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Original Research Article

Factors affecting surgical outcomes in cervical spondylotic myelopathy

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ABSTRACT

Background: Cervical spondylotic myelopathy (CSM) is the most common cause of spinal cord dysfunction in adults over 40 years. It is often progressive, and delayed diagnosis may result in irreversible disability. Surgical decompression is the primary treatment modality in moderate to severe cases. This study evaluated clinical and radiological prognostic factors influencing postoperative recovery in CSM.
Methods: A prospective observational study was conducted between February 2023 and February 2024 in the department of neurosurgery, government medical college Kottayam. A total of 85 patients undergoing anterior or posterior decompression surgery for CSM were included. Clinical outcomes were assessed using Nurick's grade and the modified Japanese orthopaedic association (mJOA) scale (Benzel's modification). Radiological parameters including effective canal diameter and intramedullary signal changes on T2-weighted MRI were studied. Statistical analysis (ANOVA, chi-square) was used to correlate factors with outcomes.
Results: Better outcomes were associated with younger age (<40 years), symptom duration <1 year, Nurick grade 0-2, single-level compression, effective canal diameter >11 mm, and absence of T2 hyperintensity. Poor prognosis was linked to age >60 years, symptoms >2 years, higher Nurick grade (four to five), multilevel compression, canal diameter <9 mm, and well-defined T2 signal changes. The newly developed prognostic scoring system showed good correlation with outcomes.
Conclusions: Early diagnosis and timely surgical intervention significantly improve functional outcomes in CSM. Age, symptom duration, preoperative disability, canal diameter, and intramedullary MRI changes are key prognostic indicators. The proposed prognostic scale may aid in clinical decision-making.

Keywords: Cervical spondylotic myelopathy, Spinal stenosis, Prognostic factors, Surgical outcome, Nurick grade, mJOA score, T2 MRI hyperintensity

INTRODUCTION

Cervical spondylotic myelopathy (CSM) is a degenerative disorder that represents the most common cause of spinal cord dysfunction in adults over the age of 40.[1] It results from progressive degenerative changes in the cervical spine, leading to narrowing of the spinal canal and compression of the spinal cord. The clinical presentation is typically insidious and progressive.[1] While conservative treatment provides limited relief, surgical decompression remains the standard of care for moderate to severe disease.[1]

Surgical outcomes, however, are highly variable and appear to be influenced by patient-specific and radiological factors.[1]

This study evaluates the impact of these factors on postoperative outcomes and proposes a practical prognostic scoring system to assist in surgical decision-making.

METHODS

This prospective observational study was conducted between February 2023 and February 2024 at the department of neurosurgery, government medical college, Kottayam. Ethical committee approval was obtained prior to initiating the study.

A total of 85 patients with a clinical and radiological diagnosis of CSM requiring surgical decompression were enrolled after obtaining informed consent.

Patients aged between 18 and 80 years were included, while those with other causes of spastic quadriparesis were excluded. Clinical assessment was done using Nurick's grading system. Radiological parameters included effective canal diameter and intramedullary T2 hyperintense signal changes.

Surgical approach (anterior or posterior) was based on the location and number of levels of cord compression. Patients were followed postoperatively at 1 month and 3 months to assess improvement using Nurick's grading. Data were analyzed using IBM SPSS v21.0. Chi-square test, ANOVA, and paired t-tests were used, and $p<0.05$ was considered statistically significant.

RESULTS

Most patients were in the 40-60-year age group (45 patients), followed by <40 years (23 patients), and >60 years (17 patients). The proportion of improved outcomes was highest in the younger age group.

The 24 patients (25%) presented with symptoms of <1 year duration, 43 (45%) with 1-2 years, and 18 (19%) with >2 years. Outcomes were better in those with symptom duration <1 year.

The 34 patients (35%) had a mild preoperative disability (Nurick grade 0-2), while 38 (40%) had grade 3, and 13 (13%) had severe disability (grades 4-5). Improvement was most frequent in those with lower grades.

The 19 patients had a canal diameter >11 mm, with 89% improving postoperatively. In contrast, only 5.9% of those with <9 mm diameter improved; 76.5% had poor prognosis.

The 20 patients had one level of compression, 24 had two levels, and 41 had three or more levels. Improvement was seen in 80% with one level and 62.5% with two levels, while 53.7% with three or more levels worsened.

The 45 patients had no signal change, 16 had ill-defined changes, and 24 had well-defined changes. Improvement was seen in 60% without signal changes, while 70% with well- defined changes worsened.

