Is there a benefit to operating on patients (bedridden or in wheelchairs) with advanced stage cervical spondylotic myelopathy?

Fabrizio Borges Scardino · Leonardo Poubel Rocha ·
Alécio Cristino Evangelista Santos Barcelos ·
José Marcus Rotta · Ricardo Vieira Botelho

Received: 14 April 2009 / Revised: 20 July 2009 / Accepted: 27 December 2009 / Published online: 13 January 2010
© Springer-Verlag 2010

Abstract Surgical treatment of cervical spondylotic myelopathy (CSM) aims to prevent or delay the progression of the disease. Many patients are diagnosed in advanced stages of the disease, presenting severe functional disability and extensive radiologic changes, which suggests clinical irreversibility. There are doubts about the real benefit of surgery in patients who are seriously ill, bedridden or in a wheelchair. The objective of the study is to evaluate the effects of surgical treatment in the clinical outcomes of patients severely affected by CSM. We analyzed patients with CSM who received an operation at a single institution between 1996 and 2008. Cases with a preoperative Nurick score equal to 5 were studied. We describe postoperative clinical improvement and compare the demographics and clinical data between the patients who improved and those who had no improvement. Radiological findings were also analyzed. We evaluated 55 patients operated on. Nine presented with preoperative Nurick score of 5 (16.3%). The mean age was 69.77 ± 6.6 years (95% CI 64.65–79.90). The mean follow-up was 53.44 ± 35.09 months (CI 26.46–80.42). Six patients (66.6%) achieved functional improvement when assessed by the Nurick scale, regaining the ability to walk. All patients improved on the JOAm scale, except one. The mean preoperative Nurick score was 5, while the mean

postoperative Nurick score was 4.11 ± 0.92 (95% CI 3.39–4.82) (Wilcoxon $p = 0.027$). The mean preoperative JOAm score was 6.4, and postoperative was 9.88 ± 2.31 (CI 95% 8.10–11.66) (Wilcoxon $p = 0.011$). All spinal cords presented high-intensity signal on T2-weighted images. There was no correlation between the number of spinal cord high-intensity signal levels and clinical improvement. Three out of seven patients (whose image was adequate for analysis) had evident spinal cord atrophy, and two of them did not improve clinically. In the whole sample of patients, the mean length of disease for those who improved was 9.25 ± 7.31 months (95% CI 1.56–16.93), and for those who did not improve was 38.00 ± 19.28 months (95% CI 9.91–85.91) (Mann–Whitney $p = 0.02$). In conclusion, two-thirds of patients with CSM Nurick scores of 5 who were either bedridden or in wheelchairs at the time of diagnosis improved at least one degree on the Nurick scale after surgical treatment, thus returning to walking. The JOAm scale was more sensitive to clinical changes than the Nurick scale. Patients with longer lengths of disease had worse outcomes.

Keywords Spinal cord compression · Spondylosis · Surgery · Prognosis

Introduction

Cervical spondylotic myelopathy (CSM) is the most common disease of the cervical spinal cord in elderly people [1]. CSM is caused by cervical spondylosis, which is secondary to degenerative spine changes related to age. In addition, CSM often occurs in patients with a previously narrow vertebral canal. Although there are several possible courses of development for CSM, including the

F. B. Scardino · L. P. Rocha · A. C. E. S. Barcelos ·
J. M. Rotta · R. V. Botelho
Spine Surgery Section, Hospital do Servidor Público
Estadual de São Paulo, São Paulo, Brazil

F. B. Scardino (✉)
Av. Fortaleza, 961, Apt. 201, Itapua, Vila Velha,
Espírito Santo 29101-575, Brazil
e-mail: fabriziobs@bol.com.br

stabilization of symptoms, this disease often presents a progressive clinical deterioration and may lead to severe disability [2].

Although surgical treatment of CSM aims to, at least, prevent or delay the progression of the disease, clinical improvement is frequently observed postoperative. Some clinical factors, such as length of disease and neurological status at diagnosis, are considered to be related to the prognosis with regard to neurological recovery; as a result, patients with longer lengths of disease or poor neurological status at diagnosis have poor prognoses.

There are doubts about the real benefit of surgery in patients who are seriously ill, bedridden or in a wheelchair. The literature addressing the surgical treatment of patients in advanced stages of CSM is scarce, consisting of articles with small samples; this is likely due to the fact that there are doubts about the benefits of surgery in these cases.

