J Neurosurg Spine 11:170–173, 2009

Anterior cervical surgery for the treatment of cervical degenerative myelopathy

Paul G. Matz, M.D.,[1] Langston T. Holly, M.D.,[2] Praveen V. Mummaneni, M.D.,[3] Paul A. Anderson, M.D.,[4] Michael W. Groff, M.D.,[5] Robert F. Heary, M.D.,[6] Michael G. Kaiser, M.D.,[7] Timothy C. Ryken, M.D.,[8] Tanvir F. Choudhri, M.D.,[9] Edward J. Vresilovic, M.D., Ph.D.,[10] and Daniel K. Resnick, M.D.[11]

[1]Division of Neurological Surgery, University of Alabama, Birmingham, Alabama; [2]Division of Neurosurgery, David Geffen School of Medicine, University of California at Los Angeles; [3]Department of Neurosurgery, University of California at San Francisco, California; Departments of [4]Orthopaedic Surgery and [11]Neurological Surgery, University of Wisconsin, Madison, Wisconsin; [5]Department of Neurosurgery, Harvard Medical School and Beth Israel Deaconess Medical Center, Boston, Massachusetts; [6]Department of Neurosurgery, University of Medicine and Dentistry of New Jersey—New Jersey Medical School, Newark, New Jersey; [7]Department of Neurological Surgery, Neurological Institute, Columbia University, New York, New York; [8]Department of Neurosurgery, University of Iowa Hospitals and Clinics, Iowa City, Iowa; [9]Department of Neurosurgery, Mount Sinai School of Medicine, New York, New York; and [10]Department of Orthopaedic Surgery, Milton S. Hershey Medical Center, Pennsylvania State College of Medicine, Hershey, Pennsylvania

Object. The objective of this systematic review was to use evidence-based medicine to examine the efficacy of anterior cervical surgery for the treatment of cervical spondylotic myelopathy (CSM).

Methods. The National Library of Medicine and Cochrane Database were queried using MeSH headings and key words relevant to anterior cervical surgery and CSM. Abstracts were reviewed, and studies meeting inclusion criteria were selected. The guidelines group assembled an evidentiary table summarizing the quality of evidence (Classes I–III). Disagreements regarding the level of evidence were resolved through an expert consensus conference. The group formulated recommendations that contained the degree of strength based on the Scottish Intercollegiate Guidelines network. Validation was done through peer review by the Joint Guidelines Committee of the American Association of Neurological Surgeons/Congress of Neurological Surgeons.

Results. Mild CSM (modified Japanese Orthopaedic Association [mJOA] scale scores > 12) responds in the short term (3 years) to either surgical decompression or nonoperative therapy (prolonged immobilization in a stiff cervical collar, "low-risk" activity modification or bed rest, and antiinflammatory medications) (Class II). More severe CSM responds to surgical decompression with benefits being maintained a minimum of 5 years and as long as 15 years postoperatively (Class III).

Conclusions. Treatment of mild CSM may involve surgical decompression or nonoperative therapy for the first 3 years after diagnosis. More severe CSM (mJOA scale score ≤ 12) should be considered for surgery depending upon the individual case. The shortcomings of this systematic review are that the group was not able to determine whether an mJOA scale score of 12 was indicative of a more severe CSM disease course, and whether patients who received nonsurgical treatment for 3 years had a significant probability for clinical deterioration after that time point.
(DOI: 10.3171/2009.3.SPINE08724)

Key Words • **cervical spine** • **cervical spondylosis** • **discectomy** • **corpectomy** • **practice guidelines** • **treatment outcome**

Recommendations

Indications: CSM. It is recommended that mild CSM be treated in the short term (3 years) either with surgical decompression or with nonoperative therapy (prolonged immobilization in a stiff cervical collar, "low-risk" activity modification or bed rest, and antiinflammatory medications) based on patient preference (quality of evidence, Class II; strength of recommendation, C). More severe CSM should be treated with surgical decompression with benefits being maintained a minimum of 5 years and as long as 15 years postoperatively (quality of evidence, Class III; strength of recommendation, D).

Methods. These will be addressed in the chapter on cervical surgical techniques for the treatment of CSM.

Timing. There is insufficient evidence to make a recommendation on timing.

Abbreviations used in this paper: ADL = activity of daily living; CSM = cervical spondylotic myelopathy; JOA = Japanese Orthopaedic Association; mJOA = modified JOA.

