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Operative Techniques in
Orthopaedics

Laminoplasty

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Multisegment degenerative cervical stenosis with progressive neurologic impairment and other symptoms can be surgically treated with anterior and/or posterior decompressive procedures with or without stabilization and fusion. Posterior procedures, including laminoplasty and laminectomy with fusion, offer the potential to effectively decompress the spinal cord over many levels, most commonly C3 to C7, when the correct indications are met. Preoperative considerations include the number of stenotic levels, the presence or absence of cervical lordosis, and any component of axial neck pain. Although both laminoplasty and laminectomy/fusion have supporters, laminoplasty may provide spinal cord decompression while sparing motion. Many laminoplasty techniques have been described but all essentially comprise a method of opening the posterior elements and a strategy for maintaining the "open" position.
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Cervical spine stenosis with resultant cord compression is an anatomic condition with etiologies such as congenital stenosis, degenerative and rheumatologic spondylosis, ossification of the posterior longitudinal ligament (OPLL), and mass lesions. The most common conditions for which decompression is preformed through a subaxial posterior approach are degenerative spondylosis and OPLL. Cord compression can cause myelopathy that clinically manifests as problems with coordination, weakness, hyperreflexia, bowel and bladder dysfunction, and a greatly increased risk of acute spinal cord injury with minimal trauma.

Options for decompression of the stenotic cervical spine include anterior procedures such as multilevel corpectomies and strut grafting, and posterior-based procedures, including laminectomy with fusion and laminectomy. Posterior procedures tend to provide easier access and subsequent decompression of the entirety of the subaxial spine. Both laminectomy and laminoplasty have their ardent supporters and often are the subject of discussion at national meetings; therefore, the debate is beyond the scope of this review. Basically, laminoplasty may preserve cervical motion, whereas laminectomy and fusion may better treat stenosis with concomitant axial neck pain. Clinical studies have found few differences in outcome in the 2 procedures.

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Ratliff and Cooper,[1] in a meta-analysis of the English-language literature on laminoplasty, reviewed 71 reports involving more than 2000 patients. The overall clinical results were similar to those of laminectomy with posterior fusion. The reported prevalence of axial neck pain ranged from 6% to 60%, the prevalence of C5 nerve-root dysfunction ranged from 5% to 12%, and a progressive loss of range of motion was noted over time.

Decision-Making

Patient selection and proper indications are perhaps the most important determinants of successful surgical outcomes. A patient presenting to a spine surgeon for the evaluation of cervical stenosis should have plain films in neutral position and undergo quality magnetic resonance imaging that correlates with the clinical picture. Once multilevel degenerative spondylosis resulting in stenosis is determined, the surgeon must consider cervical alignment, any ossification of the PLL, and whether a component of axial neck pain is present.

It is generally believed that posterior decompressive procedures are contraindicated with fixed cervical kyphosis. In a kyphotic deformity, the spinal cord is draped over the posterior aspect of the vertebral bodies and, therefore, removing the posterior elements with correction of the kyphotic deformity will not adequately relieve the cord. Suda and coworkers[2] followed 114 patients for 2 years after laminoplasty and determined that kyphosis greater then 13° statistically resulted in a worse outcome.

OPLL is a relative indication for posterior procedures, and

because of the high prevalence of OPLL in Asian subjects, much of the early work was done by Japanese, Korean, and Chinese investigators. Mizuno and Nakagawa[3] have repeatedly shown that anterior procedures in the presence of OPLL are associated with an increase risk of dural leaks.

The presence of axial neck pain is thought to be generated through the motion of arthritic, spondylotic segments. Therefore, many researchers have suggested that laminectomy and fusion is a better option in this population. Also, the relative contraindications of laminoplasty alone include previous anterior surgery or instability.

