Surgical treatment for cervical spondylitic myelopathy

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The long-term outcome of cervical spondylitic myelopathy after surgical treatment was retrospectively reviewed and critically evaluated in 100 patients with documented cervical myelopathy treated between 1978 and 1988 at our institution. Eighty-four patients were available for long-term study. The median duration of follow up was 7.35 years (range 3 to 9.5 years). There were 67 men and 17 women; their ages ranged from 27 to 86 years. The duration of preoperative symptoms ranged from 1 month to 10 years. Preoperative functional grade as evaluated with the Nurick Scale for the group was 2.1. Thirty-three patients with primarily anterior cord compression, one- or two-level disease, or a kyphotic neck deformity were treated by anterior decompression and fusion. Fifty-one patients with primarily posterior cord compression and multiple-level disease were treated by posterior laminectomy. There was no difference in the preoperative functional grade in these two groups. The patients in the posterior treatment group were older (59 vs 55 years).

There was no surgical mortality from the operative procedures; morbidity was 3.6%. Of the 33 patients undergoing anterior decompression and fusion, 24 showed immediate functional improvement and nine were unchanged. Of the 51 patients who underwent posterior procedures had additional posterior procedures, and seven (13.7%) patients who had undergone posterior procedures had additional decompressive surgery. The final functional status at last follow-up examination for the 33 patients in the anterior group was improved in 18, unchanged in nine, and deteriorated in six. Of the 51 patients who underwent posterior decompression, 19 benefited from the surgery, 13 were unchanged, and 19 were worse at last follow up than before their initial surgical procedure.

Age, severity of disease, number of levels operated, and preoperative grade were not predictive of outcome. The only factor related to potential deterioration was the duration of symptoms preoperatively.

The results indicate that with anterior or posterior decompression, long-term outcome is variable, and a subgroup of patients, even after adequate decompression and initial improvement, will have late functional deterioration.

KEY WORDS • anterior decompression • posterior approach • cervical spondylosis • laminectomy
and critical analysis of patients who underwent surgery at our institution. The aims of the study were to assess the outcome of treatment in terms of functional neurological results and to identify demographic and clinical features that may affect surgical outcome.

**Clinical Material and Methods**

**Patient Population**

One hundred consecutive patients with documented CSM underwent surgery between 1978 and 1988 at our institution. Short- and long-term follow-up data were obtained from postoperative visits and from telephone interviews. Nine patients died of unrelated causes, and seven were lost to follow-up review. Eighty-four patients were available for long-term review: 67 men and 17 women. The patients' ages at surgery ranged from 27 to 87 years (average 59 years).

**Patient Evaluation**

Independent clinical evaluation by a neurologist was obtained in all cases. Table 1 lists presenting complaints. Duration of symptoms and functional severity of CSM, as graded by the Nurick Scale, were recorded in all patients and were as follows: Grade 0 (signs or symptoms of root involvement but without evidence of spinal cord disease); Grade 1 (signs of spinal cord disease but no difficulty in walking); Grade 2 (slight difficulty in walking that does not prevent full-time employment); Grade 3 (difficulty in walking that prevents full-time employment or the ability to do daily tasks such as housework but is not severe enough to require help walking); Grade 4 (able to walk only with help or with a walker); Grade 5 (chairbound or bedridden).

Preoperative myelography and postmyelographic computerized tomography (CT) scans were obtained in all patients for the purpose of diagnosis and to eliminate other causes of myelopathy. There were 78 individuals with cervical spondylosis, five with soft-disc herniation, and one with ossification of the posterior longitudinal ligament. The myelograms were analyzed by an observer not involved in the patient's care. In all cases the number of levels showing both compression and the severity of compression, as determined by the degree of block on the myelogram (severe, moderate, or slight), was recorded.

An index of developmentally narrow cervical canal and stenosis was determined by means of the Pavlov ratio method. This was obtained by calculating the ratio of the anteroposterior diameter of the spinal canal compared with the anteroposterior diameter at midvertebral body. A value of less than 0.8 indicates a narrow cervical canal. This ratio was calculated at the site of maximum compression and at the C3–7 levels. The canal was considered narrow if more than three levels had a ratio of less than 0.8. Whenever available, the shape of the cord and the degree of its atrophy, as demonstrated on postmyelographic CT and MR images, were recorded.

