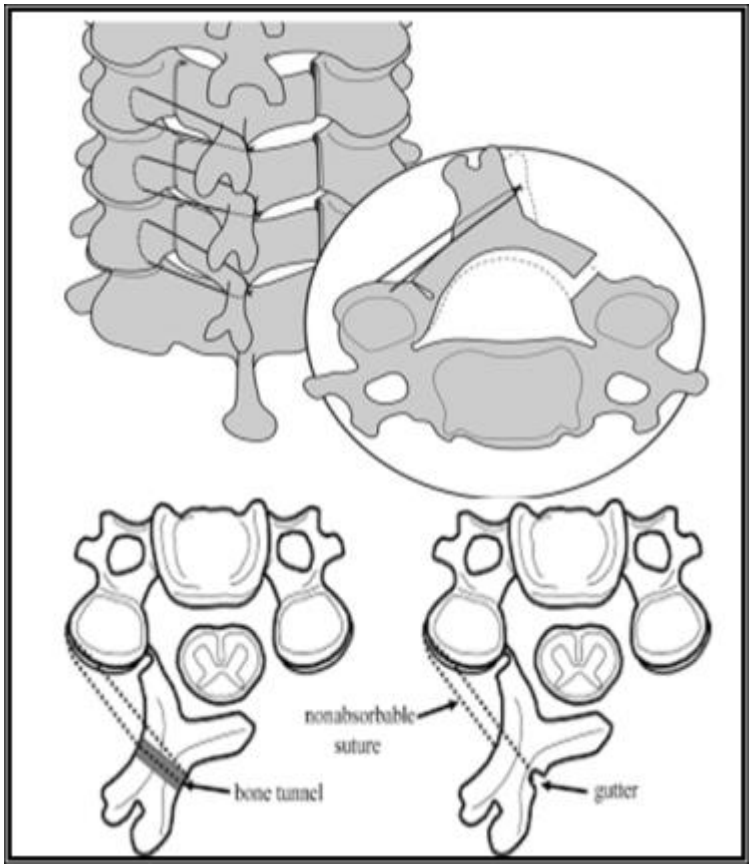


Figure S1: The laminae may be held open with sutures passing around or through the spinous processes and the facet capsule on the closed side [30**]**

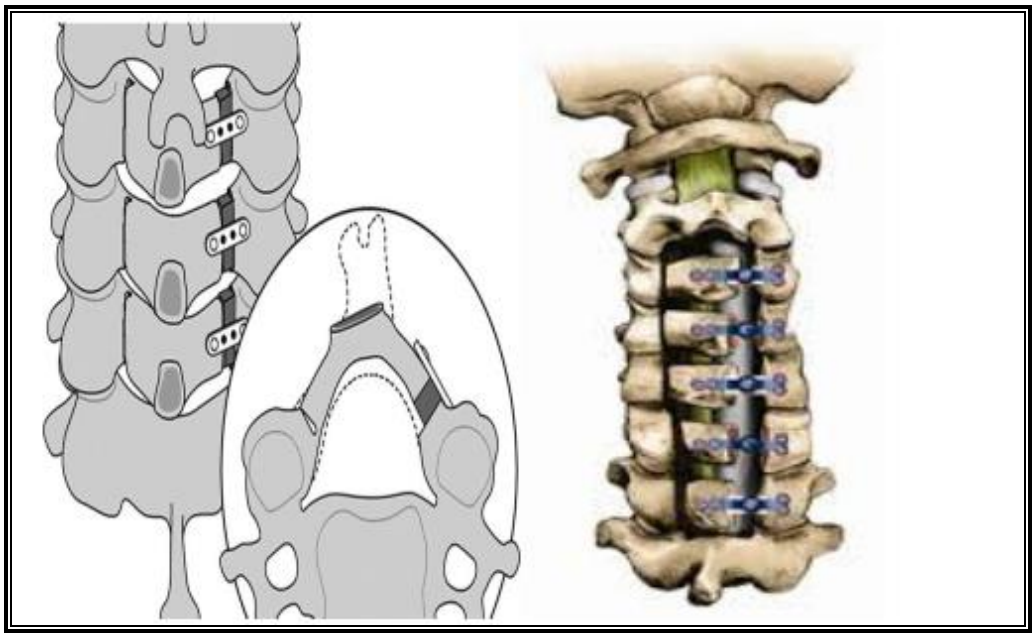


Figure S2: The laminae may also be held open with titanium miniplates **[**30**]**

