Surgical Decision Making in Cervical Spondylotic Myelopathy: Comparison of Anterior and Posterior Approach

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LEARNING OBJECTIVES: After participating in this CME activity, the spine surgeon should be better able to:
1. Describe the advantages and disadvantages associated with anterior and posterior approaches for treatment of cervical spondylotic myelopathy.
2. Evaluate clinical evidence concerning anterior and posterior techniques for the treatment of cervical spondylotic myelopathy.

Anterior Approach Techniques

Degenerative disc disease of the cervical spine is a common phenomenon associated with aging. It begins with a tear in the intervertebral disc. Subsequent degeneration results in the eventual loss of disc height altering the stability and structure of the vertebral level. These common structural changes may result in spinal canal narrowing and pathologic changes at adjacent levels. Although degenerative disc disease is often asymptomatic, significant compression of the spinal cord may lead to symptomatic cervical spondylotic myelopathy (CSM), commonly presenting as loss of fine motor control, incontinence, spasticity, and gait imbalance.

Given the degenerative nature of the pathologic process, CSM is frequently observed in older adults, is reported to be the most common cause of myelopathy in patients older than 55 years, and is the most common cause of spinal cord dysfunction in the world. Although the precise incidence and prevalence of CSM are not available in the literature, it is estimated that 1.6 of every 100,000 individuals are surgically treated for this condition. This statistic suggests that the number of individuals who experience CSM is much higher.

Preferred initial treatment for CSM includes nonoperative modalities such as physical therapy; anti-inflammatory medications; and in some cases, a cervical collar. However, refractory cases may require surgical intervention. Current literature has demonstrated surgical decompression of the cervical spine to improve functional outcomes in patients with CSM.

Decompression can be achieved via an anterior or a posterior approach; each method of decompression has its own advantages and disadvantages. To our knowledge, there are no published randomized controlled clinical studies that compare the two approaches directly, which prevents clear conclusions from being drawn. Therefore, this review aims to summarize the current literature regarding anterior and posterior approaches for the treatment of CSM, with specific emphasis on comparing treatment safety and efficacy.

Anterior Approach Techniques

The anterior approach to the subaxial cervical spine for cervical spondylosis is
often referred to as “direct” decompression, denoting the direct access to the compressive, symptomatic osteophytes and degenerative disease of the anterior column. Surgical techniques using the anterior approach include anterior cervical discectomy and fusion (ACDF) and anterior cervical corpectomy and fusion (ACCF).

Apart from “direct” decompression, other purported advantages of the anterior approach include the capacity for deformity correction and facilitated fusion. Cervical kyphosis is a commonly observed deformity in patients with CSM. Animal models have associated cervical kyphosis with demyelination and neuronal loss,7 supporting theories that correction of cervical kyphosis may lead to more favorable postoperative outcomes.9 An anterior approach to the neck allows for correction of the sagittal alignment of adjacent vertebral bodies, thus reducing the kyphotic deformity. Another advantage of anterior fusion is indirect opening of the foramina through manipulation of the intervertebral disc space.9

Choosing between ACCF and ACDF can be challenging. Earlier studies demonstrated higher adverse event rates with ACCF compared with ACDF.10-13 However, incomplete decompression was observed more frequently with ACDF because of a narrower surgical window.10 In a study of 46 patients treated with either ACDF or ACCF, Liu et al14 observed no differences in fusion rates at 3 months and comparable mean Japanese Orthopaedic Association (JOA) scores at a minimum follow-up of 5 years. The study demonstrated, however, that ACDF was associated with greater segmental lordosis at final follow-up compared with ACCF. In a meta-analysis of 6 studies, Xiao et al15 concluded that patients undergoing ACDF or ACCF experience similar postoperative JOA scores, fusion rates, and myelopathic outcomes at last follow-up. Despite these similar outcomes, ACDF resulted in improved cervical lordosis and less perioperative morbidity than ACCF. Similarly, in a larger meta-analysis of 15 studies and 1368 patients, Wen et al16 reported that despite increased perioperative adverse events and blood loss with ACCF, no differences in postoperative JOA or visual analog scale pain scores were observed.

