



Efficacy of surgical treatment in patients with cervical spondylotic myelopathy

Efikasnost hirurškog lečenja bolesnika sa cervikalnom spondilotičnom mijelopatijom

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Abstract

Background/Aim. Treatment options for cervical spondylotic myelopathy (CSM) are the topic for discussion due to the lack of controlled randomized prospective studies. Also, the natural history of CSM is unpredictable and the efficacy of surgical decompression is still controversial. The aim of this prospective study was to describe the results of surgical treatment of patients with CSM in a single institution. **Methods.** Fifty-nine patients with symptomatic CSM were enrolled in this single-center prospective study. At the end of the follow-up period of 12 months, 50 patients were analyzed. All patients were operated on; surgical decompression was performed by anterior or posterior surgical approach. Outcome evaluations were obtained preoperatively and 12 months postoperatively by using the following outcome measures: the modified Japanese Orthopedic Association (mJOA) scale, the Nurick score and the Neck Disability Index (NDI). The functional recovery ratio was calculated postoperatively by using Hirabayashi's formula. **Results.** According to our results, significant improvements were detected in all outcome variables (mJOA score, Nurick score and NDI). Also, a statistically significant improvement was observed in all three categories of patients according to the preoperative mJOA score (mild, moderate, severe). Twenty-three patients (46%) had a satisfactory functional recovery, while twenty-seven (54%) had an unsatisfactory functional recovery rate. **Conclusion.** Surgical treatment of CSM is a very effective treating method and it resulted in a significant improvement in all outcome measures for a 1-year follow-up period. New studies could be recommended to evaluate the course of the disease, define the optimal surgical strategy, and better determine surgical outcome predictors.

Key words:

spinal cord diseases; neck; surgical procedures, surgery; decompression, surgical; recovery of function.

Apstrakt

Uvod/Cilj. Izbor tretmana u lečenju cervikalne spondilotične mijelopatije (CSM) predstavlja temu za diskusiju zbog nedostatka kontrolisanih randomizovanih prospektivnih studija. Prirodan tok CSM nije moguće predvideti, a sa druge strane efikasnost hirurške dekompresije je i dalje diskutabilna. Cilj ove prospektivne studije bio je prikazivanje rezultata hirurškog lečenja bolesnika sa CSM u jednoj hirurškoj ustanovi. **Metode.** U studiju je uključeno 59 bolesnika sa simptomatskom CSM u jednom centru, na kraju perioda praćenja od 12 meseci, analizirano je 50 bolesnika. Svi bolesnici u studiji su operisani, a dekompresija je urađena prednjim ili zadnjim hirurškim pristupom. Ishod je praćen preoperativno i postoperativno nakon 12 meseci pomoću skala za merenje ishoda: modifikovana skala Japanskog Udruženja Ortopeda (mJOA), Nurick-ov skor i Neck Disability Index (NDI – indeks ograničenja sposobnosti zbog bola u vratu). Funkcionalni oporavak računat je nakon operacije, korišćenjem Hirabayashi-jeve formule. **Rezultati.** Prema našim rezultatima, značajno poboljšanje je registrovano prema svim skalama za merenje ishoda (mJOA, Nurick-ov skor, NDI). Pored toga, zabeleženo je statistički značajno poboljšanje u sve tri grupe bolesnika u odnosu na preoperativni mJOA (blaga, umerena i teška mijelopatija). Funkcionalni oporavak bio je zadovoljavajući kod 23 bolesnika (46%), dok je 27 bolesnika (54%) imalo nezadovoljavajući oporavak. **Zaključak.** Hirurško lečenje CSM veoma je efikasna metoda lečenja, ono dovodi do značajnog poboljšanja prema svim skalama za merenje ishoda u periodu praćenja od jedne godine. Takođe, mogu se predložiti nova istraživanja radi boljeg praćenja toka bolesti, definisanja optimalne hirurške strategije i boljeg definisanja faktora koji utiču na ishod operativnog lečenja CSM.

Ključne reči:

kičmena moždina, bolesti; vrat; hirurgija, operativne procedure; dekompresija, hirurška; funkcija, povratak.