Rationale

The purpose of this review was to use an evidence-based approach to examine whether patients benefit from anterior surgical intervention in the setting of mild versus severe cervical myelopathy. Cervical myelopathy is often classified as mild, moderate, or severe depending on the degree of impairment in arm and leg function. As cervical spondylosis increases in severity, it may cause compression of the neural elements, resulting in myelopathy. Compression may often occur anteriorly at the level of the disc space. In general, severe myelopathy has been considered a strong indication for surgical therapy;[7] however, the question arises whether mild cervical myelopathy with anterior compression is best treated surgically or with nonoperative measures.[5]

Search Criteria

We conducted a computerized search of the Cochrane Database and of the National Library of Medicine between 1966 and 2007 using MeSH headings. The search headings included the following terms: "cervical vertebrae," "outcome assessment," "cervical spondylosis," "myelopathy," "cervical spondylotic myelopathy," "controlled clinical trial," "spinal osteophytosis," and "spinal cord disease." The total number of citations was 1689 when terms were combined. One study (a systematic review) was found in the Cochrane database. Of these articles, we analyzed only those in the English language. We reviewed the abstracts of these citations and selected applicable articles. We reviewed the references cited in the qualifying articles to gather any other applicable manuscripts published between 1966 and 2007. Five references were found that provided potentially high-quality evidence (Table 1).

Scientific Foundation

Mild Cervical Myelopathy

The studies described by Bednarik et al.[1] and Kadanka and colleagues[3] appear to concern the same group of patients. However, the Bednarik et al. study included electrophysiological data in addition to clinical outcome data. For the purpose of this analysis, these studies will be discussed together. In total, the authors examined 61 patients with CSM. Forty-nine had mild CSM, with mJOA scale scores > 12, and 12 patients were considered to have severe CSM, with mJOA scale scores ≤ 12. All patients were younger than 75 years of age. The randomized trial examined the group of 49 patients with milder symptoms, 22 of whom were randomized to surgery, and 27 to nonoperative therapy. Nonoperative therapy included activity modification (rest or "low risk" activities), antiinflammatory medications, and cervical immobilization. Follow-up was over 24 months and included analysis of mJOA scale scores, a timed 10-m walk, and video analysis of ADLs.[3]

Patients with mild or moderate myelopathy were allocated by coin toss to each treatment arm. Age and sex ratios were similar between the 2 groups. There was a slight imbalance in mJOA scores and a greater imbalance in gait scores, which favored groups allocated to nonoperative treatment.[2] Specifically, there was a significant difference in 10-m walk times in the control group. These differences suggested that the treatment allocation might have been biased. In this study, the 18 patients underwent surgical decompression via an anterior approach compared to only 4 who received the posterior approach. Clinically, mJOA scale scores and 10-m walk times improved significantly at 6 months in the nonoperative group compared to the surgical group. However, these differences were not evident at 12 and 24 months. The authors concluded that operative and nonoperative management of mild-to-moderate CSM yielded similar results at 2 years. The subgroup of 12 patients with severe disability (mean mJOA scale score of 9.5) showed significant improvement after surgical intervention (mean mJOA scale score 10.9 at 2 years postoperatively).[1,3]

Because of its small size, this study was powered to have a minimal detectable difference in mJOA scale score of 1.7. With pretreatment mJOA scores starting at ~ 14 out of a possible 18, the level of improvement would have to be 42% (1.7/4.0) for the study to have a detectable a difference; this raises the likelihood of a Type II error. Although these studies were randomized and the outcome assessment was blinded, it appeared that concealment of allocation was biased toward the nonoperative group.[2] Furthermore, the large standard deviation in the demographic factors in each group suggests inappropriately small sample sizes. Accordingly, these studies were considered to provide Class II evidence regarding the treatment of patients with CSM.

Kadanka et al.[4] reported on 66 patients, of whom 33 underwent surgery and 33 received nonoperative therapy. Outcomes were assessed using the mJOA scale, 10-m walk times, and video ADLs. Outcome assessors were blinded to group during mJOA and video ADL assessment, and outcomes were stratified into nonresponders, responders, and very good responders. Patients in both groups showed improvement. The authors stratified outcome and observed that older patients did better with conservative therapy, whereas surgery was better if the transverse area of the spinal cord was < 70 mm^2. This study was graded Class II due to the lack of allocation concealment. Furthermore, the mJOA scores began at 14 in the surgery group and 15 in the nonoperative group, essentially creating a ceiling effect. The duration of symptoms was longer in the surgical group (3 years vs 1 year).[4]

One systematic review by Fouyas et al.[2] in the Cochrane database examined surgical treatment of myeloradiculopathy. The authors found 2 studies that met inclusion criteria. One study was on the surgical treatment of radiculopathy and the other was on treatment of CSM. The second study was undertaken by Bednarik et al.[1] and was described above. As we mentioned, the study by Bednarik and colleagues was graded Class II due to difficulties in balancing the groups with respect to mJOA scale scores and because of the lack of concealment of allocation. In their systematic review, Fouyas et al.[2] corroborated the inconsistencies in assembling and balancing the groups preoperatively.

