Surgical management of cervical myelopathy: indications and techniques for multilevel cervical discectomy
Virany H. Hillard, MD, Ronald I. Apfelbaum, MD*

Abstract
BACKGROUND CONTEXT: Surgery is usually required for treatment of cervical myelopathy to decompress the neural elements, restore lordosis, and stabilize the spine. By addressing these problems, the neurological deterioration may be halted.

PURPOSE: Multilevel cervical discectomy and fusion offers several advantages over other approaches. The authors describe the technique, discuss the indications, and present the potential complications associated with it.

METHODS: Decompression is achieved via discectomy and subsequent removal of the osteophytes using a curetting technique. Preparation of end plates in a parallel fashion allows for gapless grafting of allograft bone for enhancement of fusion. A dynamic plate and screw system strengthens the construct.

RESULTS: A high rate of fusion can be obtained using the technique of multilevel cervical discectomy and fusion with acceptable levels of complications. It is especially useful in cases of spondylisis that have a kyphotic deformity because, in addition to anterior decompression, it allows reconstruction of the spine to help restore a lordotic curvature.

CONCLUSIONS: Multilevel cervical discectomy and fusion has proven to be very effective in decompressing and stabilizing the spine for treatment of cervical myelopathy. © 2006 Elsevier Inc. All rights reserved.

Keywords: Multilevel cervical discectomy; Dynamic plating; Anterior fusion; Allograft

Introduction
Degenerative spondylosis leading to stenosis, rheumatoid arthritis, and trauma are some of the more common causes of compression of the spinal cord that can result in cervical myelopathy. The symptoms of cervical myelopathy are due to impaired motor and sensory functionality. They include clumsiness of the hand, difficulty walking, impaired balance and coordination, and sensory complaints of numbness or tingling in the hands and feet [1]. Cervical spondylosis, which most commonly occurs after age 50, is the most common cause of cervical myelopathy. It evolves from desiccation of the disc that leads to reduced disc height and bulging of the disc posteriorly into the spinal canal. The bulging disc may then calcify and, along with marginal osteophyte formation and uncovertebral spurring, narrow the spinal canal. The resultant foraminal and spinal canal stenosis produces radiculopathy and myelopathy, respectively [2,3].

Surgery is usually required to decompress the neural elements, restore lordosis, and stabilize the spine to prevent additional degeneration at the affected level. Surgery for cervical myelopathy has been performed by both posterior (laminectomy, laminoplasty) and anterior (corpectomy, multilevel discectomy) approaches, each with unique advantages and disadvantages.

Although an element of surgeon preference will of necessity be involved, some principles can assist in the selection of the appropriate approach. The location of the stenosis and the alignment of the cervical spine should be evaluated when choosing between an anterior and a posterior procedure. If the compression is posterior and related primarily to facet hypertrophy or buckling of the ligamentum flavum, posterior decompression should be considered [4]. However, ligamentum infolding can also be corrected...
indirectly by restoring disc space height anteriorly, so this factor alone is not weighted heavily when deciding on an approach. If the compression is from anterior osteophytes or disc herniations, an anterior approach via either multilevel discectomy or corpectomy offers the opportunity to decompress the spinal cord directly and should be considered.

The alignment of the patient’s spine must also be considered. If the spine is lordotic, a posterior procedure can achieve an indirect decompression and may be an excellent alternative to anterior decompression. If the spine is kyphotic, however, a posterior approach may be contraindicated because the spinal cord cannot displace dorsally from the anterior compressive structures. In such cases, a ventral approach is indicated. A ventral approach not only allows direct decompression, but the proper use of intraoperative distraction often can help restore alignment as well. This can not usually be accomplished by a posterior approach. If the patient’s spine is straight, either procedure can be used [5].

Other considerations when selecting the approach are the extent of the degenerative process (ie, the number of levels involved) and the patient’s age and overall medical condition. Anterior surgery is more prolonged, and patients with multiple levels will be more likely to have dysphagia and voice problems postoperatively. Therefore, for an older or infirm patient, posterior surgery may be preferable if the alignment is not kyphotic.