On the basis of the available literature, there is no definitive evidence to recommend ACDF or ACCF as superior for treatment of CSM. The decision to perform either procedure should be made on an individual patient basis, taking into consideration the specific location of the pathology and the patient’s health. ACDF is probably better for isolated disc herniations, whereas ACCF is effective for patients with spondylotic changes most pronounced on the posterior aspect of the vertebral body.17

**POSTERIOR APPROACH TECHNIQUES**

In contrast to the anterior approach, posterior techniques “indirectly” decompress...
the spinal cord by releasing the posterior elements, allowing posterior spinal cord drift and subsequent relief of anterior compression (Figures 1–3). Although posterior decompression is an effective method for many patients, those with significant cervical kyphosis may experience insufficient decompression because of the limited potential for posterior spinal cord drift.18

Generally, two procedures for CSM are performed via the posterior approach: (1) cervical laminectomy and fusion (CLF); and (2) expansile cervical laminoplasty (ECL). Traditionally, laminectomy without fusion also was used; however, this technique was abandoned because of concerns of subsequent development of kyphotic deformity. Several studies have compared CLF and ECL with conflicting results. Small institutional studies with fewer than 30 patients by Heller et al19 and Manzano et al20 demonstrated less improvement in Nurick scores (an objective measurement of myelopathic symptoms) with CLF compared with ECL. In addition, Heller et al19 demonstrated higher adverse event rates in the CLF cohort. In contrast, in a larger retrospective study, Woods et al21 reported no differences in rates of adverse events and revision surgery between matched cohorts of 82 patients with CLF and 39 patients with ECL. Similarly, Lee et al22 performed a meta-analysis comparing 290 patients with CLF and 302 patients with ECL, concluding that both techniques demonstrated similar symptomatic improvements.

Analogous to the comparison of anterior techniques, CLF and ECL seem to provide similar outcomes. Therefore, the decision as to treatment technique should be made on an individual basis, taking note of radiographic factors that may complicate the procedure.

**COMPARISON OF ANTERIOR AND POSTERIOR TECHNIQUES**

Although the literature demonstrates few differences in the various techniques used from the same approach (anterior or posterior), determining whether to perform an anterior or posterior technique depends on several factors. These can be organized into two general categories: efficacy and adverse events.

**Efficacy**

Postoperative functional outcomes frequently are used as a determinant of surgical efficacy. Several studies comparing postoperative neurologic recovery and functional improvement have been unable to demonstrate clinically or statistically significant differences between anterior and posterior approaches. Kawakami et al23 compared two cohorts: patients with 1- or 2-level pathology and no spinal canal stenosis who were treated with ACDF; and patients with more than 2 levels of pathology or with spinal canal stenosis who were treated with posterior laminoplasty. Despite significant variation in preoperative diagnosis, the authors were unable to demonstrate significant differences in patient recovery rates when comparing anterior and posterior approaches.21 In a comparison of 169 anterior and 95 posterior approaches, Fehlings et al24 reported no significant differences in neurologic recovery.24 Similarly, Wada et al25 followed-up patients with multilevel CSM treated with subtotal corpectomy or laminoplasty for 5 years and observed no statistically significant difference in average JOA scores. Most recently, Li et al26 demonstrated that adjusted mean postoperative JOA score, JOA score improvement, and recovery rate were not significantly different when comparing anterior and posterior approaches.