Introduction

Cervical spondylotic myelopathy (CSM) is a progressive disease in its nature; it is also a degenerative disease and a common cause of neurologic impairment in the elderly¹⁻³. Spondylosis or the degenerative disease of the cervical spine is the most common cause of the cervical myelopathy. The disease is age-related due to the direct mechanical compression of the spinal cord and the onset of symptoms commonly occurs in a slow stepwise pattern with fine motor dysfunction, decreased hand dexterity and gait and balance worsening^{1, 2}. Degenerative changes in the cervical spine can be identified in the majority of individuals beyond the fifth life decade, but most of them are asymptomatic. Symptoms in the population with cervical degeneration are estimated and may be present in as much as 5% of the general population and exist along with a wide spectrum of symptoms, from axial neck pain to radiculopathy and spondylotic myelopathy⁴. The natural history of CSM is mixed, but generally progressive and approximately 20% to 60% of patients with symptomatic CSM will deteriorate over time without surgical intervention in a stepwise fashion⁵. According to the results from a recent study, surgery improves neurological outcomes, functional status and the quality of life in patients with CSM⁶. The effects of surgery on the full spectrum of CSM cases is still in question, and accurate prediction of the results from surgical interventions continues to be a challenge for surgeons.

The aim of this prospective study was to describe the results of the surgical treatment of patients with CSM in a single institution.

Methods

This prospective study was conducted in the Department of Neurosurgery at the Military Medical Academy in Belgrade, with the approval of the Hospital Ethics Committee. Fifty-nine symptomatic patients with symptomatic CSM were enrolled in this single-center study. Our study included the patients who were 18 years old or above, had a clinical diagnosis of CSM, radiographically detected cervical cord compression, with or without hyperintensity on T2W sequences on magnetic resonance images (MRI) and had no prior cervical spine surgery. All patients in our study were operated on by anterior or posterior surgical approach at the discretion of the attending surgeon and under the approval of the Collegium of Neurosurgeons at the Department. Nine patients were excluded from the study (one patient died from another disease in the follow-up period, two had a second operation in the adjacent cervical segment, and 6 were lost in the follow-up); 50 patients were analyzed in total (follow-up ratio: 85%). Patients with asymptomatic CSM, active infections, neoplastic diseases, rheumatoid arthritis, trauma, psychiatric diseases, previous surgeries in the cervical spine and patients with concomitant lumbar spinal stenosis were excluded.

Outcome assessments

Outcome evaluations included three outcome measures: the modified Japanese Orthopedic Association (mJOA) scale, the Nurick score and the Neck Disability Index (NDI). The values of measurements were obtained preoperatively and 12 months postoperatively, and functional recovery ratio was evaluated by using Hirabayashi's formula⁷⁻¹⁰. According to the preoperative mJOA scores, the patients were classified as having mild (mJOA > 15), moderate (mJOA 12-14) and severe myelopathy (mJOA < 12).

Statistical analysis

The collected data were presented by descriptive statistics, using the means and standard deviations for continuous variables and percentages for categorical variables. The *t*-test for paired data or the Wilcoxon test was used for continuous variables for comparing preoperative and postoperative measurements. The one-way ANOVA with repeated measures test was used to evaluate the changes in the outcome measurements recorded between the pre and postoperative measurements and sorted into three categories according to the preoperative mJOA score (mild, moderate, severe).

All statistical analyses were performed using software RStudio (0.098.976) and SPSS 17.0 (Chicago, IL).