In this article, we will discuss the use of the multilevel cervical discectomy for anterior decompression of cervical myelopathy. We believe that this procedure has several advantages over single or multilevel corpectomies. Multilevel cervical discectomy can achieve the goal of decompression as well as corpectomy when proper technique is used to remove the posterior osteophytic protrusions encroaching on the spinal canal and neural foramen. However, by sparing the vertebral bodies, multiple points of fixation exist, allowing for distraction and restoration of lordosis, which is then maintained by the interbody grafting technique [6]. The spine is then stabilized with a dynamic anterior cervical plate. In a multilevel cervical discectomy, the grafts are shorter than if a corpectomy is done. This may increase the rate of fusion and avoid late failures by decreasing the distance across which fusion and ultimately bone replacement by creeping substitution must occur.

**Indications**

Multilevel cervical discectomy is appropriate for use in cases in which the compressing pathology is located anterior to the spinal cord. This includes central, broad-based disc herniations and large bridging osteophytes at or adjacent to the level of the disc space. An anterior approach offers the most direct access to the cause of the myelopathy in these cases. It also provides access in cases of segmental ossification of the posterior longitudinal ligament (PLL) in which the ligamental ossification is confined primarily to the disc space region and is not contiguous or extending extensively behind the vertebral body.

Multilevel cervical discectomy and fusion is especially indicated for patients with cervical spondylosis who do not have a lordotic spine. Posterior operations usually cannot restore lordosis and, if they do not, posterior decompression is not adequate to decompress a cord draped over the residual anterior osteophyte. Addressing the problem from the front also allows the surgeon to distract and restore disc height, which corrects the in-buckling of the elastic ligamentum flavum. A multilevel discectomy and fusion also provides multiple distraction points and therefore can restore lordosis more effectively than if a multilevel corpectomy approach is used. Lordosis is better achieved with interbody grafting, especially in comparison with a long, straight corpectomy graft such as fibular bone. The trade-off here is that removal of the osteophyte that extends behind the vertebral body is more difficult and time-consuming when an interbody approach is used. However, the same degree of decompression as is achieved with a corpectomy can be reliably achieved using the techniques described here.

**Technique**

**Preparation and position of patient**

If direct laryngoscopy for intubation cannot be easily accomplished in patients with cervical stenosis without hyperextension of the neck, which can worsen myelopathy, indirect techniques, such as fiberoptic intubation, should be used. A dose of antibiotics is given before the start of the operation. The patient is positioned supine with the head of the bed elevated to place the neck above the heart level. This enhances venous drainage and reduces bleeding. The table is flexed so the patient does not slide down toward the foot of the table, and the legs are kept level to avoid venous pooling. We place 10 pounds of halter traction on the head and a rolled towel under the neck to stabilize it. Both arms are encased in stockinette gauze tubing, which is secured with tape starting at the shoulders and wrapped in a loose spiral to below the hands. The stockinette then continues to the end of the table where 5 pounds of weight is applied to each arm. This results in steady gradual traction to allow for consistent fluoroscopic visualization of the inferior end of the cervical spine.

The C-arm fluoroscope is positioned for lateral imaging of the cervical spine and left in place during the whole procedure. To ensure a true lateral image, the C-arm should be positioned so that the facets on each side are superimposed in both cranial–caudal and anterior–posterior directions. The surgeon stands alongside the patient at the level of the torso just caudal to the fluoroscope with the surgical
assistant on the opposite side. This arrangement allows for instantaneous fluoroscopic images as needed throughout any stage of the operation. The operating microscope base is positioned on the cranial side of the fluoroscope and set up with a side observer tube rather than opposing viewing positions. Thus, both the surgeon and the assistant have access to the field at approximately a 45° angle to the sagittal plane for both the macroscopic and the microscopic portions of the operation.

Surgical exposure of the anterior spine

The fluoroscope is used to identify the level for the surgical incision. We prefer our incision to be placed slightly above the midpoint of the extent of surgical exposure, as it is easier to expose inferiorly than superiorly. A skin crease closest to the desired incision level is identified. A horizontal incision will allow access to multiple disc levels by opening the sternocleidomastoid fascia widely. The retractor system is then repositioned as needed to access specific levels. A vertical incision along the sternocleidomastoid can be used in difficult necks, although this incision is not as cosmetic.

