Management of Cervical Spondylotic Myelopathy by Laminoplasty

Essay

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By

Peter Fayek Habib
(M.B.B.CH)

Supervised by

Dr. Ahmed Mohammad El- Badrawi

Asst. Professor of Orthopaedic Surgery
Faculty of Medicine, Ain Shames University

Dr. Fady Micheal Fahmy

Lecturer of Orthopaedic Surgery
Faculty of Medicine, Ain Shames University

Faculty of Medicine
Ain Shames University
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List of Abbreviations

ACCF	:	Anterior cervical corpectomy and fusion
ACDF	:	Anterior cervical Discectomy and fusion
AIDS	:	Acquired immune deficiency syndrome
ALS	:	Amyotrophic lateral sclerosis
APCR	:	Anteroposterior compression ratio
CSM	:	Cervical spondylotic myelopathy
CT	:	Computed Tomography
DISH	:	Diffuse idiopathic skeletal hyperostosis
ELAP	:	Expansive open-door laminoplasty
HSV	:	Herpes simplex virus
HTLV-I	:	Human T-lymphotropic virus type I
LMNL	:	Lower motor neuron lesion
mJOA	:	modified Japanese Orthopaedic Association
MRI	:	Magnetic Resonance Imaging
OLF	:	Ossification of the ligamentum flavum
OPLL	:	Ossification of posterior longitudinal ligament
ROM	:	Range of motion
SI	:	Signal intensity
UMNL	:	Upper motor neuron lesion

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Abstract

Laminoplasty was developed to treat multilevel pathology of the cervical spine, namely ossification of the posterior longitudinal ligament and cervical spondylotic myelopathy. Laminoplasty was popularized in the 1980s, and since then many variations on the theme have been developed. All are similar in that they expand the cervical canal while leaving the protective dorsal elements in place. Advocates claim that this prevents the formation of the ‘‘post laminectomy’’ membrane, maintains spinal alignment, and should aid in maintaining cervical range of motion. The aforementioned are all potential shortcomings of laminectomy or laminectomy and fusion. The procedure has proven to be essentially equal to other cervical decompressive procedures in the neutral or lordotic spine, and outcome has been shown to be durable.

Keywords :

Cervical spondylotic myelopathy; Laminoplasty; Laminoplasty techniques; Comparative laminectomy; Cervical spondylosis; Cervical stenosis; Cervical cord ischemia; Cervical sagittal alignment; Ossification of posterior longitudinal ligament; Congenitally small cervical spinal canal; Cervical cord syndromes; Babinski sign; Hofffmann's reflex; Ankle clonus; Pavlov ratio; Signal intensity in MRI; Antero-posterior compression ratio; Modified Japanese orthopedic association; Hirabayashi laminoplasty; French door laminoplasty.

Introduction

Cervical spondylotic myelopathy is a common spinal disorder that commonly results from the degenerative process of the vertebral column and associated soft tissue structures.[(1)]

In the majority of patients, the cervical spondylotic myelopathy (CSM) occurs secondary to degenerative changes associated with the normal aging process. Progressive cervical spondylosis may lead to spinal cord compression, which may be exacerbated by spinal instability, kyphotic deformity, ossification of the posterior longitudinal ligament (OPLL), and large central disc herniation. [(2)]

The diagnosis of the cervical spondylotic myelopathy include many symptoms and signs at both upper and lower extremities and many tests may be positive, also radiographic evaluation by plain x-ray, CT scan and MRI is needed to fulfill the diagnosis. [(2)]

The treatment of cervical spondylotic myelopathy is by conservative treatment in the beginning which includes medical treatment and physiotherapy and if there is no response surgical treatment is considered in the form of decompression procedures to relieve the cord compression. [(3)]

Laminoplasty achieve posterior decompression of the cord and many techniques are used for this procedure. [(3)]

Chapter 1

Relevant Anatomy

The cervical spine is uniquely adapted to allow for a wide range of motion including flexion, extension, and movements in the lateral bending planes. It consists of seven vertebrae stacked on top of each other, spinal ligaments, and the spinal cord which run within the spinal canal. The C1 and C2 vertebrae are anatomically different from other vertebrae while the others are almost identical. Normally, the cervical spine has a lordotic curvature. [4]

The cervical vertebral canal is smooth-walled tubular space formed by vertebral foramina of the seven cervical vertebrae which lying one above the other. Its anterior boundaries are the bodies of vertebrae, intervertebral discs and the posterior longitudinal ligaments. Posteriorly the canal bounded by the vertebral lamina, spinous process and ligaments flava. While at sides the pedicles of vertebrae form the lateral boundaries. There is a transverse process which project from the junction of the pedicle to the vertebral body. The cervical vertebra articulates with each other through intervertebral disc anteriorly and facets posteriorly. [4]