Sampath et al.[6] reported on 62 patients with CSM

TABLE 1: Evidentiary summary of manuscripts examining the efficacy of anterior surgery versus nonoperative management for degenerative cervical myelopathy*

Authors & Year	Description	Results	Class	Conclusions
Kadanka et al., 2000	48 patients w/ CSM (mJOA score >12, age <75 yrs) randomized to surgery (21 patients) or nonoperative Tx (27 patients). The surgeries included 18 w/ the anterior approach & 3 w/ the posterior approach. 24-mo FU.	Both groups improved but not one more than the other on mJOA, 10-m walk, & video ADLs.	II	Mild CSM may be managed operatively or nonoperatively over 24 mos. Class II because of the mixture of anterior & posterior surgeries, the bias in mJOA scores toward nonoperative Tx, the small no. of patients.
Bednarik et al., 1999	61 CSM patients: 49 mild (mJOA score >12) & 12 severe (mJOA score <12). The 49 mild cases were randomized to surgery (22 patients) & conservative Tx (27 patients). 24-mo FU.	In both groups, aggregate EP & mJOA generally improved w/o significant difference. In the severe group, mJOA score improved postop. Once again, the surgeries were mixed. In the randomized trial, 18 patients had anterior surgery & 4 had posterior surgery. In the severe group, 7 had anterior surgery & 5 had posterior surgery.	II	Class II because of the mixture of anterior & posterior surgeries, the bias in mJOA scores toward nonoperative therapy, small no. of patients. However, it appears that surgery & nonoperative management may both be effective in the short term.
Sampath et al., 2000	62 patients of a 503-patient study. Surgery was recommended for 31 of the 62 patients. Surgery was a mixture of anterior & posterior approaches.	Only 46 of the 61 trial patients underwent FU. In general, surgical patients performed better in functional status on the Neurological Rating Assessment. ADL assessment showed the nonoperative patients did worse.	III	Class III due to poor FU & selection bias. Surgeries were a mix of anterior & posterior surgery. Surgery did seem to help CSM more than nonoperative management.
Kadanka et al., 2005	Prospective randomized study comparing 66 patients w/ mild CSM (mJOA scale score ≥12) underwent surgery (n = 33) or nonoperative Tx (n = 33). Outcomes measured using mJOA scale & a 10-m walk test. 3-yr FU.	Both groups improved over 3 years w/o statistical difference. Better results were seen in older patients w/ nonoperative Tx. Better correlation w/ postop outcome if area of spinal cord <70 mm^2.	II	Class II due to nonblinded allocation & nonvalid stratification of outcome measures. Duration of symptoms was 1 yr in conservative vs 3 yrs in the surgical group. There was a ceiling effect of the mJOA: it began at 15 in conservative group & at 14 in surgical group.
Fouyas et al., 2001	Systematic review of surgery for cervical radiculopathy & myelopathy. Inclusion & exclusion criteria included. 2 studies were found that met criteria. Only 1 study dealt w/ surgery for myelopathy (Bednarik et al.).	The systematic review found equivalency between surgery & nonoperative management over a 3-yr FU period. However, the authors noted that group allocation was not blinded & bias of preop paring favored the nonoperative group (better mJOA scores & 10-m walk times).	II	The systematic review was graded Class II because the study examining surgery for myelopathy itself was graded Class II because of biases in the stratification of groups that were duly noted.

* The criteria for scoring each manuscript into a class are described in *Introduction and Methodology: Guidelines for the Surgical Management of Cervical Degenerative Disease*, which appears in this issue of the *Journal of Neurosurgery: Spine*. Abbreviations: EP = electrophysiological potential; FU = follow-up.

who were enrolled as part of a larger 503-patient study. The study physicians recommended surgery in 31 of the 62 patients while the remaining 31 patients underwent nonoperative therapy. Surgery was a mixture of anterior and posterior approaches. Only 43 of the 62 patients underwent follow-up, 23 in the medically treated group, and 20 in the surgical group. Neurological outcome was assessed using the Neurological Rating Assessment, which was a validated, reliable scale. In this study, surgical patients improved on "Neurological Rating Assessment" and stayed the same with regard to video-assessed ADLs. Neurological and ADL assessments showed that the patients who did not undergo surgery had worsened functionally in both categories. Because of the poor follow-up and ad hoc subgroup analysis, this study was graded Class III.[6]