Results

There were 59 subjects in the study, one patient died during the follow-up period of unrelated causes, two patients were excluded due to the second operation in the adjacent cervical segment, and six were lost during the follow-up period. After that, 50 subjects were analyzed. There were 37 men and 13 women and the average age was 59.06 (SD 10.98). Twenty-eight patients were operated on by an anterior approach and twenty-two underwent a posterior approach. The patients in the anterior surgical group were operated on by anterior cervical discectomy and fusion (ACDF) or ACDF and anterior cervical plate (ACP) fixation, and those in the posterior surgical group underwent laminectomy or laminectomy with lateral mass screw fixation. Table 1 summarizes demographic, clinical and outcome characteristics of the subjects in the study. In this study, there were 10 patients with one stenotic level, 18 with two, 16 with three, and 6 patients with four stenotic levels. The most involved segment was C5/C6 (35.6%), the second was C4/C5 (32.2%), on the third place was C6/C7 (19.5%), and at the end was C3/C4 (12.7%). Among the subjects in our group, 34 had high signal intensity on T2-weighted magnetic resonance images, while 16 subjects had normal T2 signal intensity. According to the mJOA scores of subjects in the study, 9 patients had mild myelopathy, 19 moderate and 22 had severe myelopathy preoperatively, whereas postoperatively, 26 patients had mild myelopathy, 14 moderate and 10 had severe cervical spondylotic myelopathy. Table 2 presents statistics for outcome

Table 1
Descriptive subjects' characteristics

Parameters	Values
Sex, n (%)	
male	37 (74)
female	13 (26)
Age (years), mean \pm SD	59.06 \pm 10.98
Number of stenotic levels, n (%)	
1	10 (20)
2	18 (36)
3	16 (32)
4	6 (12)
Anatomical level of stenosis, n (%)	
C3-C4	15 (12.7)
C4-C5	38 (32.2)
C5-C6	42 (35.6)
C6-C7	23 (19.5)
T2W signal, n (%)	
hyper	34 (68)
normal	16 (32)
Nurick score, mean \pm SD	
preoperative	2.70 \pm 1.18
postoperative	1.78 \pm 1.39
mJOA score, mean \pm SD	
preoperative	11.90 \pm 2.48
postoperative	14.46 \pm 2.89
mJOA score (preoperative), n (%)	
mild	9 (18)
moderate	19 (38)
severe	22 (44)
mJOA score (postoperative), n (%)	
mild	26 (52)
moderate	14 (28)
severe	10 (20)
Functional recovery rate, n (%)	
satisfactory	23 (46)
unsatisfactory	27 (54)
NDI score, mean \pm SD	
preoperative	25.88 \pm 8.40
postoperative	15.54 \pm 10.75
Surgical approach, n (%)	
anterior	28 (56)
posterior	22 (44)

mJOA – modified Japanese Orthopedic Association; NDI – Neck Disability Index; n (%) – number (percentage) of the patients; SD – standard deviation.

measures: Nurick score, mJOA and NDI preoperatively and postoperatively, and also the analysis of changes in outcome parameters between baseline and 12-month follow-up period for all patients. The extent of improvement in all outcome assessment measures shows that all outcome variables improved significantly from their baseline values after the operation ($p < 0.001$). Table 3 shows the analysis of changes in the outcome parameter mJOA pre and postoperatively. The patients were divided according to the preoperative mJOA score into three groups, mild (mJOA > 15), moderate (mJOA 12–14) and severe myelopathy (mJOA < 12). The extent of improvement was statistically significant in all three categories of patients according to the mJOA score ($p < 0.001$). The extent of functional recovery (recovery ratio, RR) was calculated by using the formula of Hirabayashi et al. ¹⁰ [postoperative mJOA score - preoperative mJOA score/full score - preoperative mJOA score) x 100]. A recovery rate in the mJOA that was less than 50% was considered as an unsatisfactory outcome. The mean RR was 47.99% (SD 35.05). In our study, 23 patients (46%) had a satisfactory functional recovery, while 27 (54%) of all patients had an unsatisfactory functional recovery by Hirabayashi's method, after operative treatment. No matter how it looks, Hirabayashi's formula and the recovery rate according to it, are very demanding, and this recovery ratio could be accepted as a very important fact for patients with CSM.

Table 3
Improvement in the mJOA score according to the category of myelopathy

Category of myelopathy	Preoperative mJOA score (mean \pm SD)	Postoperative mJOA score (mean \pm SD)	<i>p</i>
Severe	9.59 \pm 1.62	12.41 \pm 2.84	< 0.001
Moderate	12.95 \pm 0.85	15.47 \pm 1.95	< 0.001
Mild	15 \pm 0.01	17.22 \pm 0.97	< 0.001

For abbreviations see under Table 1.

