Research Article

Outcome factors in surgically treated patients for cervical spondylotic myelopathy

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Context/Objective: To investigate prospectively preoperative parameters that might be related to the outcome of surgically treated patients for cervical spondylotic myelopathy (CSM).

Design: Prospective study.

Setting: Single Center in Ioannina, Greece.

Participants: Thirty-six patients were included in the study. There were 21 males and 15 females, mean age 50.8 years, range 39–70 years. The mean BMI was 27.3.

Outcome measures: From each patient, we recorded age, sex, BMI, symptoms, duration of symptoms, comorbidities, lifestyle, myelopathy grade based on MRI and levels of compression. All patients completed the modified JOA (mJOA) and NPE questionnaires preoperatively and at 1, 3, 12 months and 5-years postoperatively.

Results: The mean mJOA score significant improved from 10.8 ± 1.9 points preoperatively to 16.6 ± 2.2 points at 12 months postoperatively. The mean mJOA score at 5-years postoperatively was 15.5 ± 3 points. The difference was still highly significant. The mean NPE score significant improved from 59.8 ± 12.2 points preoperatively to 28.2 ± 8.5 points at 1 month, to 35.8 ± 8.1 points at 3 month and to 28.2 ± 8.8 points at 12 months postoperatively. Younger patients had significant higher baseline mJOA scores and significant higher mJOA scores 5-year postoperatively. No correlation was found between sex, BMI, symptom duration, baseline mJOA or myelopathy grade and outcome at 12 months or 5-year postoperatively.

Conclusion: Age was highly predictive factor of outcome for patients undergoing surgical treatment of CSM.

Keywords: Cervical spondylotic myelopathy, Surgery, outcome, ACDF

Introduction

Cervical spondylotic myelopathy (CSM) is the most common cause of spinal cord dysfunction in persons over 55 years of age and rare in persons under 40 years of age.¹ The incidence of CSM was estimated to be at least 41 per million and the prevalence at least 605 per million in North America.² Age-related alterations to the spinal axis is the causative factor. Symptoms progress steadily and involve upper extremity complaints such as clumsiness of the arms and hands, inability to perform fine motor tasks, numbness or

weakness and lower extremities symptoms such as gait instability and imbalance.³ In more severe cases, there are long-tract signs such as spasticity and abnormal reflexes such as Babinski's or Hoffman's sign. There may be also bladder, rectal disturbances and erectile dysfunction.^{4,5} MRI is the preferred examination and demonstrates cord signal changes suggestive of severe compression. There are hyperintense signal changes on T2-weighted images (T2WI) and hypointense changes on T1WI.

Early surgical treatment may stop further deterioration and improve the neurological condition and quality of life by decompressing the neural elements, restoring lordosis and preventing further disease progression.² Surgical treatment options include both

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anterior (cervical discectomy and fusion, cervical corpectomy and fusion) and posterior (laminectomy, laminoplasty) approaches.^{2,4} The preoperative planning does not only involve the surgical approach, anterior or posterior, but also the number of levels that should be treated and the decision to perform fusion or arthroplasty after discectomy.⁶ Postoperatively most patients experience improvement; however, the key factors that predict the surgical outcome remain unclear.⁷ This is important in identifying ideal candidates for surgery and predicting the degree of functional improvement. To date several factors such as age, duration of symptoms and preoperative neurological function have been reported to have prognostic implications; however, few studies with long-term follow-up exist.⁷ The aim of the present study was to identify prognostic factors associated with the favorable outcome of patients treated surgically for CSM.

Methods

This is a prospective study approved by the University Hospital of Ioannina review board and informed consent was received from all patients. The study involved patients that were treated by anterior cervical microdiscectomy and fusion (ACDF) (with artificial cages) over a 2-year period (September 2010 to March 2012). The inclusion criteria were the presence of symptoms or signs suggestive of CSM and compatible findings in the imaging work-up. The exclusion criteria were infection, neoplastic disease, previous surgery for CSM, rheumatoid arthritis, ankylosing spondylitis, previous trauma and symptomatic lumbar spinal stenosis. On MRI myelopathy was classified into three grades. Grade I when there was absence of intramedullary signal intensity (SI) abnormality on T1WI or T2WI, grade II when there was no intramedullary SI abnormality on T1WI and high intramedullary SI on T2WI and grade III when there was low-intensity intramedullary signal abnormality on T1WI and high-intensity intramedullary signal abnormality on T2WI.⁸ All patients underwent cervical X-ray immediately postoperative and at 1 month, 3 months, 1 year and 2 years postoperatively. Cervical MRI was performed 6 months postoperatively.

