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Surgery Versus Conservative Care for Cervical Spondylotic Myelopathy: Surgery is Appropriate for Progressive Myelopathy

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Cervical spondylotic myelopathy (CSM) is the most common cause of spinal cord dysfunction.¹ The condition presents insidiously and is defined in terms of its clinical symptoms (gait instability, bladder dysfunction, fine finger motor difficulties) and signs (hyperreflexia, weakness, alteration of joint position sense). CSM is caused by dynamic repeated compression of the spinal cord from degenerative arthritis of the cervical spine.² Proposed mechanisms include axonal stretch-associated injury² and spinal cord ischemia from compression of larger vessels and impaired microcirculation.^{3,4} Surgery to decompress and stabilize the spine is often advocated for severe or progressive symptoms, with mixed results. About two-thirds of patients improve with surgery, while surgery does not result in improvement in 15%-30%.⁵ Over 112,400 cervical spine operations for degenerative spondylosis are performed annually in the US (100% increase over the past decade),⁶ with CSM accounting for nearly 20% of cervical spine operations in the US.⁷ Annual hospital charges for CSM surgery exceeds 2 billion dollars per year.⁶ In addition, CSM is associated

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with substantial postoperative outpatient expenses (e.g., physician visits, imaging, physical therapy, medications).

Recently, the Institute of Medicine designated CSM as one of the top 100 national health research priorities for comparative effectiveness research.⁸ There is a great need for modern prospective studies with validated outcomes tools to assess the effectiveness of surgical treatments for CSM. Most American cervical spine experts (both orthopaedic and neurological surgeons) believe that there is sufficient clinical equipoise to support a comparative randomized clinical trial (RCT) if the study population is carefully defined.⁹

Most experts feel that surgery can prevent the progression of spinal cord dysfunction and can, in many cases, improve the symptoms of cervical spondylotic myelopathy. It is unclear, however, what the optimal surgical technique might be (ventral versus dorsal), and in up to 30% of cases the clinical outcome is not satisfactory.⁵ Furthermore, the complication rate for CSM surgery is high (17% in a recent prospective study),¹⁰ particularly in patients over 74 years of age,¹¹ which is a growing segment of the US population.¹² Lastly, the 5-year re-operation rate following surgery for CSM is nearly 15%.¹³

Surgery for CSM

Today, the choice of strategy for the management of CSM provokes debate and discussion at academic meetings year after year. The most significant issue is whether to perform a ventral or dorsal procedure. Most neurological and orthopaedic surgeons recommend surgical treatment for CSM, although rigorous high quality RCTs have not been performed comparing surgery with conservative care. The clinical question in most situations is whether surgery can be performed without major complications.

Pathophysiology and Rationale for Surgery for CSM

Historically, spinal cord compression resulting in ischemic injury was thought to be the major mechanism responsible for the symptoms of CSM. More recently, axonal stretch and axial strain mechanisms in the context of repetitive spinal motion have been hypothesized to be responsible for the development of CSM.² Spinal cord ischemia from compression of larger vessels is another proposed mechanism.^{3,4} The natural history of CSM is variable. Many patients with mild CSM can be followed for years without surgery. Surgery is often advocated for patients with progressive or more severe symptoms. Older series have found that approximately two-thirds of patients improve following surgery, while surgery fails to result in improvement for 15-30% of patients.⁵ Some series report clinical worsening following surgery.⁵

In the twentieth century, laminectomy alone, without stabilization, was a major treatment option utilized for treating some patients with CSM. The first cervical laminectomy for spinal cord injury was performed in 1828.^{14,15} Today, laminectomy without stabilization is still utilized, but several factors have limited its widespread use. The development of instability and/or postoperative kyphotic deformity can be a problem in some cases. Therefore, many surgeons choose to stabilize the cervical spinal column when performing a laminectomy by adding posterolateral fixation with lateral mass or pedicle screws and

fusion. Some surgeons prefer to perform a cervical laminoplasty, which enlarges the spinal canal without fusing or removing the laminae, possibly reducing the risk of late failures. Dorsal procedures are sometimes limited because of the inability to address and remove ventral compressive osteophytes. In 1985, Fessler et al, suggested that ventral corpectomy surgery might be superior to dorsal decompression.¹⁶ Enthusiasm for ventral surgery has been tempered to some degree by the number of complications following multi-level corpectomy procedures.