The cervical spinal canal is relatively large and triangular in cross-section except at the level of the atlas vertebra, where it is almost circular. The size of the canal decreases from the first to the third cervical vertebra, but inferior to this it is relatively constant. The transverse diameter of the spinal canal is larger than, or equal to, the sagittal diameter. Sagittal spinal canal diameter in the lower cervical spine averages 17-18 millimeters in the normal individuals. Most compressive symptoms are generated in the C5 through C7 levels due to the fact that the cervical spinal cord occupies 3/4 of the canal at this level in the normal patient. The minimal sagittal spinal canal diameter considered to be normal in the lower cervical region is 13 millimeters. Sagittal canal diameters less than or equal to 12 millimeters are considered to be critical to the development of myelopathy. It should be noted that the spinal cord average antero-posterior diameter is 10 millimeters, with a range from 8.5 millimeters to 11.5 millimeters. [5]

The vertebral body has a convex anterior surface and a flat or minimally concave posterior surface and its discal margins give attachment to the posterior longitudinal ligament. The superior surface is saddle-shaped while the inferior surface is concave. [5]

The pedicles are stout bars extending postero-laterally from the superior aspect of the vertebrae. In spite of their size and composition largely of cortical bone, they are commonly injured in severe trauma because of their orientation. [5]

The laminae extend dorsomedially from the pedicles, fuse in the midline to form the dorsum of the canal and give rise to the spinous processes. The spinous processes, which are short, often bifid, and point inferiorly, serve as attachment points for muscles and ligaments, as do the transverse processes. The spinous processes are attached to the ligamentum nuchae and numerous deep extensors, including semispinalis thoracis and cervicis, multifidus, spinalis and interspinales. [5]

The uncinate processes are seen from C3 to C7 as protrusions dorso-laterally from the vertebral bodies and serve to prevent lateral displacement. [5]

The transverse processes project from the junction of the pedicle to the vertebral body, incorporating the transverse foramen from C1 to C6, which transmits the vertebral artery.[6]

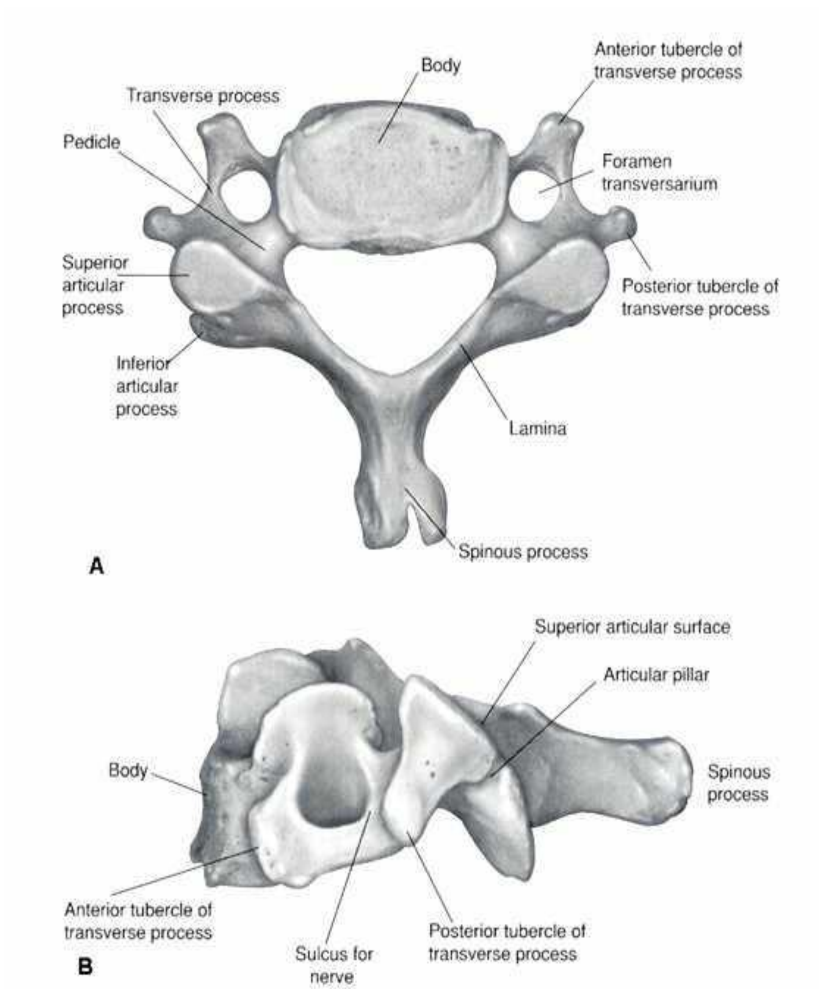

Fig.(1): Anatomy of cervical vertebrae. A: axial view, B: lateral view. [5]

The facets arise from the superior and inferior surfaces of the pedicle. The superior surfaces project cranially, and the latter project caudally. In the cervical spine, the facets face upward 45 degrees towards the horizontal, allowing significant physiologic rotation. At C3, a change in orientation occurs which explains, in part, the relatively high frequency of facet dislocations occurring at this level. Facets are important in absorbing compression force, particularly in traumatic loading conditions; because of their capsules and orientation, they are also important flexion limiters. [7,8]