Severe Cervical Myelopathy

In their study detailed above, Bednarik et al.[1] also described an observational group of 12 patients with severe myelopathy (mJOA score < 12). The patients in this group had an average mJOA score of 9.5; all underwent surgical decompression, via an anterior approach in 7. This group had a statistically significant improvement in mJOA scale scores beginning at 6 months and continuing through 24 months. Simultaneous improvement in electrophysiological function also occurred in these patients.[1] Because there was no nonoperative group for patients with mJOA scores < 12, this study was graded Class III with respect to surgical treatment of severe CSM.[1]

Wada and colleagues[7] examined a group of patients with severe CSM over a 15-year period after surgery. These authors compared cervical corpectomy to lamin-

oplasty for the treatment of severe CSM. Similar to the Bednarik study, there was no nonoperative control group. Twenty-three patients (average age 52 years with symptoms of 15 months' duration) underwent subtotal corpectomy and reconstruction. The average preoperative JOA score was 7.9 (out of a maximum of 17). The average JOA scores improved to 13.3 at 1 year, 13.9 at 5 years, and finally 13.4 at an average follow-up of 15 years. This study was scored as Class III because there was not a nonoperative control group. In addition, it was not evident whether outcome assessors were blinded.

Summary

Currently, there exists no Class I evidence to assess the efficacy of anterior surgery for mild or severe CSM. Class II studies have indicated improvement with both operative and nonoperative therapy for mild CSM. Controlled clinical trials comparing the 2 approaches in the setting of mild CSM have been flawed but indicated equivalency between surgery and nonoperative therapy in 1 group of studies derived from the same patient population (Class II), and greater benefit for surgery in a different trial that was part of a larger trial (Class III). Current evidence (Class II) suggests that mild CSM (mJOA scale score > 12) may be managed with surgery or nonoperative management over the short term (3 years). However, more severe CSM (mJOA scale score < 12) appears to respond more readily to surgery (Class III).

The shortcoming of any evidence-based approach is that the recommendations are only as strong as the underlying studies. Although the studies systematically reviewed in this article indicate a stable time course for patients with mild symptoms, several questions and concerns arise. First, an mJOA score of 12 may not necessarily be considered mild disease as it was in the underlying studies. In general, patients with an mJOA score of 12 have a moderate impairment in gait, bladder, or hand function (motor or sensory), or a combination of disabilities. Clinical deterioration from this point may be ominous in terms of the functional ability. Secondly, even if CSM is stable without surgical correction for 3 years, what about the probability of deterioration after 3 years? If the underlying problem is not corrected, deterioration after 3 years may be an issue. Once again, the limits of the evidence-based approach are that it cannot specifically answer this question if it has not been studied. Other systematic reviews in this series on laminectomy, laminoplasty, laminectomy and fusion, and anterior surgery indicate clinical improvement after surgery over several years' duration. This segues into the third issue: the absence of Level 1 evidence on this subject and how to ameliorate that deficiency. It is probably impossible to design a practical study that would provide Level 1 evidence; however, Level 2 evidence could potentially be gained from a well-structured case-control series based on a prospective registry.

Key Issues

It is imperative that further investigation of CSM be undertaken using larger, multicenter, controlled clinical trials to examine the specific benefit, if any, that surgery has in the treatment of mild CSM and to determine its overall benefit in severe CSM.

Disclosure

Administrative costs of this project were funded by the Joint Section on Disorders of the Spine and Peripheral Nerves of the American Association of Neurological Surgeons and Congress of Neurological Surgeons. No author received payment or honorarium for time devoted to this project. Dr. Resnick owns stock in Orthovita. Dr. Matz receives support from the Kyphon Grant for Thoracolumbar Fracture Study, and an advisory honorarium from Synthes for the cadaver laboratory. Dr. Heary receives support from DePuy Spine and Biomet Spine, and receives royalties from DePuy Spine and Zimmer Spine. Dr. Groff is a consultant for DePuy Spine. Dr. Mummaneni is a consultant for and receives university grants from DePuy Spine and Medtronic, Inc., and is a patent holder in DePuy Spine. Dr. Anderson is an owner of, consultant for, and stockholder of Pioneer Surgical Technology; a consultant for and receives non–study related support from Medtronic, Inc.; and is a patent holder in Stryker. The authors report no other conflicts of interest concerning the materials or methods used in this study or the findings specified in this paper.

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Manuscript submitted October 18, 2008.
Accepted March 5, 2009.
Address correspondence to: Paul G. Matz, M.D., Neurosurgery and Neurology, LLC, 232 South Woods Mill Road, Chesterfield, Missouri 63017. email: matzpg@yahoo.com.