Today, there exists considerable debate regarding the optimal approach for surgery (ventral versus dorsal) when treating CSM. While ventral corpectomy is an important strategy in some cases, multi-level anterior cervical discectomy and fusion (ACDF) has also been utilized with satisfactory results (Figure 1). Alternatively, dorsal procedures, which have been advocated, include laminectomy alone, laminectomy with lateral mass/pedicle screw fixation and posterolateral fusion, and laminoplasty.

Comparative Studies - Mixed Results for Surgery

Two small prospective studies have been performed comparing operative treatment to conservative treatment for cervical spondylotic myelopathy.^{17,18} Kadanka and colleagues, in 2000, published their results of a small RCT (48 patients) comparing surgical treatment versus non-operative treatment for CSM.¹⁷ Using the modified Japanese Orthopedic Association (mJOA) disease-specific tool as the primary outcome measure, they found no difference between patients treated with surgery versus no surgery over 2 years follow-up. In this study, no improvement was observed in the mJOA scores in either cohort. It was surprising that surgery did not improve outcome. Many in the conservative group were treated with collar immobilization. This study was useful in demonstrating that many patients with mild CSM are stable for at least 2 years. The major weakness of this study is that it was underpowered and no sample size calculation was reported in the manuscript. In addition, two years might not be an adequate duration of follow-up for this population. In the same year, another group published a prospective study of 43 patients comparing surgery to conservative care.¹⁸ This group found surgery resulted in superior outcomes at 11.2 months using the Cervical Spine Research Society (CSRS) questionnaire as the outcomes instrument.

Kadanka and colleagues subsequently performed a sample size analysis and increased the number of patients enrolled in their RCT study to 68 patients. They reported 3-year follow-up results in 2002, similarly finding no difference in mJOA outcome between those treated surgically and those treated non-surgically.¹⁹ The surprising factor again was the lack of change in mean mJOA score in either cohort. A 10-year follow-up, published in 2011, also found no difference, although the percent of patients available for follow-up (73%) at that point was below the estimated sample size required to determine if a difference existed.²⁰ The major points that emerged from these studies are that many patients with mild CSM are stable and that surgical treatment must be optimized to effectively treat myelopathic symptoms and improve outcomes. These studies also highlight the importance of identifying the specific patient population that would likely benefit from surgery.

It is important not to misuse the data from the Kadanka studies to argue that surgery for CSM should not be performed. Firstly, the sample size used was likely too small. Recently published sample size estimates for a Patient-Centered Outcomes Research Institute (PCORI) sponsored RCT comparing different treatment options for CSM suggest that 159 patients would be needed to demonstrate a difference using the Short Form-36 Physical Component Summary (SF-36 PCS) score as the primary outcome instrument.²¹ These sample size estimates were based on observed differences in CSM treatment from preliminary published data.¹² Secondly, modern studies demonstrate improvement in mJOA and SF-36 PCS scores following surgery for CSM.^{12,22} The mean mJOA scores for patients in the Kadanka studies did not improve following surgery and it is unclear what the reasons were for the lack of improvement.

Guidelines

Physician professional organizations have systematically reviewed the literature and published clinical guidelines for the surgical management of CSM.²³ In most situations, these clinical guidelines have been unable to issue definitive guidance because rigorous, high quality clinical research comparing treatment approaches is lacking. Published series contain heterogeneous patient populations and varying approaches, and the reported outcomes measures differ, making comparisons difficult.⁵ Several studies have attempted to identify patient characteristics that predict clinical improvement after surgery.²⁴⁻³⁴ The significance of many of these variables as outcome predictors remains controversial and their validity and impact on the choice of surgical approach is unclear.

Guidelines do suggest, however, that patients with electromyography (EMG) evidence for radiculopathy in the context of cervical spinal canal stenosis should be considered to be surgical candidates because these patients might progress to develop clinically significant CSM.³⁵ Patients with asymptomatic cervical spinal canal stenosis with spinal cord compression do not necessarily require surgical management. These patients should be followed closely.^{35,36}

Modern Prospective Studies

Our group has performed a prospective pilot study evaluating both ventral and dorsal surgery for CSM.¹² We found a mean improvement of 2 points using the disease specific mJOA score and found an improvement of 8 points using the SF-36 PCS score.¹² Fehlings et al performed a prospective study of 278 patients treated surgically for CSM. They observed a 2.5-3.5 point improvement in mJOA following surgery (regardless of approach) and also significant improvements in the SF-36 PCS scores.²² Although non-operative treatment was not compared to surgical treatment in these studies, the number of patients studied was larger than previous RCTs and the study used validated outcomes tools to demonstrate the treatment effect of surgery.