All patients in this series did not undergo MR imaging, because the series involved patients who were treated between 1978 and 1988, and MR imaging was first available at the Mayo Clinic in 1984. Surgical decompression was recommended if progressive, incapacitating neurological symptoms and confirmatory signs of myelopathy were present. No prophylactic procedures were performed.

**Functional Outcome**

Postoperative functional outcome was assessed at three intervals: the immediate postoperative period, at 1 month, and at last follow up. The patients were asked to subjectively rate their degree of satisfaction with the procedure, and their Nurick functional grade was assessed by means of a standardized questionnaire.

The functional results received independent critical analysis with contingency tables according to whether individuals had anterior or posterior procedures. Statistical significance was determined to be p less than 0.05.

**Results**

Thirty-three patients who had primarily anterior cord compression, one- or two-level compression on CT myelography, or loss of normal lordosis had anterior decompression and fusion. Fifty-one patients with a narrowed canal extending more than two levels underwent decompression via a posterior laminectomy, with or without foraminotomy.

The clinical characteristics of the patient population undergoing an anterior surgical approach are summarized in Table 2. Significant age differences are noted between the group operated via an anterior approach and those operated via a posterior approach (p < 0.05).

In both groups, the average duration of symptoms was less than 1 year in 40 patients, between 1 and 3 years in 28 patients, and more than 3 years in 16 patients.

Preoperative functional grade is shown in Tables 2 and 3. There were no individuals with normal functional status, and no difference in distribution in the various functional grades in terms of the choice of surgical approach.

Radiological determination of a congenitally narrow spinal canal as calculated from the Pavlov ratio was done.
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in 77 patients. The Pavlov ratio was less than 0.8 in seven patients in the anterior group and 24 patients in the posterior group (p ≤ 0.01). The degree of myelographic block was recorded in 68 individuals and the difference in the degree of block in the anterior and posterior groups was found to be significant. A tendency toward more severe block was noted in the patients in the posterior group.

There was no surgical mortality in this series. There was major morbidity in one patient who suffered a postoperative cerebrovascular accident. Two patients presented with temporary acute postoperative confusional states.

Anterior Approach

Of the 33 patients who underwent surgery via the anterior approach, 22 had one level decompressed and 11 had two levels. Complications from the anterior procedure included a dislocation of the bone graft in one individual who sustained no neurological deficits but who required revision. In one patient, a hematoma developed at the site of bone harvesting.

Early Outcome. Table 4 summarizes postoperative results: 23 individuals (70%) improved immediately after anterior approach surgery, with an average improvement of 1.5 Nurick grade. There was no difference in outcome between patients operated at one level and those operated at two levels.

Nine patients were unchanged, and one had deteriorated at early follow up. This man had undergone a decompressive laminectomy at another institution 12 years previously. He improved in the immediate postoperative period, but 3 days after surgery he suddenly suffered a hypotensive episode and decrease in strength. Functional deterioration was from Grade 2 to Grade 3.

Late Outcome. At long-term follow up (average 6.96 years; range 60 to 113 months), 18 patients undergoing an anterior approach (54.5%) were improved, nine (27.3%) were unchanged, and six (18.2%) had deteriorated. Duration of symptoms prior to surgery was significantly related (p < 0.05) to long-term outcome.

Of the six patients who had deteriorated at long-term follow up, three deteriorated in the 1st year after their initial procedure, and three deteriorated 36 to 68 months postoperatively. This deterioration (average one Nurick grade) was progressive in all patients. Additional diagnosis was made in two patients of multiple sclerosis and arteriovenous fistula. Surgical correction of the fistula did not lead to improvement in the patient. Concomitant diagnoses were made in three individuals: one of cerebral palsy and two of polio. Two patients showed spinal cord atrophy on MR imaging. Four people underwent reoperation at another institution via the posterior approach, but only one showed temporary clinical improvement.