The skin is prepared and draped in the usual manner. Local anesthetic with 1:200,000 epinephrine is used to infiltrate the skin. After the skin incision and dissection of the subcutaneous fat, a Weitlaner retractor is used to retract the skin incision, and the platysma is identified, elevated with a curved clamp, and incised with electrocautery. The sternocleidomastoid is identified, and the superficial cervical fascia along its medial border is sharply incised. Extending this opening of the fascia superiorly and inferiorly as far as possible is the key to adequate multilevel vertebral exposure. Blunt finger dissection is then performed in the natural tissue plane between the carotid sheath laterally and the esophagus and trachea medially down to the anterior spine. If the omohyoid muscle crosses the field, it can usually be mobilized for exposure. Rarely, it may need to be bisected. Handheld Cloward retractors are positioned for exposure, and the prevertebral fascia is opened in a cranial–caudal fashion in between the two longus colli muscles down to the level of the anterior longitudinal ligament (ALL).

The appropriate levels of the disc spaces are confirmed with the fluoroscope. The midline can be identified by reference to the medial edge of the two longus colli muscles. By marking the midline with monopolar cautery and reinforcing this with a marking pen (Fig. 1A) above and below the extent of the ALL that will be incised and retracted, the midline can be identified throughout the procedure. This will help proper positioning of the plate later in the procedure.

An incision in the midline is then made with the monopolar cautery through the ALL down to the vertebral body. A small Key periosteal elevator is then used to elevate the ALL and longus colli muscle subperiosteally (Fig. 1B) from the middle of the vertebral bodies laterally to allow for placement of the retractor system. The mobilization of the longus colli muscle should extend over the majority of the vertebral bodies above and below the disc levels to be treated to allow for placement of the instrumentation. The ligament, muscle, and periosteum are elevated together widely over the entire anterior surface of the vertebral body. Care should be taken to minimize shredding of the periosteum, especially if it is adherent to anterior osteophytes that may be present.

A Caspar retractor system using sharp-toothed blades of the shortest length possible is then inserted beneath the longus colli muscle on either side and opened to expose the working field further (Fig. 1C). Sharp-toothed blades will engage tightly into the preserved periosteum/longus colli/ALL layer and are less likely than blunter blades to slip and compress the trachea and esophagus medially and the carotid arteries laterally. At this time, the endotracheal tube

Fig. 1. (A) Exposure of the anterior surface of the spine showing the midline marked in the anterior longitudinal ligament above and below the level of fusion. (B) The periosteum/anterior longitudinal ligament/longus colli complex is elevated with a Key periosteal elevator. (C) Self-retaining retractors are placed under the longus colli muscles, and the distractor is inserted over the distraction pins at the upper level in preparation for the decompression.
cuff is deflated and reinflated by the anesthesiologist to allow the endotracheal tube to recenter itself inside the larynx after the trachea is retracted. This has been shown to reduce the incidence of recurrent laryngeal nerve injury significantly [7].

Before the distraction pins are placed, the anterior osteophytes are removed using bone rongeurs or a high-speed drill. Lateral fluoroscopy is helpful in determining the extent of osteophyte removal down to the anterior margin of the vertebral body. The Caspar distraction posts are then placed under fluoroscopic guidance, aiming perpendicular to the posterior margin of the vertebral body and choosing a length to engage as much of the vertebra as can safely be achieved (Fig. 2, top). The cranial distraction pins are usually positioned at the upper third of the vertebral body to be fused and the caudal pins are placed at the lower third of the vertebral body, thereby avoiding any overlap in the permanent screw positions. Intervening pin placement is usually centered in the vertebra. The pins will often not be parallel to one another because of the degeneration of the spine. After the disc space is emptied, cervical lordosis will be restored as distraction is applied (Fig. 2, bottom). The use of these distraction pins is an important and powerful tool whose value is often underestimated. Their use increases disc space height (and hence access) as well as restores lordosis. The distraction posts also help retract the soft tissues at the extremes of the incision so we usually do not need to use cranial–caudal retractors. For extensive multilevel exposure, we usually place three posts and treat two interspaces including grafting, then move to the other interspaces, removing the initial posts and placing the remaining ones as needed.

Removal of disc and preparation of end plates

We usually begin the discectomy at the highest disc level to be addressed and proceed inferiorly. The distractor is placed over the post above and below the disc level, and distraction is applied. The disc annulus is incised in a rectangular fashion with a #15 blade, and a pituitary rongeur is used to perform the initial discectomy. Angled curettes are then used to evacuate the nucleus pulposus and remove the cartilaginous end plates. As the discectomy progresses, additional distraction is applied to maximize the restoration of lordosis and height of the disc space.