Complications

According to a recent study using the Nationwide Inpatient Sample, cervical spondylosis with myelopathy (19% of 932,009 admissions) was associated with higher complication

rates compared with other types of cervical spine surgery.⁷ Dorsal surgery was independently associated with higher complication rates than ventral surgery. Another recent study found the complication rate in patients 75 years was 38% compared with 6% in younger patients.³⁷ Boayke et al., using the Nationwide Inpatient Sample from 1993-2002 (58,115 CSM admissions), identified a complication rate of 11.9% for ventral surgery versus 16.4% for dorsal fusion surgery.³⁸

Two types of surgical complications are commonly observed after operations for treating CSM: Dysphagia (difficulty with swallowing - more common after ventral surgery) and C5 nerve root paresis (temporary, but occasionally permanent, weakness of the shoulder - seen after both ventral and dorsal surgery but more commonly after dorsal surgery). Edwards reported a 31% rate of persistent dysphagia or dysphonia (hoarseness) after ventral surgery and noted that this complication is often under-reported.³⁹ Published rates of C5 paresis range from 12% (ventral procedures) to 30% (dorsal procedures).⁴⁰ This complication often is disabling for several months and might be related to traction on the C5 root caused by spinal cord shift after decompression.⁴¹ Administrative hospital discharge databases are not likely to capture these complication rates accurately nor can they estimate complication severity or impact on a patient's quality of life.⁷ Prospective studies are required to provide reliable postoperative complication rate data and assess the impact of these complications on patients' lives.

New Concepts – Cervical Sagittal Balance

Today, surgery for CSM is effective at improving symptoms related to spinal cord dysfunction. However, many patients following surgery do not enjoy improved health-related quality of life (HR-QOL) either secondary to complications from surgery or from neck pain. Our pilot study demonstrated that poor sagittal balance following surgery might explain a major difference in HR-QOL outcome between ventral and dorsal surgery.⁴² Figure 2 shows that patients with C2-C7 sagittal imbalance postoperatively do not demonstrate improvement in HR-QOL scores. Further studies will be necessary to identify which patients are at greater risk of poor sagittal balance and will provide the foundation for future studies that will be required to improve today's surgical approaches.

Summary and Next Steps

Surgical management is the accepted standard of care for progressive CSM, making any future RCTs comparing surgery to non-surgical treatment unlikely to be feasible and potentially unethical. The clinical question for most spinal surgeons is which surgical approach (ventral versus dorsal) for CSM patients will result in better outcomes with fewer complications. Without better evidence, surgeons (with their biases) will continue to perform complex procedures without knowing their true utility and risks, and may be choosing the wrong procedure for many patients.

The clinical evidence on this topic suggests that conservative non-operative treatment is reasonable for patients with mild myelopathy who are stable and are not progressing. Older studies have demonstrated mixed results for surgery for CSM. Many patients improve following surgery, while some develop complications or develop worsening symptoms.

Recent clinical prospective studies show that surgery results in improvement in myelopathic symptoms and improved HR-QOL when the appropriate surgery is done on the right patients. PCORI is currently sponsoring a prospective RCT comparing ventral and dorsal surgery for treating CSM.²¹ A non-operative arm was not included in this trial because there was no clinical equipoise among spinal experts to justify a non-operative cohort when surgical treatment is available. Today, a patient with progressive symptoms of CSM should be considered for surgery unless the risk of complications is high. Further research will define the optimal surgical approach and provide new clinical data to identify risk factors including cervical sagittal imbalance that must be considered when performing surgery for CSM.

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Figure 1.

(A) Pre-operative cervical spine MRI in a 55-year-old male with mild cervical spondylotic myelopathy. Preoperatively, the patient was having multiple falls while playing tennis and had a L'hermitte's sign as well as pathological hyperreflexia on neurological examination. (B) The patient underwent C4-C5 and C5-C6 ACDF with resolution of his symptoms within 2 weeks. He returned to work full time in 2 weeks and was playing tennis 3 months following surgery.

(A) Change in SF-36 PCS Score = +18.2 (B) Change in SF-36 PCS Score = -9.0

Figure 2. Schematic representing a patient with (A) satisfactory (1.3cm) and (B) unsatisfactory (4.5cm) postoperative cervical sagittal balance. Change in SF-36 PCS scores at 1 year are depicted below the schematics. (C) Patients with C2-C7 sagittal imbalance (≥ 4 cm) postoperatively do not demonstrate improvement in HR-QOL scores compared to patients with satisfactory postoperative sagittal balance ($P = 0.067$).