Posterior Approach

Of the 51 patients who were operated on via the posterior approach, three had three-level, 13 had four-level, 20 had five-level, 11 had six-level, three had seven-level, and one had eight-level decompressive procedures (Table 3). The C-2 level was decompressed in 18 cases. Short- and long-term outcomes of patients who underwent surgery via the posterior approach are summarized in Table 4.

**TABLE 2**

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<th>Factor</th>
<th>Improved</th>
<th>Unchanged</th>
<th>Deteriorated</th>
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**TABLE 4**

Functional status over time in 84 patients with cervical spondylitic myelopathy by operative approach

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<th>Time Period</th>
<th>Functional Status (Nurick Grade)</th>
<th>Operative Approach</th>
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<td>Anterior Approach</td>
<td>Posterior Approach</td>
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<td>No. of Patients (%)</td>
<td>No. of Patients (%)</td>
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<td>unchanged</td>
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<td>deteriorated</td>
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</tr>
<tr>
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<td>improved</td>
<td>18 (54.5)</td>
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<tr>
<td></td>
<td>unchanged</td>
<td>9 (27.3)</td>
</tr>
<tr>
<td></td>
<td>deteriorated</td>
<td>6 (18.2)</td>
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Early Outcome. Of the 51 patients, 35 (68.6%) were improved at early follow up, 11 (21.6%) were unchanged, and five (9.8%) had deteriorated. Average improvement was 1.4 Nurick grade. Of the five patients who were worse at early follow up, two awoke from surgery with neurological deterioration, one of whom recovered to the initial presenting functional grade. One patient suffered deterioration following a hypotensive episode 64 hours after presenting functional grade. One patient suffered deterioration, one of whom recovered to the initial grade, and number of levels decompressed are summarized in Table 2 and 3.

Late Outcome. At long-term follow up (average 7.6 years; range 36 to 115 months), 19 of 51 patients (37.3%) had sustained functional improvement, 13 (25.5%) patients were unchanged and 19 (37.2%) had deteriorated. Age at surgery, duration of symptoms, preoperative functional grade, and number of levels decompressed are summarized in Table 2 and 3.

Of the 13 patients who remained unchanged at long-term follow up, six had noted temporary improvement but progressively deteriorated between 3 and 96 months after surgery. Three patients who were initially worse after surgery recovered to their initial functional grade and remained so at long-term follow up; three patients had an additional surgical procedure. Of the 19 patients who deteriorated, three were worse within 1 year of surgery and late deterioration occurred in the other 16 patients from 2.5 to 8 years after posterior decompression.

The patients who had late deterioration demonstrated a slow and protracted decline. Fifteen individuals had one Nurick grade of deterioration and four had two Nurick grades of deterioration. Five patients had additional radiological imaging, and four had an additional anterior surgical procedure. None benefited from the second procedure. Secondary diagnoses were present in four individuals: multiple sclerosis in one, cerebral palsy in two, and dystonia in one. Of note is that three people were older than 80 years of age and at follow up one had dementia, three had cardiac problems, and one had prostate cancer.

Discussion

This study is unique in its evaluation of a large number of patients treated surgically for CSM over a long interval using objective criteria. The patient population was highly selected and therefore relatively homogeneous as 78 of 84 had spondylitic stenosis. Other studies have often included soft-disc herniations and ossification of the posterior longitudinal ligament. Furthermore, the patients in this study were treated after the advent of modern imaging and with a uniform strategy adopted in the past decade.10,15,18

In the short-term follow-up results, both approaches yielded a good outcome (anteror 72.7%; posterior 68.6%), substantiating previously published reports.10,11,17,19,22,24,47,52,56 A significant proportion of patients treated by either approach had at least temporary benefits from the surgery. Despite the early studies of Lees and Turner,12 suggesting that CSM is a benign condition in most cases, surgery improved outcome except in the most severely affected patients.