The end plates are then flattened so that the later grafting can be done with a parallel-sided graft that will be in close apposition over its entire surface to achieve a “gapless” graft position. This involves shaping the vertebral end plates with a high-speed drill using magnified vision, preferably with the operating microscope, as it provides superior visualization and illumination. The microscope also allows the assistant to have good magnified vision without interfering with the surgeon’s view. In addition, a video image is obtained to allow the scrub nurse to see the surgery and thereby assist more effectively.

The superior end plate of the disc space is usually cup shaped. To flatten it, the anterior portion in front of the central depression is removed using repetitive side-to-side stroking movements of the drill to create a flat surface from one side of the vertebral body to the other (Fig. 3). Once the anterior portion is flattened (Fig. 4C), we can often see residual cartilaginous end plate and we will remove it with a curette. The microscope is then positioned so that the field of view is coaxial with the end plate (Fig. 4H). This helps create the desired flat surface as protruding irregularities are easily seen and removed. The posterior part of the superior end plate of the disc space is then resected (Fig. 4D) as needed to flatten it down to the PLL. Again, gentle side-to-side sweeping movements of the drill are used.

We then turn our attention to the inferior surface of the disc space. It generally slopes cranially at its depth and may also have an upward curve at the lateral ends. Using the flattened superior end plate as a visual reference, the inferior end plate is shaped to be parallel to the superior from side to side, and then flattened to be anterior–posteriorly parallel to the already flattened superior end plate. This
involves resecting increasing amounts of bone as the resection proceeds into the depth of the interspace (Fig. 4E). Progress can be checked frequently with the fluoroscope, which aids in achieving perfectly flattened parallel end plates.

**Decompression of the spinal canal and foramen**

As the end plate recontouring is completed to the level of the PLL, a substantial portion of the osteophytic protrusion into the spinal canal will have been removed. The PLL provides protection for the neural elements as this is being done. Light pressure with the drill will progressively thin down and remove the bone to the PLL. The end plates can then be undercut 1–2 mm with the drill to start to remove residual osteophytes behind the margins of the vertebrae (Fig. 4F).

It is important that the vertebral bone removal be done to almost the full width of the interspace to resect the enlarged uncinate processes and uncinate spurs bilaterally. At the lateral margins of the interspace posteriorly, we use the drill to complete the removal of the disc and open the neural foramina laterally, in essence beginning an anterior foraminotomy, which will then be completed with curettage. We avoid downward pressure of the drill in this region to avoid additional pressure on the root that is exiting in an anterior oblique angulation through the foramen.

We then complete the removal of the osteophytes and complete the spinal canal decompression with curettage using a series of angled curettes. Initially, a 5-0 angled curette is used to separate the PLL from the vertebrae and begin the bone removal. A standard 9-inch curette is adequate for this but does not allow enough force to be applied to remove dense osteophytes. We then switch to a 4-0, 45° up-angled, longer curette (12” handle) to work on the superior vertebra and also the foramen bilaterally. To complete the removal of the superior osteophytes (Fig. 4I) and for all of the inferior vertebral osteophyte removal (Fig. 4J), we use 12-inch 4-0 curettes with 90° angulation to minimize intrusion into the spinal canal. These curettes are available with three different “reaches”—that is, increasing length from the shaft to the cup of the curette. These are used in sequence behind the inferior and superior vertebrae.

The technique of curettage is not immediately intuitive but is easily learned. Initially, the instrument is placed behind the vertebra very delicately. One feels with it as though one were using a microdissector and in this manner gains useful information about the anatomy of the osteophytes. It should never be forced. If it cannot be fit in to its full reach, partial cuts at less than full depth are initially used and then the instrument is advanced. The cutting action of the curette is achieved with a rotatory motion about the shaft of the instrument, not by a side-to-side translation. The cutting occurs between the tool and hard underlying bone and so requires that the tool be held very firmly against the bone. The technique therefore is to insert the tip gently, and then pull the tip very firmly up against the vertebral body while rotating the instrument (Fig. 5). The upward pull is relaxed just as the tip emerges from behind the body. We usually start in the middle and move to each side by reinserting the curette at or just behind where it emerges from the previous cut. At the ends of the
interspace, the rotation is toward the midline to protect the roots. Sequentially longer-reach curettes are used as dictated by the extent of the osteophytes. The longest curettes will reach to just beyond the middle (vertebral height) of most vertebrae. Additional osteophytes beyond that distance are approached from the adjacent interspace.