Although the studies mentioned reported equivocal functional outcomes, several studies have conflicting results. Hirai et al27 observed higher mean JOA scores and improved recovery rates at the 2-, 3-, and 5-year follow-up visits after ACDF compared with ECL. In a 2011 study by Ghogawala et al,28 the anterior approach was associated with greater improvements in quality of life, as assessed using the Short Form-36 survey Physical Component Score, despite both approaches resulting in similar postoperative mean JOA disability scores. In contrast, Seng et al29 observed greater improvement in JOA scores and lesser improvement in neck disability index scores at 6-month follow-up in patients treated with laminoplasty compared with those treated with ACDF.
However, there were no significant differences in functional outcomes at 2-year follow-up.\textsuperscript{29} Cunningham et al\textsuperscript{30} performed a meta-analysis of four studies, reporting no significant differences in postoperative JOA scores or recovery rates when comparing patients who underwent laminoplasty versus ACDF. In contrast, Jiang et al\textsuperscript{31} performed a meta-analysis of 13 studies and demonstrated higher postoperative JOA scores and neurologic recovery rates after ACDF or ACCF compared with laminoplasty.

Although several studies have demonstrated equivalence throughout follow-up and others have suggested that anterior approaches may be more effective than posterior approaches, evidence as to which approach results in superior postoperative neurologic outcomes has not yet been reported.

**ADVERSE EVENTS**

The most commonly discussed adverse events associated with surgical treatment of CSM include airway compromise, dysphagia, dysphonia, and C5 nerve palsy; however, procedural blood loss and postoperative wound infection rates also must be considered. Although anterior exposure of the cervical spine involves more complex and potentially dangerous anatomy, which in theory means more technical expertise is required compared with treating similar pathology from a posterior approach,\textsuperscript{9} current literature with regard to exposure-related adverse events provides inconclusive results.

Variability in the invasiveness of each technique and approach factor heavily into estimated blood loss (EBL). Supported by Hirai et al\textsuperscript{27} and Wada et al,\textsuperscript{25} the reduced requirement for soft tissue dissection and bony resection associated with laminoplasty compared with ACCF resulted in a decreased EBL in the ACCF population. In contrast, Seng et al\textsuperscript{29} demonstrated reduced EBL in patients treated with the anterior approach as compared with laminoplasty. Of note, the majority of the anterior approach cohort was treated with ACDF, which is expected to have reduced blood loss compared with ACCF. However, it is conceivable that manipulation of the highly vascular cervical paraspinal musculature for laminoplasty would result in greater blood loss than ACDF.

Decompression of the spine is generally associated with a low infection rate; however, studies suggest this rate may be increased after a posterior approach. In a prospective multi-institutional study of 302 patients, Fehlings et al\textsuperscript{32} observed wound infections in 4.7% of patients treated with the posterior approach compared with 0.6% of patients treated with the anterior approach. Despite this observation, several other studies have reported little difference in approach-related wound infection rate.\textsuperscript{6,26,29}

Overall, the anterior approach is associated with increased rates of adverse events after treatment of single- and multilevel CSM.\textsuperscript{33,34} However, greater rates of C5 nerve palsy have been associated with the posterior approach. A recent meta-analysis by Shou et al\textsuperscript{15} reported the posterior approach to be associated with a 5.8% rate of C5 nerve palsy compared with 5.2% in patients treated via an anterior approach. Posterior laminectomy and fusion procedures were associated with the highest rate of C5 nerve palsy (11.0%), whereas ACDF was associated with the lowest rate (3.3%).\textsuperscript{35}

**OPPORTUNITIES FOR FUTURE RESEARCH**

Our summary of the literature highlights the uncertainty regarding the selection of an anterior or posterior approach. Overall, current literature and clinical studies have demonstrated relative equivalence in both efficacy and adverse event rates. Therefore, future research should focus on prospective randomized trials comparing homogeneous populations to determine long-term outcomes and approach-related revision and adverse event rates, as this may result in a clear distinction between approaches.

**CONCLUSION**

Clinically acceptable outcomes with regard to efficacy and adverse event rates have been observed after anterior and posterior decompression. However, there is no definitive evidence to support one approach over the other. Ultimately, clinical and radiographic presentation, along with the unique comorbidity profile of each patient, will determine which approach is most appropriate. Surgeons should consider the location of pathology, number of levels that require decompression, and bone quality when considering approaches.