Objective

To evaluate the effects of surgical treatment on the clinical outcomes of patients severely affected by CSM.

Methods

We analyzed patients with CSM who received an operation at a single institution between 1996 and 2008. The patients were classified according to the Nurick's classification of disability (Table 1) [3]. Cases with a preoperative Nurick score equal to 5 were studied (patients who were bedridden or in wheelchairs at the time of diagnosis). Neurological and functional status were assessed at admission and in July 2008. Those patients with preoperative Nurick scores less than 5 and those with co-morbidities that affect gait were excluded.

We also used the evaluation system proposed by the Japanese Orthopedic Association (JOAm) modified by Benzel et al. [4], which incorporates analysis of the upper limbs. This scale was also used to permit detection of any changes in the patient's clinical status (Table 2).

Table 2 Japanese Orthopaedic Association Cervical Spine Myelopathy Functional Assessment Scale, modified by Benzel et al. [4]

	Score
Motor dysfunction score of the upper extremities	
Inability to move hands	0
Inability to eat with spoon but able to move hands	1
Inability to button shirt but able to eat with a spoon	2
Able to button shirt with great difficulty	3
Able to button shirt with slight difficulty	4
No dysfunction	5
Motor dysfunction score of the lower extremities	
Complete loss of motor and sensory function	0
Sensory preservation without ability to move legs	1
Able to move legs but unable to walk	2
Able to walk on flat floor with a walking aid (i.e., cane or crutch)	3
Able to walk up and/or down stairs with handrail	4
Moderate to significant lack of stability but able to walk up and/or down stairs without handrail	5
Mild lack of stability but able to walk with smooth reciprocation unaided	6
No dysfunction	7
Sensory dysfunction score of the upper extremities	
Complete loss of hand sensation	0
Severe sensory loss or pain	1
Mild sensory loss	2
No sensory loss	3
Sphincter dysfunction score	
Inability to micturate voluntarily	0
Marked difficulty with micturation	1
Mild to moderate difficulty with micturation	2
Normal micturation	3

In addition, we compare the demographics and clinical data between patients who improved and those who had no improvement.

The decision-making process was based on the original algorithm proposed by Naderi et al. [5]. In the presence of an effective kyphosis or ventral spinal cord compression up to three levels, the anterior surgical approach was used. In patients with maintenance of an effective lordosis or dorsal

Table 1 Nurick's classification of disability in CSM [3]

Grade 0	Root signs and symptoms. No evidence of spinal cord involvement
Grade 1	Signs of spinal cord involvement, but no difficulty walking
Grade 2	Slight difficulty walking which does not prevent full-time employment
Grade 3	Gait abnormality prevents employment, but does not require someone else's help to walk
Grade 4	Able to ambulate only with assistance (walker)
Grade 5	Chair bound or bedridden

Fig. 1 Algorithm for surgical decision-making in cervical spondyloathic myelopathy (based on [5])

Table 3 Demographics and clinical data

Case	Age (years)	Gender	Nurick pre	Nurick post	JOAm pre	JOAm post	Surgery
1	72	F	5	5	7	9	Laminectomy
2	80	M	5	4	8	11	ACDF
3	77	F	5	4	8	13	Laminectomy and fusion
4	74	F	5	2	2	9	Laminectomy
5	71	F	5	5	6	6	Laminectomy and fusion
6	62	F	5	4	6	11	Corpectomy and fusion
7	66	F	5	5	9	11	Laminectomy
8	65	M	5	2	5	13	Corpectomy and fusion
9	61	M	5	4	7	9	Laminoplasty

Pre preoperative, post postoperative, JOAm modified JOA scale, ACDF anterior cervical discectomy and fusion

compression the posterior approach was elected. In the cases with straightened spine, the position of spinal cord compression was essential for the decision-making. Patients with spondylolisthesis or straightened spine operated by dorsal approach were fused and instrumented using lateral masses screw systems (Fig. 1).

Statistics

Demographic data are described using the mean, standard deviation and confidence interval (CI) 95%.

The distributions of the pre- and postoperative Nurick and JOAm scale scores are described by the mean, standard deviation and CI 95%. Differences in distribution were analyzed by the Wilcoxon test.

Results

We evaluated 55 patients operated during the study period. Nine presented with Nurick scores of 5 (16.3%) and were selected for analysis. The demographic and clinical data of these patients are presented in Table 3.