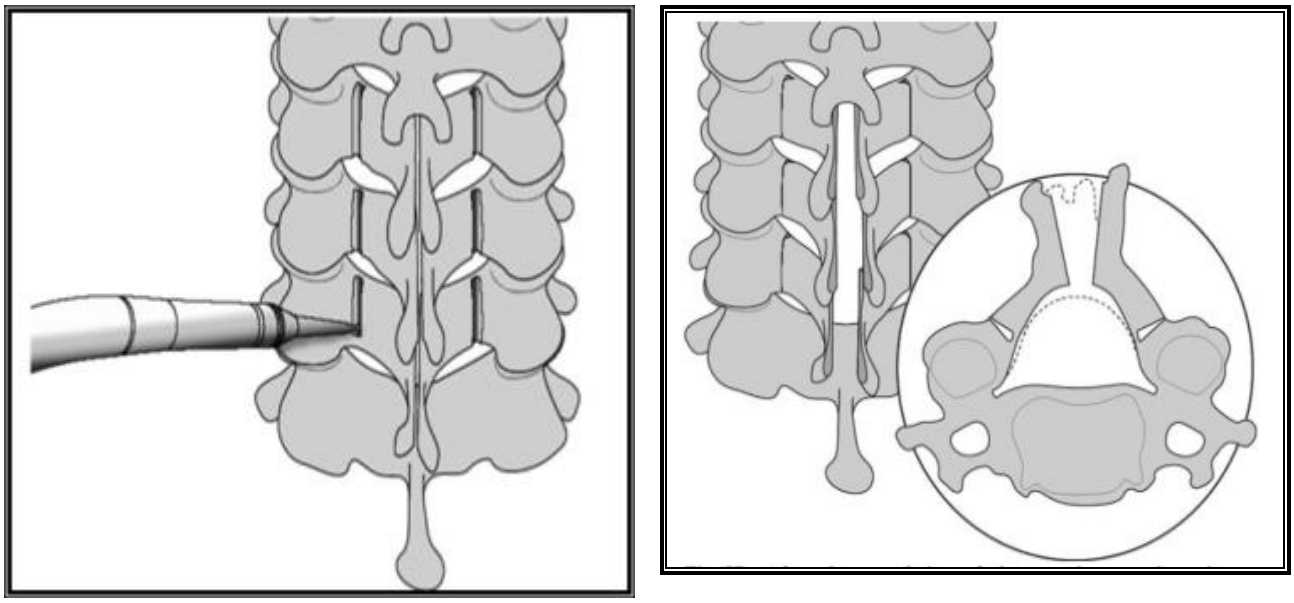
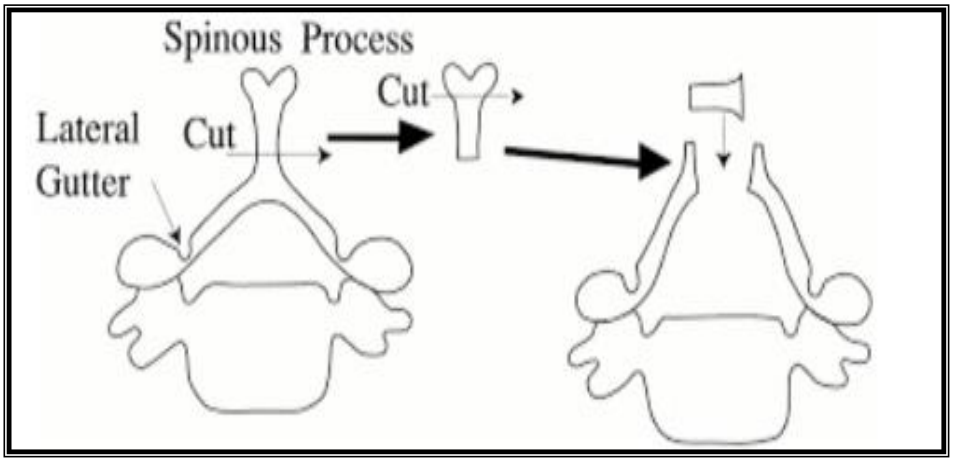