**REFERENCES**


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1. You are considering anterior cervical fusion for a 59-year-old woman with CSM. Which one of the following outcomes has not been demonstrated with ACDF versus ACCF?  
A. Improved cervical lordosis after ACDF  
B. Less perioperative morbidity after ACDF  
C. Greater blood loss after ACCF  
D. Increased postoperative pain after ACCF  
E. Increased risk for adverse events after ACCF

2. CSM can be treated by all of the following anterior or posterior approaches except  
A. ACDF  
B. laminectomy without fusion  
C. cervical laminectomy and fusion  
D. ACCF  
E. expansile cervical laminoplasty

3. You evaluate a 58-year-old man who is myelopathic. His MRI scan reveals cord compression, mostly from a large extruded disc fragment from the C5-C6 disc that has migrated caudally behind the C6 vertebral body. Which one of the following is the best approach in this case?  
A. ACDF  
B. Laminoplasty  
C. Laminectomy  
D. ACCF  
E. Combined anterior-posterior

4. Postoperative radiculopathy is a known adverse event of posterior decompression in the treatment of CSM. One potential mechanism is thought to be tethering of the nerve root with dorsal migration of the spinal cord. Which one of the following is the most common radicular pattern seen with this condition?  
A. Sensory-dominant with pain in the lateral shoulder  
B. Sensory-dominant with pain in the lateral forearm  
C. Motor-dominant with weakness of the triceps  
D. Motor-dominant with weakness of the wrist extensors  
E. Motor-dominant with weakness of the deltoid

5. With regard to question 4, to which one of the following nerve roots does this palsy correspond?  
A. C3  
B. C4  
C. C5  
D. C6  
E. C7

6. A 61-year-old woman presents with worsening myelopathic symptoms, for which she recently had to start using a wheelchair. Radiographs reveal maintained cervical lordosis. MRI reveals cord compression from 4 disc levels. Which one of the following is the most appropriate treatment?  
A. Laminoplasty  
B. Multilevel ACCF with stabilization  
C. Continued nonoperative treatment  
D. Multilevel ACDF with stabilization  
E. Laminectomy alone

7. A 60-year-old woman presents with 24 months of increasing clumsiness in her hands. On physical examination, she is frankly myelopathic. She has 5/5 strength in all of her major muscle groups. MRI reveals cerebrospinal fluid effacement and retrodiscal cord compression at C5-C6 and C6-C7. Which one of the following is the most appropriate treatment?  
A. Laminectomy at C5, C6, and C7  
B. Foraminotomy at C6 and C7  
C. Physical therapy and an epidural corticosteroid injection  
D. C5-C6 and C6-C7 ACDF  
E. Physical therapy, close observation

8. Which one of the following techniques may be associated with improved clinical outcomes for treatment of CSM?  
A. ACDF  
B. ACCF  
C. Anterior cervical arthrodesis  
D. Posterior cervical arthrodesis  
E. Laminoplasty

9. Which one of the following scenarios provides the strongest indication to perform a combined anterior-posterior decompression for multilevel CSM?  
A. Postlaminectomy kyphosis of 20 degrees  
B. Ossification of the posterior longitudinal ligament occupying 30% of the canal  
C. Herniated discs at 2 continuous levels  
D. Herniated discs at 3 continuous levels  
E. Cervical kyphosis of 5 degrees

10. A 68-year-old woman presents with a loss of manual dexterity; a broad-based, shuffling gait; and exaggerated deep tendon reflexes in the lower extremities. Radiographs reveal an overall cervical kyphosis of 15 degrees. Which one of the following is the most appropriate treatment?  
A. C3-C6 laminectomy and fusion  
B. C3-C6 laminectomy  
C. C3-C6 laminoplasty with plate fixation  
D. Multilevel ACDF with stabilization  
E. Immobilization in halo traction for 4 weeks, followed by physical therapy