As we work and once sufficient decompression has been achieved, hemostasis is obtained using Gelfoam slurry (Gelfoam powder mixed with thrombin), which is placed in the disc space and tamponaded into the epidural space with a cottonoid patty. This is repeated as needed. This will usually stop bone bleeding as well, but any residual bony bleeding from the posterior vertebral body can be stopped using wax applied to the site with an angled Caspar periosteal elevator. Any excess wax is then removed. We try to avoid use of wax on the interbody surfaces because it may hinder fusion. Epidural veins and bleeding from the PLL can also be cauterized using an angled bipolar tip at a low power setting.

Graft selection and insertion

Many types of grafting material have been used in the interspace. Because the goal of grafting is to achieve a solid fusion to provide structural support, bone (allograft or autograft) is the ideal material. It becomes living bone that matches the strength and elasticity of the adjacent bone, responds to stress by becoming stronger, and is self-repairing [8]. Synthetic materials lack all of these properties. They may be a poor biomechanical match with the adjacent bone and, if too dense, may erode into the vertebral bodies. They may also stress-shield the adjacent graft and cannot repair themselves if damaged. Cages and similar devices occupy space that could, and in our opinion should, be occupied by bone. The authors prefer to use allografting, and in particular, tricortical iliac crest bone, because it is an excellent biomechanical match that provides a cortical shell for support and a cancellous core for early incorporation. It also avoids donor site problems and pain. Tricortical iliac crest allograft, when used in a two-level anterior cervical fusion without plating, had a significantly lower fusion rate of 37% as compared with 83% for autograft [9], and is more likely to collapse [10]. However, when used with anterior cervical plating, allograft results in a fusion rate equal to that of autograft [11] and superior to noninstrumented autograft fusions [12]. It is important, however, to use allograft bone that has not been subjected to high-dose radiation (>3 megarads), as this substantially weakens the graft [8]. Regardless of the material chosen, the graft should ideally fill most of the prepared interspace, which in the middle to lower cervical spine will typically be 18–22 mm wide and 14–18 mm deep.

The Caspar adjustable calipers are used to measure the height, width, and depth of the prepared disc space to determine the size of the graft. An allograft of the desired width is then precisely cut to the correct height to fit snugly into the distracted interspace using a parallel-bladed reciprocating saw. The graft depth is trimmed to a length approximately 1 to 2 mm short of the measured depth of the interspace.
Once fashioned, the tricortical graft is inserted with the cortical surface toward the anterior margin of the vertebral body and the noncorticated surface toward the dura mater and gently tapped into position. We pass a nerve hook bilaterally and palpate the back of the graft, checking with fluoroscopy to verify that it has not rotated and sits in good position. The distraction is then released. This process is repeated at each level. If the fusion involves more than two levels, we first complete the decompression and grafting of the upper levels and then remove the distraction pins at these levels and relocate the retractor to expose the lower levels. Once the decompression is completed at these levels, we complete our fusion with bone grafting placed first in the lowest disc space to allow a more generous graft at that level, which is exposed to the most stress. We then proceed with inserting the remaining bone grafts in a caudal to cranial direction.

Plating and screw placement

Many cervical plating systems are currently available. We prefer a dynamic plating system that does not restrict settling. Dynamic plating systems allow for true load sharing on the bone graft, because the forces working on the bone graft include the axial load from the weight of the head and the cervical muscle forces [13,14]. Over time, these forces are maintained even when the grafts are partially absorbed as part of the normal bone-healing process. This axial loading seems to encourages faster and more complete bone incorporation and therefore a higher rate of fusion [15].

Placement of the ABC (Aesculap, Tuttingen, Germany) dynamic plating system is described below. Before the start of plating, the distraction pins are removed and the pin holes are waxed for hemostasis. The shortest plate possible is preferred. We choose a plate that covers no more than half of the upper and lower vertebral bodies to be fused. As settling occurs in the first month or two, this shorter plate will extend over a greater extent of these vertebral bodies but will be less likely to encroach over the adjoining disc spaces. The plate length and alignment are verified with fluoroscopy. Any residual anterior osteophytes are removed to allow the plate to sit flat on the anterior surface of the vertebrae. Any additional contouring of the plate that is needed is performed using the system’s benders to ensure that the plate lies flush against the anterior spine surface. The plate is then aligned using the previously placed midline markings, and temporary pins are placed at both ends to hold the plate in position.

