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Minimally Invasive Cervical Stenosis Decompression

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Epidemiology

Cervical spondylotic myelopathy is one of the most common disorders of the spinal cord. In most cases, this is the result of normal degenerative processes resulting in ventral spinal cord compression attributable to disc bulges or herniations and osteophytes and posterior compression from hypertrophied facets and a thickened ligamentum flavum. In some cases, a congenitally narrow spinal canal contributes to the disease.

Patients with cervical spinal stenosis are at risk for chronic myelopathy in addition to the potential for acute spinal cord injury. The normal average cervical spinal canal diameter on plain radiographs is 17 mm, whereas symptomatic stenosis can occur with a diameter anywhere less than 13 mm [1]. Injury to the spinal cord is probably attributable to a combination of mechanisms ranging from mechanical compression to ischemic insults [2].

Clinical evaluation

Patients with cervical stenosis with myelopathy often present with a wide variety of complaints. Crandall and Batzdorf [3] described several typical presentations:

- Upper and lower motor neuron dysfunction with minimal sensory disturbance
- Myeloradiculopathy
- Central cord syndrome
- Brown-Sequard syndrome
- Involvement of anterior horn cells, corticospinal and spinothalamic tracts, and posterior columns

Two thirds of patients present with a chronic progressive myelopathy, whereas the remainder present with more acute deterioration [4]. Typical complaints and findings include hyperactive reflexes, Babinski and Hoffman signs, clonus, sensory loss or pain, and weakness. Urinary sphincter disturbance (characterized by urgency) occurs in roughly half of these patients, although loss of anal sphincter tone is uncommon. Interestingly, despite the degree of cervical spondylosis in these patients, axial neck pain is an uncommon finding. Several authors have described patients who have cervical and lumbar stenosis, and, occasionally, patients are referred to a spine surgeon for lumbar complaints and found to have cervical spondylotic myelopathy on examination and subsequent imaging [5–7].

Evaluation of these patients includes flexion and extension radiographs to evaluate alignment and stability and MRI or CT/myelography to define the amount and location of compression. Electromyography can help to distinguish cervical spondylitic myelopathy from amyotrophic lateral sclerosis (ALS), a common demyelinating disorder. Dysarthria, tongue fasciculations, or a hyperactive jaw-jerk reflex favors ALS.

Current surgical management

Cervical spinal decompression is typically performed from an anterior or posterior approach depending on many factors, including extent of disease, amount of deformity, prior surgery,

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health of the patient, and familiarity of the surgeon with the various procedures. One rule of thumb often quoted is "anterior disease, anterior procedure," although this means a longer and more challenging operation in many cases.

The standard anterior cervical approach to the spine is the favored treatment for one- or two-level disease in the middle to lower disc levels. This approach is more difficult and has a higher potential morbidity at C2 to C4 and C7 to T1. Depending on the extent of the disease, an anterior cervical discectomy with fusion (ACDF) or an anterior cervical corpectomy with fusion is performed. The anterior approach offers a simple dissection to the spine and a means to decompress the ventral spinal cord, which is often the site of the most compression. Disadvantages include potential complications involving the anterior neck structures, dysphagia, recurrent laryngeal nerve injury, and loss of one or more motion segments.

Posterior cervical decompressions are commonly performed for disease spanning more than two levels or involving the cranial or caudal cervical spinal canal. Although a posterior decompression gives more space for the thecal sac, it does not address any anterior compression from disc herniation, osteophytes, or ossification of the posterior longitudinal ligament. A variation on the standard laminectomy is the addition of dentate ligament sectioning, even though one study did not find any difference in outcome [8,9]. Although a simple multilevel laminectomy is a relatively straightforward procedure, it also is usually more painful for the patient and often results in a longer hospitalization. In addition, cerebrospinal fluid (CSF) leak, wound issues, and instability (resulting in swan-neck deformity) are not uncommon.