Early deterioration may be a result of factors such as surgical trauma, positioning of the patient at surgery, and intraoperative or postoperative spinal cord ischemia. In three patients, deterioration was noted immediately postoperatively and in two patients deterioration was noted to develop in the early postoperative period. This early deterioration, although rare, has been reported14,50 and an ischemic event is favored as the cause in cases in which radiographic evaluation did not demonstrate a compressive etiology (hematoma, subluxation, or bone graft dislocation).12

At long-term follow up, functional outcome noticeably declined in both groups but the decline was more pronounced in the posterior group. The causes of failure and indication for reoperation included inadequate decompression and additional pathology. Only 30% of the patients who deteriorated were encouraged to undergo additional surgery. These results corroborated the findings of Snow and Weiner50 and Clifton, et al.,12 who studied postoperative CT and MR images of patients with poor outcome after surgery for CSM. In both of those studies, approximately 20% of patients deteriorated with no radiological explanation. The number of levels decompressed did not seem to have a negative effect on outcome. Of note, however, is that only one individual with severe cord atrophy showed long-lasting improvement; all others were either the same or worse at long-term follow up.

Because this study was done between the years 1978 and 1988, many of the patients did not undergo MR imaging. We believe that new imaging procedures will prove to be a very helpful way of quantitating cord atrophy, recognizing intramedullary abnormalities, and possibly even clarifying diagnosis. Undoubtedly, many large series of patients undergoing spinal cord decompression for what is thought to be spondylitic myelopathy may have demyelinating disease or some other process that has not been recognized. In future reviews of this subject, it is anticipated that preoperative MR imaging will become increasingly important in the evaluation and management of patients with a presumptive diagnosis of CSM. In fact, one patient who showed early improvement following decompression showed significant neurological deterioration several months following the decompression (Fig. 1). A repeat MR image at that time showed an intramedullary lesion that initially was thought consistent with a neoplastic process. A resolution of this intramedullary abnormality and further review of the MR images suggested that this deterioration was not due to a missed intramedullary tumor, but rather due to cord infarction following decompression. This patient eventually regained much of the improvement that was experienced following the decompressive procedure, but never totally regained the improvement shown following the decompression.

The history of this patient suggests that some of the early and late deterioration following decompression procedures, whether they be done anteriorly or posteriorly, is related to vascular pathology associated with the spondylitic myelopathy. Even though this patient experienced very satisfactory early and late outcomes, there is no question that a vascular event occurred months after the decompression, most likely secondary to the long-recognized intravascular changes associated with spondylitic myelopathy.

Relatively few studies have evaluated the long-term
surgical results for CSM, but all noted a significant deterioration over time whether the surgical approach utilized.2,15,17–19,48,50,52 Gregorius, et al.,19 reviewed 55 patients with CSM who were followed for a mean of 7 years. Twenty-six anterior (only one individual operated on at more than two levels) and 29 posterior procedures were performed. Preoperatively, nine patients were unimpaired, 20 were moderately impaired, and 24 were severely disabled. At last follow up, 17 had improved, 24 were unchanged, 12 had worsened, and two could not be counted. Sphincter disturbances, excessive lower-extremity weakness, and long duration of symptoms were associated with poor postoperative results. A trend toward improvement in disability after anterior decompression and a tendency to late worsening in disability following cervical laminectomy were significant.19 Deterioration occurred as late as 8 to 12 years after plateau.18,19

Wilberg52 reported a series of 99 patients undergoing surgery with a follow-up period ranging from 2 to 8 years. Seventy-one patients were treated via posterior surgical procedures, 15 via anterior, and 13 via combined; however, of these, 73% had radiculopathy. The progression of CSM was arrested in 95% of the patients after surgery. Improvement was obtained in 80%, both at early and late follow up, compared with the preoperative functional status. The evaluation disclosed a tendency for rapid improvement during the first 3 months, followed by slow improvement in 50%, and slight deterioration in 15% of the patients. The degree of improvement in many individuals was not sufficient to raise the functional capability to a higher level in the grading system. The study concluded that it is important to operate as early as possible before neurological deficits are too pronounced.

Arnold, et al.,2 studied 70 patients with a mean follow-up period of 8 years. Fifty-one underwent a posterior surgical approach; 34 of these individuals improved early, and 17 improved at last follow up. Predictors of outcome, age, duration of symptom, and the method of evaluation were not specified.