Surgical technique

All patients received ACDF by the same senior surgeon (SV). Surgical procedures were performed using the anterior approach via a right-sided skin incision. The posterior longitudinal ligament was always excised completely in order to achieve adequate neural decompression. The polyetheretherketone (PEEK) Fidji cervical

cages (Abbott Spine, Bordeaux, France) were used, which were filled with bone graft.

Outcome measures

Age, sex, BMI, symptoms, duration of symptoms, comorbidities, lifestyle, myelopathy grade based on MRI and levels of compression were recorded. All patients completed the modified JOA (mJOA) and NPE questionnaires preoperatively and at 1, 3, 12 months and 5 years postoperatively.^{9,10} The mJOA score is one of the most commonly used outcome measures to assess functional status in patients with CSM. The mJOA is an 18-point scale that addresses four groups of dysfunction: upper and lower limbs, sphincter and sensory capacity of the upper limbs.⁹ The NPE questionnaire consists of 57 questions and evaluates neck pain, lower and upper limbs dysfunction, satisfaction with self-care ability, leisure situation and sexual life.¹⁰

Statistical analysis

The internal consistency of the NPE questionnaire was assessed using Cronbach's alpha. For the convergent validity, we used Pearson correlation coefficients for the association between the mJOA and the NPE scores. The descriptive results of patients' characteristics were presented as mean $\pm$ SD. We used the Mann-Whitney *U* test and *T*-test for the comparison of preoperative with postoperative data. For continuous variables, we used the Spearman Rho analysis. MANOVA test was used for the multivariate analysis. A 2-sided *P* value < 0.05 was considered statistically significant.

Results

Thirty-six patients met the inclusion criteria, including 21 males and 15 females, mean age 50.8 years (range 39–70 years). The mean BMI was 27.3 (range 21.7–35.9). Table 1 presents the demographic and diagnostic characteristics of patients. Nine patients were operated on one level, 17 in two levels, 8 in three levels and 2 in four levels. Frequent symptoms included numbness, weakness, neck pain and loss of balance. Adequate spinal cord decompression was seen in all patients immediately postoperative and 6-month follow-up. None of the patients included in the study required revision surgery for inadequate cord decompression nor for treatment of adjacent segment disease. The mean mJOA score improved from 10.8 ± 1.9 points preoperative to 16.6 ± 2.2 points at 12 months postoperative ($P < 0.0001$). There was no decline in the mJOA score during this period. One patient showed no improvement based on the mJOA score. At 5-years follow-up 1 patient

Table 1 Patients' data.

Characteristics	% (No of patients)
Sex	
Male	21 (58.3%)
Female	15 (41.7%)
Mean age	50.8
Anatomical level of stenosis	
C3–C4	8 (22.2%)
C4–C5	23 (63.8%)
C5–C6	30 (83.1%)
C6–C7	13 (36.1%)
No. of stenotic levels	
1	9 (25%)
2	17 (47.2%)
3	8 (22.2%)
4	2 (5.6%)
Mean duration of symptoms $\pm$ SD (mo)	21 $\pm$ 8.3
MRI grade	
0	1 (0.8%)
1	31 (86.1%)
2	4 (11.1%)
Baseline mJOA score	
Mild (> 15)	1 (2.7%)
Moderate (12–14)	18 (50.0%)
Severe (< 12)	17 (47.3%)
BMI	
Obese	7 (19.4%)
Overweight	23 (63.9%)
Normal	6 (16.7%)

died and 5 were lost to follow-up. From the remaining 30 patients, 6 underwent laminectomy for lumbar stenosis. The mean mJOA score at 5-years postoperatively was 15.5 ± 3 points. There was a decline in the mJOA score in 4 patients during this period. The difference was still highly significant compared to preoperative mJOA ($P < 0.0001$) (Table 2).

The mean NPE score improved from 59.8 ± 12.2 points preoperatively to 28.2 ± 8.5 points at 1 month ($P < 0.0001$), to 35.8 ± 8.1 points at 3 month ($P < 0.0001$), to 28.2 ± 8.8 points at 1 year ($P < 0.0001$) and to 32.4 ± 7.9 points at 5 years ($P < 0.0001$) postoperatively (Table 2). Younger patients had significant higher baseline mJOA scores ($P = 0.014$) than older patients. Also, younger patients showed higher postoperative mJOA scores at 12 months ($P = 0.06$) and a statistical significant difference at 5-year post-surgery ($P = 0.01$). No correlation was observed between outcome at 12-months or 5-years postoperatively and

Table 2 Functional outcome.