Another procedure for posterior decompression is laminoplasty. Although there are variants on the procedure, the basic premise is a hemilaminectomy combined with a partial-thickness cut in the contralateral lamina. The posterior arch is then pried open with the partial-thickness cut acting as a hinge. A bone graft is typically placed in the ipsilateral side to keep the canal expanded. Although this can reduce the incidence of postoperative deformity, there is reported to be a significant incidence of axial neck pain afterward [4,10,11].

Minimally invasive posterior cervical decompression

With the recent advent of more specialized instruments and access devices, minimally invasive spinal surgery has proven to be a useful tool for the treatment of spinal disease while minimizing soft tissue damage. Minimally invasive surgery for stenosis has been shown to treat lumbar disease effectively and is an ideal application of this technology. In a clinical study of 50 patients, lumbar microendoscopic decompression for stenosis (L-MEDS) reduced intraoperative blood loss by almost two thirds and hospitalization by half. Outcome scoring for back pain and neurogenic claudication was similar compared with traditional open laminectomy [12].

Application of a similar technique to the cervical spine follows naturally, and some small studies are underway to determine the feasibility and efficacy of this procedure. Recent studies using a percutaneous transmuscular working tube to perform a minimally invasive decompression for radiculopathy and myelopathy concluded that the basic technique was safe and feasible [13,14]. Wang and colleagues [15] describe a cadaveric feasibility study using minimally invasive techniques to perform a multilevel laminoplasty.

Fig. 1. Intraoperative patient positioning.

More recent work has led to adaptation of the L-MEDS technique for the cervical spine. This technique is presented next.

Cervical microendoscopic decompression for stenosis technique

The surgical technique for posterior cervical microendoscopic decompression for stenosis (C-MEDS) is similar to the lumbar technique. Some differences exist, however, and the procedure is technically more demanding.

Before surgery, the patient must have flexion and extension radiographs to rule out gross instability before surgery. Myelography or MRI is used to define the extent of the surgery. Routine medical and laboratory evaluations are obtained. The anesthesia team must be aware of the need for possible fiberoptic intubation.

During surgery, the patient is placed in the sitting position with the head fixated in a skull-pin device (Fig. 1). A mobile C-arm is positioned so as to provide lateral images while not interfering with the surgeon. The sitting position has the advantages of reducing blood loss and providing improved visibility on fluoroscopy by using gravity to pull the shoulders down. The skin of the neck is prepared and draped in the usual sterile manner.

A spinal needle is placed percutaneously through the paramedian musculature approximately 10 mm from the midline down to the desired cervical spinal level (Fig. 2). Care should be taken to optimize the trajectory, because this affects the difficulty of the procedure. The left or right paramedian approach may be used, depending on patient symptoms, and central

Fig. 2. Localization using spinal needle.

decompression can be combined with focal foraminal decompression for radiculopathy. An 18-mm vertical paramedian incision is made centered on the entry point of the spinal needle.

At this point, special care should be taken to incise the fascia sharply for the entire length of the skin incision. If more than one level is to be decompressed, it is helpful to extend the facial incision cranially and caudally to allow manipulation of the working channel. The purpose of this is to allow placement of the serial dilators under gentle controlled motion to avoid slipping into the wide interlaminar space. A Cobb elevator may be used to scrape away the muscle overlying the lamina and facet to facilitate dilation and exposure, although, anecdotally, this may increase postoperative muscle spasms. Using concentric tubes, the muscle is dilated down to the lateral mass of the level of interest, and a working tub of appropriate length is placed and secured. Fluoroscopy is used to confirm placement at the correct level and trajectory with each dilation (Fig. 3). Up until this point, the procedure is