Although several reviews5,7,24,28,29,44,54,56 have claimed impressive outcomes after anterior decompression, usually the extent of the disease has been limited to one or two levels, and follow up has been short (average 20 months), and therefore the results were biased favorably. Recently, Goto, et al.,18 reviewing a series of 52 patients treated by an anterior surgical approach with a 12-year follow up, found a rising incidence of progression of myelopathy. Magnetic resonance imaging of these cases revealed newly developed intervertebral disc herniation and progression of spondylosis associated with spinal malalignment in both the cephalad and caudad directions. Of further concern is the recent study by Saunders, et al.,48 in which the reported complication rate was 47.5% and 12% of the complications were long term. The consequence of such anterior decompression/fusion on the accelerated degeneration of spinal segments above and below the graft site causing recurrent cord compression needs to be considered.

In our review, the only common significant variable predictive of outcome was the duration of disease. This finding implies that there is a point at which irreversible damage is done to the cord, which makes patients less likely to benefit from surgery. Neuropathological evidence supports these permanent changes.39,43,46 With the benefit of MR imaging, some recent reports have attempted to correlate spinal cord changes with prognosis, but the results have been contradictory.2,21,35,55 Some authors suggesting no importance, others attributing prognostic value. Of note in these studies is that follow up was not considered or was short. There was a noticeable difference in patients with ossification of the posterior longitudinal ligament and those with CSM, the former doing better in general.

There is as yet no single best approach to the treatment
of all patients with CSM; although in selected individuals an appropriate surgical approach and procedure will yield favorable results, some will not benefit or maintain improvement from surgery. Recently, there has been some change in the philosophy on anterior surgical decompression; more and more radical procedures, including multiple-level corpectomies, are being performed and early results suggest that outcomes may be very favorable. Although the potential for significant morbidity, including graft dislocation and spinal deformity, does exist, those experienced with this technique have produced very encouraging early results, which will need to be compared with the long-term outcomes of reviews like this. During the time period of this study, the number of somewhat radical anterior decompressions was so limited at our institution that we cannot draw any meaningful conclusions from our own data, but must await the review of our own future data as well as that of others such as the proposed Saunders Cooperative Study that is presently being organized.

This review does not answer the question of which procedure is ultimately the best operation for all patients, but rather suggests that surgical approaches should be individualized.

**Conclusions**

Satisfactory anterior or posterior decompression does not necessarily mean an ideal outcome; however, a less than ideal outcome does not necessarily mean an inadequate or poorly performed operation or an inadequate decompression.

The review of this series with commonly selected procedures for cervical cord decompression for patients with CSM suggested that 1) there is a low rate of morbidity in even the older age group; 2) good functional outcome from both procedures is provided in the early postoperative period, but there is a progressive decline in good results in both groups of patients over time; 3) because of the nature of the surgical selection process, there are significant differences between the two groups in the age of the patients at surgery, type and number of levels of compression on the CT myelogram and the Pavlov ratio; 4) duration of symptoms prior to surgery is the only significant predictor of long-term outcome; 5) care should be taken to maintain postoperative blood volume and to avoid postoperative hypotension, which can result in early postoperative deterioration; 6) because severe cord atrophy and the duration of symptoms are of prognostic significance, early rather than late surgery seems desirable.

We believe that this review confirms that there is more to CSM than cord compression. There is a certain percentage of patients who will not achieve the desired clinical improvement even though adequate decompression is done. There is also a group who will initially improve following surgery and then later deteriorate. It is suggested in our review of this data as well as a review of recent literature that there is increasing enthusiasm for anterior decompression of the spinal cord. Although in general the anterior decompressions in this series were done on a somewhat younger age group of patients and were limited to one or two levels, a more radical anterior decompression involving multiple-level corpectomies appears to offer some additional benefit over the anterior procedures that simply involved removal of spondylitic spurs with anterior fusion alone. The availability of MR imaging should help us better understand the late deterioration that is seen in some patients.

**References**


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