Posterior Approach to the Subaxial Spine

Common to most procedures, positioning and surgical exposure are paramount to a safe, well-performed surgery. After induction of general anesthesia, Mayfield tongs are located transversely on the head, avoiding pin placement in the occipital region. Intraoperative neurophysiological monitoring is commonly used and may aid in the detection of impending C5 nerve root injury.[4] With a moderately flexed neck, the patient is turned to the prone position on chest rolls without rotation of the neck and secured to the Mayfield table attachment. Mayfield tongs provide 3-point stabilization of the head to maintain fixed flexion or extension of the cervical spine. A careful assessment must always be made to ensure the tongs clear the chin, nose, and brow in the planned surgical position. The head is gently extended and the bed placed into slight reverse Trendelenberg. This positioning stretches the over-redundant skin in the posterior neck, aiding exposure and wound closure, and distracts the shingled posterior elements, aiding with dissection and increasing the safety of bone work. Cervical extension also increases the mean canal area by putting the ligamentum flavum on stretch so it does not kink into the canal.

After sterile skin preparation and perioperative antibiotic administration, bony landmarks are palpated and mapped, including the inion and C2 and C7 prominences. A midline incision is made and dissection carried down to the spinous processes. Subperiosteal elevation of paraspinal musculature is performed to the middle of the lateral masses bilaterally. As opposed to exposure in preparation of posterior fusion, dissection need not be carried over the edge of the masses. Careful attention should be paid to meticulous hemostasis, especially as one moves in the field laterally. After exposure and radiographic confirmation of levels are completed, attention is turned to the laminoplasty. Decompression can be accomplished with either of 2 types of laminoplasty, the open-door technique or the French door technique. Both techniques have advocates and provide adequate decompression for multilevel stenosis, as recently described by computer modeling by Wang and coworkers,[5] and there have been no longitudinal, clinical studies that have suggested improved outcomes or decreases complications of one technique over the other.

Open-Door Techniques

The open-door technique is based on opening the entirety of bilateral lamina that are hinged on one side. To allow for hinging, the proposed site must be scored and the contralateral side must be opened.

Troughs

Troughs are based at the medial third of the lateral masses, or the intersection of lateral mass and lamina, using a high-speed burr. Choice of the side of the opening is commonly debated based primarily on surgeon preference. Some argue that the opening should be created on the more symptomatic side, whereas others assert that the more radigraphically stenotic side should be opened regardless of symptoms. If foraminotomies are to be performed for foraminal stenosis, then the opening should be made on that side for ease of access.

The open side trough is created first. The goal is simple, to thin the bone to where it can be cracked open with a Cobb retractor without injury to the neural elements and minimal bleeding, but the technical nuances are considerable. The "open" trough is begun with an aggressive burr through the posterior cortex and cancellous bone. At this point, a switch is made to a low aggression burr and the anterior cortical bone is systematically thinned. The ligamentum flavum attaches near the mid portion of the undersurface of the cranial lamina and originates from the superior leading edge of the caudal lamina. This configuration allows for more protection from the ligamentum when burring the caudal half of the lamina. As the remaining bone is removed, the white cortex will give way to the yellow ligamentum. A Penfield #2 retractor can be used to gently palpate for remaining bone. Any small residual bony bridges can be removed with a 1.0-mm Kerrison punch. The ligamentum should be left intact as much as possible at this time as to minimize bleeding from adherent epidural veins.

The "hinge" trough is fashioned in the manner although the goal is to leave an amount of bone that allows for hinging but also has integrity so the door will not become "unhinged" and risk displacement into to the canal. As discussed previously, the lamina of the cervical spine is shingled; therefore, the cranial edge projects more ventral toward the canal. Therefore, it is more common to remove too much of the caudal edge of the lamina while removing too little of the cranial side of the lamina. Gentle attempts at opening the door should be made throughout the process of making the hinge trough to assess the completeness of the "open" side and the stiffness of the "hinge" side.

Opening Door

The posterior element door is opened with either a curved curette, nerve hook, or Cobb elevator. As the door is opened slowly, bipolar electrocautery is used to ligate epidural veins. A well-crafted hinge trough should provide the surgeon the ability to plastically deform the remaining ventral cortex of the hinge when opening the door. An adequate decompression of the stenotic spine can be verified with return of dural pulsations.

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