	Preoperative	1-year postoperative	5-year postoperative
mJOA	10.8 ± 1.9	$16.6 \pm 2.2^*$	$15.5 \pm 3^*$
NPE	59.8 ± 12.2	$28.2 \pm 8.8^*$	$32.4 \pm 7.9^*$

*Statistical significant difference compared to preoperative score.

the following variables sex ($p = 0.63$), BMI ($P = 0.47$), symptoms duration ($P = 0.59$), baseline mJOA ($P = 0.55$) or myelopathy grade ($P = 0.7$) (Table 3). In multivariate analysis, no factor reached statistical significance. Regarding convergent validity, the NPE was moderate correlated with the total mJOA score ($r = -0.51$). The internal consistency of the NPE questionnaire, as measured by Cronbach's alpha, was excellent (0.97).

Discussion

The main finding of this prospective study was that patients that underwent surgery for CSM with ACDF had sustained improvement even at 5-year follow-up. Younger age was highly predictive of favorable outcome based on the mJOA score for patients undergoing surgical treatment of CSM. We found no association between sex, BMI, symptom duration or myelopathy grade on MRI and outcome based on the mJOA score. Although the present study included a limited number of patients, these important findings are relevant for the surgeon in the decision-making process.

Outcome predictors for patients treated surgically for CSM remain uncertain. The majority of evidence to date are based on retrospective studies.^{3,11,12} A recent systematic review that included 91 studies found only 16 studies of excellent design. The results showed that the most important predictors of outcome were preoperative severity and duration of symptoms. Other less significant predictors included signs, symptoms, comorbidities and smoking status.³ Apart from the study design, another limitation of the recent literature was the lack of use of the modified version of the JOA scale.¹¹ The present study had a prospective design and the mJOA was used, however preoperative disease severity and duration of symptoms were not found to have a significant correlation with patients' outcome and should not prohibit a surgical intervention. Regarding the NPE questionnaire, which evaluates neck pain and quality of life, the Cronbach's alpha was high, indicating potential item redundancy.

Younger age was associated with better outcome. This has also been reported from a prospective study that

Table 3 P values of possible prognostic factors.

	1-year postoperative	5-year postoperative
Age	0.06	0.01
Sex	0.63	0.95
BMI	0.47	0.69
Symptom duration	0.59	0.65
Baseline mJOA	0.55	0.37
Myelopathy grade	0.7	0.5

included 65 CSM patients.¹² The significance of age and baseline mJOA remained in the multivariate analysis. Contrary to our study, the degree of spinal cord compression and patterns of SI changes on MRI, although not independently predictive of outcome, correlated with the functional status at the time of presentation and patients' age.¹² Zhang *et al.* also reported the prognostic significance of age. After investigating 110 patients, the authors found that the best cut-off for predicting poor outcome were age over 63.1 years, symptom duration over 9 months and SI ratio over 1.455.¹³ Tetreault *et al.* recently investigated significant predictors of achieving a minimum clinically important difference on the mJOA scale at 2 years post-surgery for CSM. The results showed that key predictors on the mJOA scale were younger age, shorter duration of symptoms, nonsmoking status, and lack of significant gait impairment.¹⁴ Although gait impairment was investigated in the present study, we found no prognostic significance.

In this prospective study, we found no correlation between the grade of myelopathy on MR and patients' outcome. In a prospective study of 112 CSM patients that quantitatively assessed SI changes preoperatively and postoperatively, the SI ratio on T2 was the main significant prognostic factor of surgical outcome. The grading system that was used based on T2WI, which is close to the one used in our study, provided predictive information for patient's outcome.¹⁵ The fact that in our study myelopathy grade on MRI did not reach statistical significance might be explained by the limited number of patients included. Uchida *et al.* found that low SI on preoperative T1 but not on T2 correlated with poor outcome. Additionally, on postoperative MRI the presence of decreased SI on T1 and increased SI on T2 were associated with poor neurologic outcomes.¹⁶ The use of several different grading systems of SI changes on MRI have been used to assess prognosis.^{17,18} Furthermore, it is of great interest the implementation of latest MR techniques such as Diffusion Tensor Imaging (DTI) for CSM prognostication and diagnosis of cervical spinal cord disease.^{1,17–22}

Body mass index has been significantly associated with lumbar intervertebral disc degeneration on MRI and outcome of patients treated surgically for lumbar disc herniation.²³ No association was found in the present prospective study between BMI and the outcome of patients treated surgically for CSM. Thus, patients with increased BMI should not be prohibited from undergoing operative intervention. Nevertheless, increased BMI has been reported as predictor of infection in surgical CSM patients.²³

Conclusion

In conclusion, the present prospective study showed that patients that underwent surgery for CSM with ACDF had sustained improvement even at 5-year follow-up. Younger patients had better outcome based on mJOA score but no association was found for sex, BMI, symptom duration or myelopathy grade. These findings are relevant for the surgeon in the decision-making process.

Disclaimer statements

Contributors None.

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Declaration of interest None.

Conflict of interest None.

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