The two most cranial screws are aimed upward and inward to increase holding strength and the most caudal screws are aimed downward and inward. A double-barreled drill guide, which creates convergent trajectories for the screws, is used. The holes can be drilled or made with a starter awl, but in either case, it is best to use fluoroscopic control to optimize the position and angulation with the vertebrae. When unicortical screws are used, the drill or awl hole is usually placed to a 14-mm depth using the fixed-depth drill guide. The fluoroscopic image of the drill depth in the bone allows one to choose the best screw length, which typically ranges from 14 mm to 18 mm but can vary. Ideally, we prefer to use a screw length that traverses approximately 75% to 80% of the vertebral body depth. These screws are self-tapping. When bone density is poor, bicortical screws are preferable for their greater pullout force; these are drilled with the adjustable-depth drill guide, which allows the depth to be increased in 0.5-mm increments. This allows the drilling to progress safely under fluoroscopic control until the posterior cortex is attained. The bicortical screws are blunt tipped and not self-tapping, so the pilot hole is also tapped under fluoroscopic control before they are placed. Rescue screws with a larger diameter are also available if the initial screw torque is suboptimal.

After all screws are in position, the locking mechanism of each screw is engaged to prevent back-out of the body or plate, while allowing axial settling to occur. The most recent version of this system uses self-locking screws. In the previous version, a locking tool engages the internal...
locking pin and pulls the pin up into the locked position. The temporary plating pins are then removed, and the holes are waxed for hemostasis as needed.

Closure

Before closure, the wound is irrigated copiously with antibiotic solution to clean out any debris, blood, or devitalized tissue fragments. The retractor system is removed one blade at a time. The longus colli is repositioned over the lateral edge of the plate. Using the handheld Cloward retractor, each layer of tissue is inspected for bleeding or damage before closing with sutures. Once hemostasis is achieved, we close in several layers and usually do not use drains. The sternocleidomastoid muscle fascia is brought together with 2-0 Vicryl absorbable sutures (Ethicon, Inc., Somerville, NJ), and the platysma is reapproximated with 3-0 Vicryl sutures. The skin is closed with 4-0 Monocryl absorbable sutures (Ethicon, Inc.) using a subcuticular stitch and reinforced with benzoin and Steri-Strips (3M, St. Paul, MN).

Complications

Complications occurring with multilevel cervical disectomy approaches can be related to injuries to the soft tissue during dissection or to the neurological elements. In addition, postoperative fusion or hardware failure can occur. Among injuries related to dissection and mobilization of soft tissue in the neck, recurrent laryngeal nerve injury and swallowing difficulties are the most common postoperative problems. The reported incidences vary widely from 0.07% to 11% [16,17] to as high as 24.2% [20]. Baron et al. [19] calculated the overall incidence reported in the literature as 12.3% for dysphagia, 4.9% for hoarseness, and 1.4% for unilateral true vocal fold motion impairment. Most laryngeal nerve injuries are transient, lasting weeks or months, and are now recognized as most commonly attributable to compression of the recurrent laryngeal nerve within the endolarynx rather than to injury within the soft tissue of the neck. The maneuver of deflating and reinflating the endotracheal cuff can significantly lessen the incidence of this complication. The temporary occurrence rate fell from 6.8% to 1.7% when the maneuver was applied. The permanent vocal cord paralysis rate was 0.3% [7].

The incidence of dysphagia can be as high as 50–67% [18,19] after an anterior cervical procedure. Edwards et al. [22] emphasized that it is frequently underreported. It is usually transient, however, with residual symptoms decreasing to 4.8% after 6 months [23] and 23% at 10 months [23]. Although it appears to occur more frequently in anterior approaches, dysphagia may not be specific to them as it also is reported in 20% of patients who had posterior operations [23]. Instrumentation has not been shown to increase the risk of dysphagia [23–25]. It has been noted that older patients have a higher risk of developing dysphagia [21,24] and that, when tested, many of these older patients have preexisting but subclinical swallowing dysfunction preoperatively [17].