Figure S3: French door laminoplasty after troughts are made on both sides the lamina is split in the midline **[**30**]**



FigureS4: Kurokawa modification. **[20]**

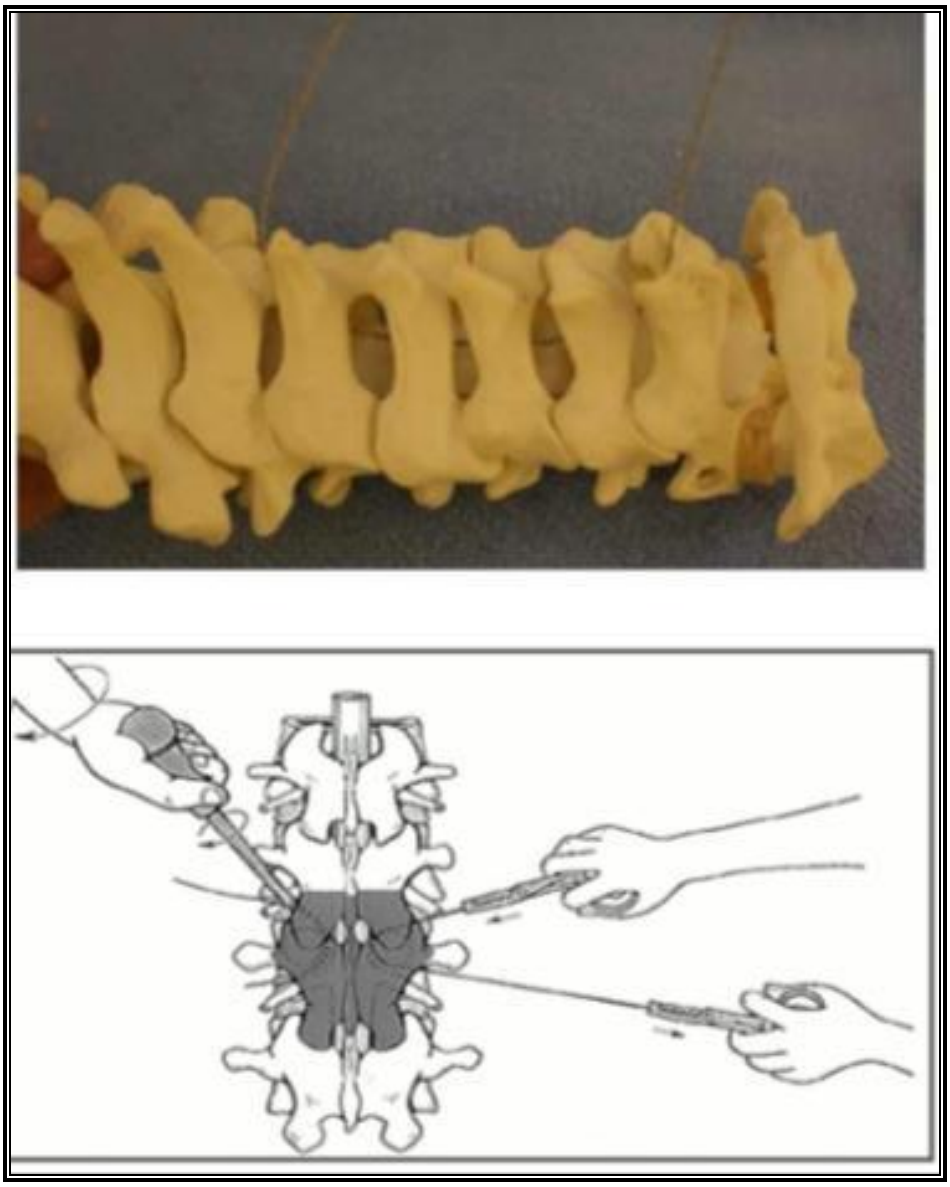


Figure S5: Tomita modification (T saw laminoplasty) **[18].**

Citation:

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