The mean age of the patients was 69.77 ± 6.6 years (95% CI 64.65–79.90) and the mean follow-up was 53.44 ± 35.09 months (CI 26.46–80.42).

Results of surgery

Six patients (66.6%) achieved functional improvement when assessed by the Nurick scale, regaining the ability to walk. All patients improved on the JOAm scale, except one patient who had the same score postoperatively (Table 3).

The mean preoperative Nurick score was 5 (range 5–5), and the mean postoperative Nurick score was 4.11 ± 0.92 (95% CI 3.39–4.82) (Wilcoxon $p = 0.027$). The mean preoperative JOAm score was 6.4 ± 2.06 (CI 95% 4.85–8.03), and the mean postoperative JOAm score was 9.88 ± 2.31 (CI 95% 8.10–11.66) (Wilcoxon $p = 0.011$).

MRI analysis

The radiological analysis was based on images from seven out of the nine patients since only seven patients had a high enough picture quality to allow for adequate evaluation.

Fig. 2 MRI of case 9. Four levels of spinal cord high-intensity signal in a patient who returned to walking after surgery

Table 4 Comparison between patients who improved and not improved

Data	Patients with Nurick improvement	Patients without Nurick improvement
<i>n</i>	6	3
Mean age (years)	69.8	69.6
Gender	3 males; 3 females	3 females
Length of disease (months)	9.2	38
JOA pre	6.4	9.8
Chair bound	3	2
Bedridden	3	1

All spinal cords presented high-intensity signals on the T2-weighted images (T2WI). The changes in the spinal cord signals were distributed as follows: one level of high-intensity signal in T2WI in two cases; two levels in three cases; three levels in one case; and four levels in one case. There was no correlation between the number of spinal cord high-intensity signal levels and clinical improvement since a patient with two levels of high-intensity signal in T2WI showed no improvement, while another patient with four levels of spinal cord signal changes had postoperative clinical improvement (Fig. 2).

Three out of the seven patients had evident spinal cord atrophy, and two of them did not improve clinically. Four patients showed no atrophy and improved clinically (Fisher, $p = 0.42$).

Comparative analysis between data from patients who improved and those who did not improve

The demographics and clinical characteristics of the patients who returned to walking (postoperative Nurick score ≤ 4) were compared with those of patients who retained a Nurick score of 5 (Table 4).

There was no significant difference between the ages of patients in both groups. Six patients improved (three females and three males), and three patients had no improvement (all females) (Fisher $p = 0.45$). The mean length of disease for those who improved was 9.25 ± 7.31 months (95% CI 1.56–16.93), and the mean length of disease for those who did not improve was 38.00 ± 19.28 (95% CI 9.91–85.91) (Mann–Whitney $p = 0.02$).

Discussion

In 1972, Nurick defined CSM as a generally benign disease with an initial commitment followed by a period of stability, except in elderly patients, in whom the disease tends to have a progressive course [6]. Clarke and Robinson [2] later defined four patterns of the clinical course for CSM in the absence of an operation: slow progression of symptoms with episodes of exacerbation, periods of exacerbation alternating with periods of clinical stabilization, abrupt initial presentation followed by slow progression of symptoms and abrupt initial presentation followed by clinical stabilization.

Fig. 3 Multiple levels of anterior and posterior spinal cord compression in a patient who had postoperative clinical improvement (case 4)

Many authors have described that in the advanced stages of compressive myelopathies, the spinal cord lesion can be irreversible. In these cases, the window for surgery was lost (Fig. 3) [7, 8].

The clinical status of patients with CSM can be evaluated using scales of neurological and functional assessment; the most cited scales in the literature are the Nurick and JOAm scales. The Nurick scale proposes a score based on symptoms, neurological examination and ability to walk. This score ranges from 0 (less affected) to 5 (most affected) [3]. On the other hand, the JOAm scale evaluates four parameters (motor dysfunction of the upper extremities, motor dysfunction of the lower extremities, sensory dysfunction of the upper extremities and sphincter dysfunction), assigning points for each one separately. The JOAm score ranges from 0 (most affected) to 18 (asymptomatic) [4].

The JOAm scale was also applied because it allows for the assessment of the four limbs and is more sensitive to clinical changes than the Nurick scale [9]. However, improvement in the JOAm scale does not necessarily represent a functional gain, unlike the Nurick scale, in which the improvement of only one degree means a patient totally dependent (bedridden or in wheelchair) now has partial functional and social independence (able to walk).