Discussion

Cervical spondylotic myelopathy is the most common cause of spinal cord dysfunction in those over 50 years of age worldwide. Despite that, there remains a lack of a guiding strategy for the surgical management of patients with CSM ¹⁻³. CSM is caused by spinal cord ischemia, axonal stretch-associated injuries, and the combination of static factors and dynamic repeated compression of the spinal cord that lead to CSM in some patients ¹¹. The management of

Table 2
Outcome variables (pre- and postoperative values)

Score	Preoperative (mean \pm SD)	Postoperative (mean \pm SD)	Difference (mean \pm SD)	<i>p</i>
Nurick	2.70 \pm 1.18	1.78 \pm 1.39	0.92 \pm 0.88	< 0.001
mJOA	11.84 \pm 2.44	14.44 \pm 2.95	2.56 \pm 1.96	< 0.001
NDI	25.88 \pm 8.40	15.54 \pm 10.75	10.34 \pm 8.96	< 0.001

For abbreviations see under Table 1.

CSM is controversial. The fact that the surgical treatment of CSM is better than no treatment seems to be well established. However, even this assumption continues to be questioned. The results of some studies indicate that the outcome of surgically treated CSM has not improved in comparison to the natural history or nonoperative therapy and notes that there are no clear guidelines for selecting patients who will benefit from the surgery, while other studies favored surgical management^{6, 12, 13}. Reasons for that are: the presence of confounding variables, variable course of the disease, and the absence of randomized, controlled studies to allow evidence-based treatment choice^{6, 13}. Decompressive surgery for CSM has been the treatment of choice for most patients with neurological deficits. CSM is usually treated with either anterior or posterior decompression with or without fusion, and each has its advantages and disadvantages. The choice between the two is often determined by multiple and obscure rules^{14, 15}. However, the choice of strategy for the treatment of CSM is unclear and even today confusion about those topics remains. Numerous publications favor the nonoperative treatment in patients with a stable disease. Kadaňka et al.¹⁶ performed a prospective randomized study comparing conservative and operative treatment of patients with mild and moderate CSM (mJOA > 12) with no or very slow progression and long duration of symptoms. They analyzed clinical outcomes by modified JOA scores, recovery rates, results from a timed 10 m walk test, daily activity scores recorded by video, and subjective assessment of patients. The results of this study suggest that there was no significant difference in clinical outcome measures between groups in the 2-year follow-up period, which means that the surgery did not show better results than the conservative treatment during the follow-up period. Also, Kadanka et al.^{17, 18} continued to

follow their prospective, randomized study group in a 3 and 10-year follow-up period, and again they concluded there was no significant difference in clinical outcomes in that follow-up period. On the contrary, there were other studies that favor surgical treatment in patients with CSM, and it could not be concluded that surgery for CSM is not useful^{6, 11, 19, 20}. Therefore, Fehlings et al.⁶, in their prospective study of 278 patients, found a statistically significant improvement in mJOA after surgery, regardless of the surgical approach. In our prospective study, we also observed the significant improvement in all outcome measurements (mJOA score, Nurick score and NDI). We found a 2.56 ± 1.96 mean improvement in mJOA score after surgery; in the Nurick score, it was 0.92 ± 0.88 , and there was also a significant improvement in the NDI (10.34 ± 8.96). We analyzed the results of surgical treatment of CSM according to the preoperative mJOA (mild, moderate and severe), and we found a significant improvement in all three groups after the surgical treatment.

Conclusion

CSM is a very complex, multifactorial and heterogeneous disease with unpredictable natural history and the most common cause of spinal cord impairment in the elderly. Surgical treatment of CSM resulted in significant improvements in all outcome measures for a 1-year follow-up period, also, surgery prevents further disease progression. The anterior and posterior surgical approaches could be effective in treating CSM and preventing the devastating consequences of this disease. However, new studies are recommended for evaluating the course of the disease to define the optimal surgical strategy and better determine the surgical outcome predictors.

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