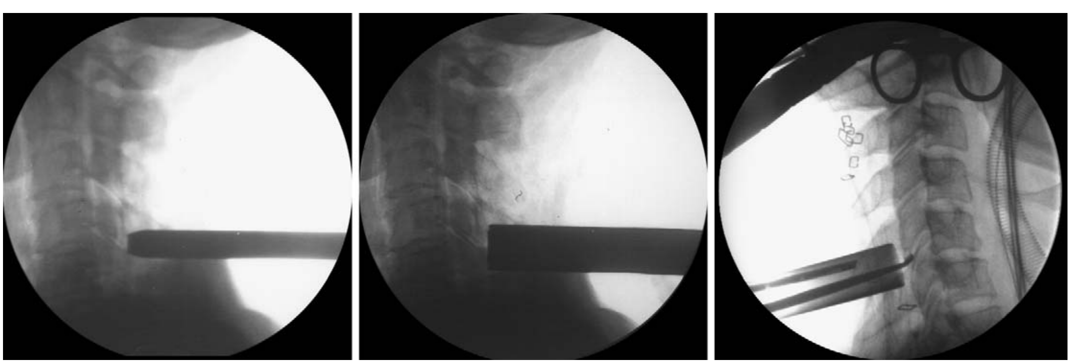

Fig. 3. Serial dilation and subsequent placement of working tube (MetRX system; Medtronic Sofamor-Danek, Memphis, Tennessee).

Fig. 4. Guarded drill (Medtronic Midas Rex, Fort Worth, Texas).

exactly as performed for a microendoscopic cervical foraminotomy, as described elsewhere.

Once the working tube is secure, the endoscope is placed, and using a specially designed high-speed drill (Medtronic Midas Rex, Fort Worth, Texas) with an adjustable guard, an ipsilateral hemilaminotomy is performed to expose the underlying ligament (Fig. 4). Care should be taken to leave the ligament intact at this point. The working tube and drill are then angled medially, and the base of the spinous process and contralateral lamina is undercut with the drill guard placed between the cutting surface and the ligament similar to the L-MEDS technique (Fig. 5). This is performed to the medial aspect of the contralateral facet. This decompression is continued cranially and caudally at each level with stenosis; approximately two to three levels can be safely performed per skin incision if the skin entry point is chosen with care. Thus, a C2-to-C7 decompression can potentially be accomplished with two small incisions. An obvious difference between the C-MED and L-MED techniques is that the dura cannot simply be pushed down for better visualization. This can require proportionally more bone removal in the cervical spine. Because of the often thin lamina present, breaches through

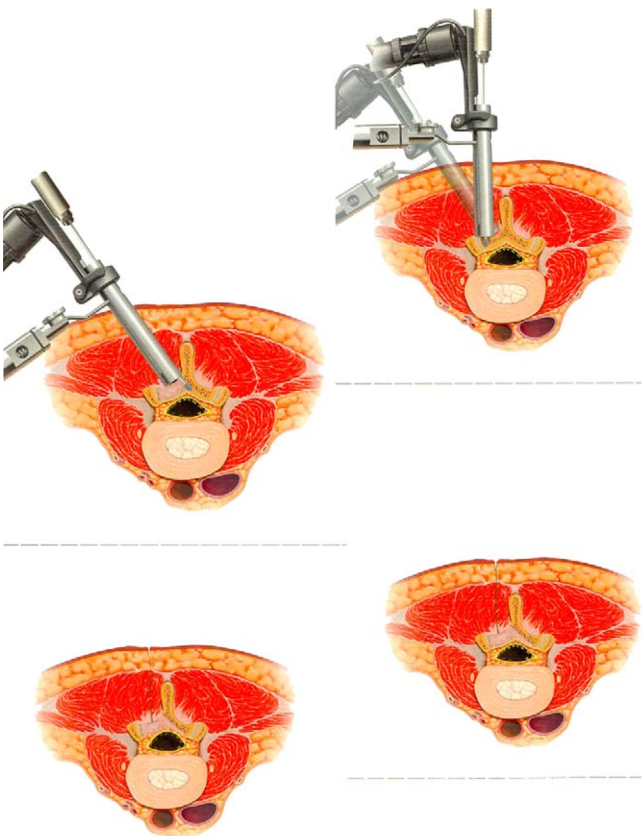

Fig. 5. Diagram of undercutting technique for L-MEDS technique.