Some factors, such as longer time of symptoms, presence of spinal cord signal change and spinal cord atrophy on MRI, advanced disease at the diagnosis and presence of clinical comorbidities are associated with poor prognosis in patients with CSM [10–17].

Chiles et al. [18] noted that spinal cord atrophy had a highly significant predictive value in multivariate analyses, but was only weakly predictive when observed in univariate analyses. In the present study, the presence or absence

Fig. 4 Evident spinal cord atrophy between C4 and C5 in T1-weighted image

of spinal cord atrophy could be studied in seven patients (Fig. 4). Among the three patients who had spinal cord atrophy, two did not improve. Four patients had no atrophy, and all of them improved. Although the correlation between atrophy and neurological prognosis is suggestive, the number is too small to reveal significant differences.

Mastronardi et al. [19] found a significant correlation between the surgical results and the length of the patient's clinical history. They also observed a correlation between spinal cord signal presence and the surgical results. Alafifi et al. [20] stated that spinal cord T2WI hyperintense signal was not so absolutely related to the final prognosis but patients who do not have clonus or spasticity may experience a good surgical outcome and may have a reversal of the MRI abnormality. They reported a less favorable surgical outcome in the presence of spinal cord low signal on T1-weighted images (T1WI), clonus or spasticity. Chiles et al. [18] studied the changes of spinal cord signal as a prognostic factor, and they noted that the presence of preoperative signal changes was predictive of a poor surgical outcome, although it was not statistically significant. They attributed this lack of statistical significance to the small number of patients in their study group who presented with this finding.

All of the patients in the present study showed high-intensity signal on T2WI. This factor could not be correlated with the final neurological outcome. The small number of patients with a Nurick score 5 present in most studies on CSM does not allow a higher correlation between the prognosis and the radiological changes. The strongest data associated with the prognosis in our patients was the length of disease, which is in agreement with the data shown by Mastronardi et al. [19].

Few studies have presented separate results for each grade in the Nurick scale and the number of seriously ill patients operated on is low, limiting the conclusions of the papers published until now (Table 5).

In 1997, Macdonald et al. [21] studied eight cases of CSM with Nurick scores of 5 undergoing surgery and found 50% clinical improvement (improvement of at least one degree in the Nurick scale), in a mean follow-up of 31 months. Alternatively, in 2004, Matsunaga et al. [22] considered 31 patients with Nurick scores of 5 and reported improvement in only 16.2% at a mean follow-up of 211.2 months. Rajshekhar and Kumar [23], in 2005, evaluated 17 patients and found clinical improvement in 100% of patients with Nurick scores of 5 after 36.3 months of mean follow-up. In the present nine cases of patients with Nurick scores of 5, we found 66.6% clinical improvement in a mean follow-up of 53.4 months. Considering these four papers, a total of 65 patients were studied with a mean follow-up of 82.9 months; an improvement was demonstrated in $51.12 \pm 58.16\%$ of the cases (95% CI 41.42–143.68).

Although there is no consensus regarding the natural history of CSM, it is unlikely that patients who are seriously ill, with advanced neurological deficits and radiological findings, can improve without surgical treatment. In

contrast, the surgery was able to improve the functional status of most of these patients.

Conclusion

Two-thirds of patients with CSM with a Nurick score of 5, who were either bedridden or in wheelchairs at the diagnosis, improved at least one degree on Nurick scale after surgical treatment, thus regaining the ability to walk. The JOAm scale was more sensitive in detecting clinical changes than the Nurick scale. Patients with longer lengths of disease had poorer outcomes.

Conflict of interest statement None.