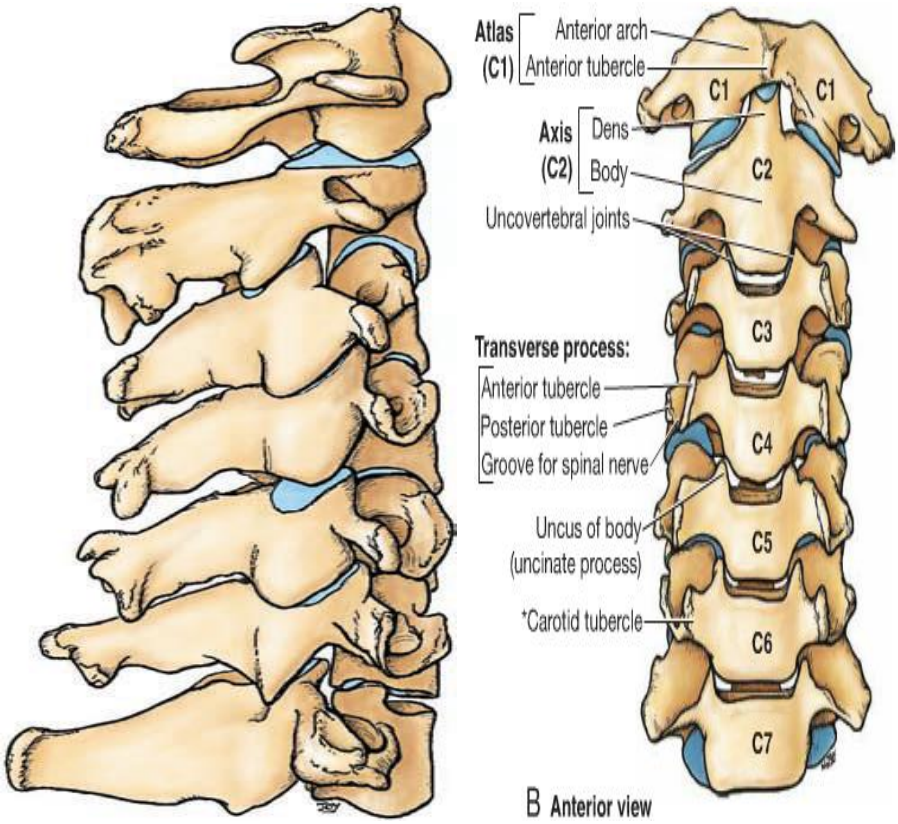

Fig. (2): Articulated cervical vertebrae [9]

The lateral mass of the cervical vertebra **(Fig. 3)** consists of the superior and inferior facets. The area of the lateral mass is the part lateral to the lamina and between the margins of the adjacent facets. The mean supero-inferior diameters of the lateral mass range from 11 mm at C3 to 15 mm at C7, the average medio-lateral diameters (width) is (11.92 ± 0.96 mm) and the average antero-posterior diameter (depth) of the lateral mass is (12.83 ± 1.28 mm) which is smaller at the C6-C7 levels than at the levels above. [5,8]

Anterior to the lateral mass are the pedicle, transverse foramen, and posterior ridge of the transverse process. The adjacent pedicle, the postero-lateral wall of the vertebral body, and the antero-medial aspect of the superior articular process form the interpedicular foramen. The posterior ridge of the transverse process originates from the latero-inferior portion of the anterior aspect of the lateral mass just above the inferior articular facet. It develops laterally and inferiorly to accommodate the course of the ventral ramus of the spinal nerve. [5,7]

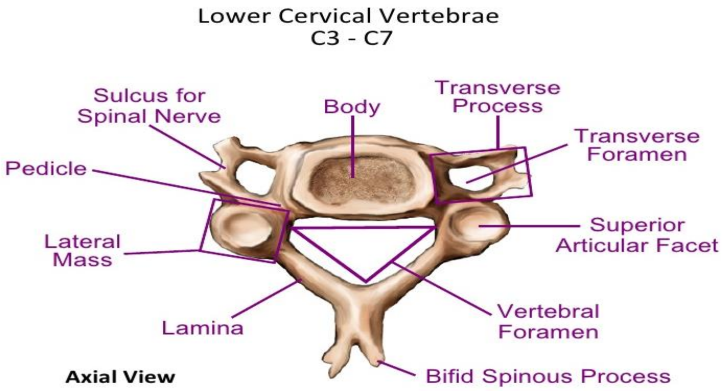

Fig. (3): The anatomy of the lateral mass of cervical spine. [6]

Ligaments:

The spinal ligaments are composed of elastin and collagen in varying ratios. They are uni-axial structures, resisting tension and buckling in compression. With age, their effectiveness is diminished. Studies of ligament strength have suggested the tensile strength varies from ligament to ligament and even within a given ligament at different spinal levels, in part due to ligament size. [5]

From the standard point of normal and pathologic spinal motion, ligaments may be the most important structures in the spinal column, as they serve to allow a certain degree of physiologic motion, maintain anatomic relationships, and as noted by **White and Panjabi,** protect the spinal cord during traumatic situations. [5]