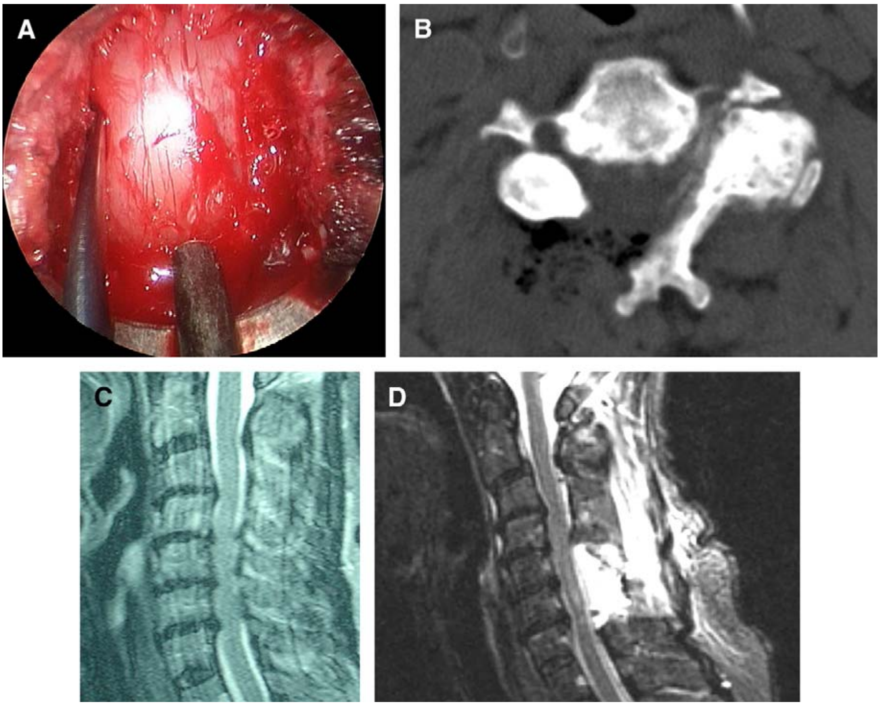

Fig. 6. (*A*) Intraoperative view of decompression. (*B*) Preoperative sagittal T2-weighted MRI scan. (*C*) Postoperative sagittal T2-weighted MRI scan. (*D*) Postoperative axial CT scan.

the superficial cortex of the contralateral lamina may sometimes be necessary.

After adequate bone removal has been accomplished, the ligamentum flavum is carefully removed using various curettes, dissectors, and rongeurs (Fig. 6). Hemostasis is obtained, and once all the diseased levels have been treated, the working channel is removed and the wound is closed in standard fashion (Fig. 7).

Potential benefits

By decompressing the cervical spine through a minimally invasive approach, it is hoped to achieve shorter hospitalizations, less blood loss, fewer wound healing problems, and reduced incidence of postlaminectomy kyphosis in addition to resolution of preoperative symptoms. Because there have not been many of these procedures done, it remains to be seen if these objectives can be reached.

Potential complications

Minimally invasive surgery requires a thorough knowledge of anatomy and training with the particular instruments. The C-MEDS technique is technically more challenging than the L-MEDS technique in that one is not able to push down the dura to obtain a better view.

Nerve injury, spinal fluid leakage, and spinal cord injury are all potential risks. In addition, more work is required to determine if there is

Fig. 7. Postoperative incisions.

indeed a benefit compared with traditional open laminectomy. Without the benefit of a wide viewing area as in open surgery, the risk of incomplete decompression also exists, especially in the early development of the procedure.

Summary

Minimally invasive decompression for cervical stenosis is technically feasible. Employing a technique similar to that used for minimally invasive lumbar decompression, the cervical spine can be treated in the same manner. The procedure has inherently higher risk for spinal cord injury, however.

The technique is still in its early stages of investigation. More studies are required to determine the exact benefits compared with open surgery.

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