References

- Cooper PR (1997) Cervical spondylotic myelopathy. *Contemp Neurosurg* 19(25):1–7
- Clarke E, Robinson P (1956) Cervical myelopathy: a complication of cervical spondylosis. *Brain* 79:483–510
- Nurick S (1972) The pathogenesis of the spinal cord disorder associated with cervical spondylosis. *Brain* 95:87–100
- Benzel EC, Lancon J, Kesterson L, Hadden T (1991) Cervical laminectomy and dentate ligament section for cervical spondylotic myelopathy. *J Spinal Disord* 4:286–295
- Naderi S, Benzel EC, Baldwin NG (1996) Cervical spondylotic myelopathy: surgical decision making. *Neurosurg Focus* 15:1(6):e1
- Nurick S (1972) The natural history and the results of surgical treatment of the spinal cord disorder associated with cervical spondylosis. *Brain* 95:101–108
- Epstein J, Janin Y, Carras R, Lavine LS (1982) A comparative study of the treatment of cervical spondylotic myeloradiculopathy. Experience with 50 cases treated by means of extensive laminectomy, foraminotomy, and excision of osteophytes during the past 10 years. *Acta Neurochir* 61:89–104
- Symon L, Lavender P (1967) The surgical treatment of cervical spondylotic myelopathy. *Neurology* 17(2):117–127
- Dalitz K, Vitzthum HE (2008) Evaluation of five scoring systems for cervical spondylogenic myelopathy. *Spine J* [Epub ahead of print]
- Ebersold MJ, Pare MC, Quast LM (1995) Surgical treatment for cervical spondylotic myelopathy. *J Neurosurg* 82:745–751
- Gonzalez-Feria L (1975) The effect of surgical immobilization after laminectomy in the treatment of advanced cases of cervical spondylotic myelopathy. *Acta Neurochir (Wien)* 31:185–193
- Philips D (1973) Surgical treatment of myelopathy with cervical stenosis. *J Neurol Neurosurg Psychiatry* 36:879–884
- Guidetti B, Fortuna A (1969) Long-term results of surgical treatment of myelopathy due to cervical spondylosis. *J Neurosurg* 30:714–721
- Mehalic TF, Pezzuto RT, Applebaum BI (1990) Magnetic resonance imaging and cervical spondylotic myelopathy. *Neurosurgery* 26:217–227
- Matsuda Y, Miyazaki K, Tada K et al (1991) Increased MR signal intensity due to cervical myelopathy. *J Neurosurg* 74:887–894
- Yone K, Sakou T, Yanase M, Ijiri K (1992) Preoperative and postoperative magnetic resonance imaging evaluations of the cervical spinal cord in myelopathy. *Spine* 17(Suppl 10):S388–S392

Table 5 Literature data in surgical treatment of Nurick 5

Author	Year	<i>n</i> (Nurick 5)	Improvement rate (decrease unless 1 grade in Nurick scale) (%)	Follow-up (months)
Macdonald et al. [21]	1997	8	50	31
Matsunaga et al. [22]	2004	31	16.2	211.2
Rajshekhar and Kumar [23]	2005	17	100	36.3
Scardino et al.	2010	9	66.6	53.4
		$\sum n = 65$	Mean = 58.20%	Mean = 82.97

Year year of publication, *n* number of Nurick 5 patients studied
Improvement rates are expressed in percentage of cases

17. Kumar VGR, Rea GL, Mervis LJ, McGregor JM (1999) Cervical spondylotic myelopathy: Functional and radiographic long-term outcome after laminectomy and posterior fusion. *Neurosurgery* 44:771–778
18. Chiles BW 3rd, Leonard MA, Choudhri HF, Cooper PR (1999) Cervical spondylotic myelopathy: patterns of neurological deficit and recovery after anterior cervical decompression. *Neurosurgery* 44(4):769–770
19. Mastronardi L, Elsawaf A, Roperto R, Bozzao A, Caroli M, Ferrante M, Ferrante L (2007) Prognostic relevance of the post-operative evolution of intramedullary spinal cord changes in signal intensity on magnetic resonance imaging after anterior decompression for cervical spondylotic myelopathy. *J Neurosurg Spine* 7(6):615–622
20. Alafifi T, Kern R, Fehlings M (2007) Clinical and MRI Predictors of outcome after surgical intervention for cervical spondylotic myelopathy. *J Neuroimaging* 17(4):315–322
21. Macdonald RL, Fehlings MG, Tator CH, Lozano A, Fleming JR, Gentili F, Bernstein M, Wallace C, Tasker RR (1997) Multilevel anterior cervical corpectomy and fibular allograft fusion for cervical myelopathy. *J Neurosurg* 86:990–997
22. Matsunaga S, Sakou T, Taketomi E, Komiya S (2004) Clinical course of patients with ossification of the posterior longitudinal ligament: a minimum 10-year cohort study. *J Neurosurg* 100(3 Suppl Spine):245–248
23. Rajshekhar V, Kumar GSS (2005) Functional outcome after central corpectomy in poor-grade patients with cervical spondylotic myelopathy or ossified posterior longitudinal ligament. *Neurosurgery* 56(6):1279–1285