This problem appears to be related to esophageal motility dysfunction secondary to or exacerbated by retraction. Intermittently releasing the retractors to decrease soft-tissue compression has been suggested to try to reduce this problem. Most people experiencing this complication will complain that solid or dry food gets stuck in the process of swallowing. In these cases, diet modification until full recovery is recommended and, if dysphagia is very severe, a temporary feeding tube may be used to supply adequate nutrition. Perforations of the esophagus and trachea are very rare injuries that may be avoided by proper placement of the retractor blades underneath the periosteum/PLL/longsus colli.

Other complications relating to anterior cervical surgery include injuries to the vertebral artery and dural tears. Vertebral artery injury is rare and usually is related to an ectatic nature of the vessel. It is more common in corpectomy than in a discectomy [26]. Dural tears are also rare, but in cases of ossification of the PLL, the ossification may involve the dura mater, which may need to be resected. In such cases, primary closure is not usually possible so the defect is covered with fascia lata or other suitable dural substitute. We seal this with fibrin glue and place several layers over the dural defect. A lumbar drain is then placed to divert the cerebral spinal fluid and reduce pressure on the surgical site for approximately 3 days.

Neurological complications relating to surgery have been reported to occur in 0.3% of patients [27] who have had anterior cervical surgery and up to 5.5% in another series that included posterior operations for cervical myelopathy, which is known to have a higher neurological complication rate than anterior operations [28–30].

Spinal nerve root deficits are more common than cord injury. Many authors [18,31–33] have reported postoperative C5 radiculopathy, which may be immediate or delayed. The cause of this is unknown. It has been hypothesized to be possibly related to graft complications or to a tethering effect on the nerve root when the spinal cord shifts as it is decompressed. It occurs in both anterior and posterior approaches, with a higher incidence in posterior surgical techniques. Direct nerve root injury is rare but also can occur if orientation is lost or drilling is not done with proper technique.

Complications relating to bone grafting and plating include nonunion, and late failure such as graft collapse, fracture, or extrusion. Loss of alignment, plate breakage, and screw breakage or backout may also occur. The introduction of plating has increased the rate of fusion in multilevel discectomy and arthrodesis [34–37]. Emery et al. [38] reported a 6.9% rate of pseudoarthrosis in 108 patients treated with anterior cervical discectomy and fusion for cervical spondylotic myelopathy. Earlier rigid plating systems used in multilevel corpectomies have been reported
to have a construct failure rate of 10–16%, whereas the ABC dynamic plating system had no hardware failures [39]. Screw or plate breakage does not occur because the screws and plate are not under load in this dynamic system. In addition, dynamic plating that allows for subsidence has decreased the nonunion rate. In the senior author’s initial reported experience, 93% fusion was achieved at 12 months and the fusion rate reached 100% at 24 months using very stringent criteria [40]. Graft extrusions, which have been reported in noninstrumented fusion, are also eliminated by plating [41].

**Bracing**

We do not routinely use postoperative bracing when this approach is used and especially when dynamic plating systems are used. With dynamic (load-sharing) plating, compression is maintained on the graft, which, in addition to its other aforementioned benefits, results in a stronger initial construct [14]. The authors prefer that the patients use their neck muscles to regain neck mobility and strength, which can best be achieved when no bracing is used. Infrequently, however, if the bone quality is of serious concern, a rigid external collar for 6–8 weeks may be used. This is in contradistinction to the practice of many surgeons [42]; however, we have seen no adverse affects and believe it improves the patients’ sense of well-being and facilitates their recovery.

**Conclusion**

Multilevel cervical discectomy and fusion is an appropriate technique for treatment of cervical myelopathy. It allows restoration of the spinal canal and neural foramen to normal dimensions to decompress the spinal cord and nerve roots. It is especially useful in cases of spondylosis that have a kyphotic deformity because, in addition to anterior decompression, it allows reconstruction of the spine to help restore a lordotic curvature (Fig. 6). Lordosis is easier to achieve and maintain because of the multiple points of distraction and fixation in addition to the graft and interbody space shaping. Fusion rate may also be improved with the shorter grafts, so that late failures can be avoided. In addition, an external orthosis is usually not necessary.

This approach is more labor-intensive and time-consuming than other approaches but has proven to be very effective in decompressing and stabilizing the spine. For all of these reasons, multiple cervical discectomy for treatment of cervical spondylotic myelopathy has become our technique of choice.

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**References**