In our study, 80% with a score of 9 or less worsened; 59% with a score of 10-13 remained static; and 81% with a score of 14 or above improved.

Table 1: Demographics and baseline clinical data, (n=85).

Variables	Category	N (%)
Age group (in years)	<40	23 (27.1)
	40-60	45 (52.9)
	>60	17 (20.0)
Duration of symptoms (in years)	<1	24 (28.2)
	1-2	43 (50.6)
	>2	18 (21.2)
Preoperative Nurick grade	0-2	34 (40.0)
	3	38 (44.7)
	4-5	13 (15.3)
Canal diameter (mm)	>11	19 (22.4)
	9-11	49 (57.6)
	<9	17 (20.0)
Levels of compression	1	20 (23.5)
	2	24 (28.2)
	≥3	41 (48.2)
T2 signal change	None	45 (52.9)
	Ill-defined	16 (18.8)
	Well-defined	24 (28.2)

Table 2: Surgical outcome by prognostic variables.

Prognostic variable	Category	Improved (%)	Stationary (%)	Deteriorated (%)
Age group (in years)	<40	87.0	13.0	0.0
	40-60	55.6	37.8	6.6
	>60	5.9	41.2	52.9

Continued.

Prognostic variable	Category	Improved (%)	Stationary (%)	Deteriorated (%)
Symptom duration (in years)	<1	54.2	37.5	8.3
	1-2	27.9	44.2	27.9
	>2	11.1	38.9	50.0
Nurick grade	0-2	70.6	23.5	5.9
	3	23.7	60.5	15.8
	4-5	7.7	30.8	61.5
Canal diameter (mm)	>11	73.7	21.1	5.3
	9-11	38.8	46.9	14.3
	<9	5.9	17.6	76.5
Compression levels	1	80.0	20.0	0.0
	2	62.5	33.3	4.2
	≥3	7.3	39.0	53.7
T2 signal change	None	60.0	31.1	8.9
	Ill-defined	18.8	56.2	25.0
	Well-defined	8.3	20.8	70.9

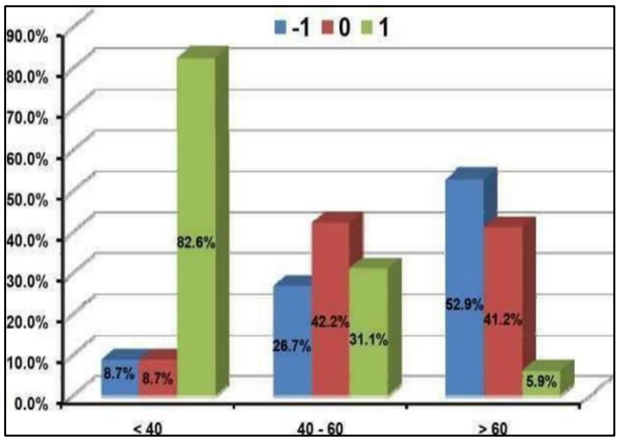

Figure 1: Age vs. outcome.

The average age was 49±12 years. There was statistically significant difference in outcome between age groups. The 82.6% below 40 showed significant improvement while 52.9% of those more than 60 had a poor outcome while in the 40-60 age group 42.2% had intermediate outcome (p=0.000<0.05) (ANOVA test).

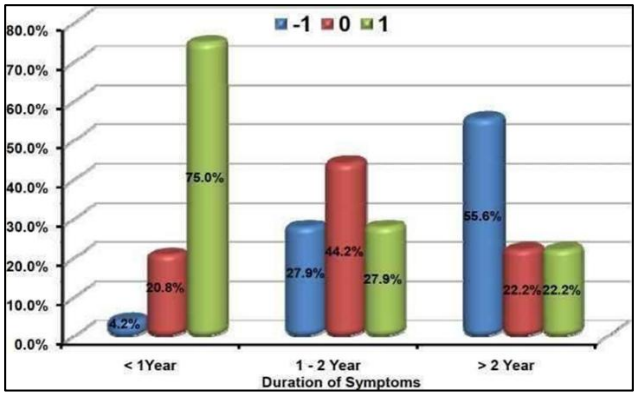

Figure 2: Duration vs. outcome.

The range of duration of symptoms varies from 16.8±7.2 months. There was statistically significant difference in outcome between duration of symptoms (p=0.000<0.05) (ANOVA test).

The 75% of the subjects with symptom duration less than 1 year had a good prognosis while 55.6% above 2 years had a poor outcome with 44.2% had an intermediate outcome in the 1-2 year duration.

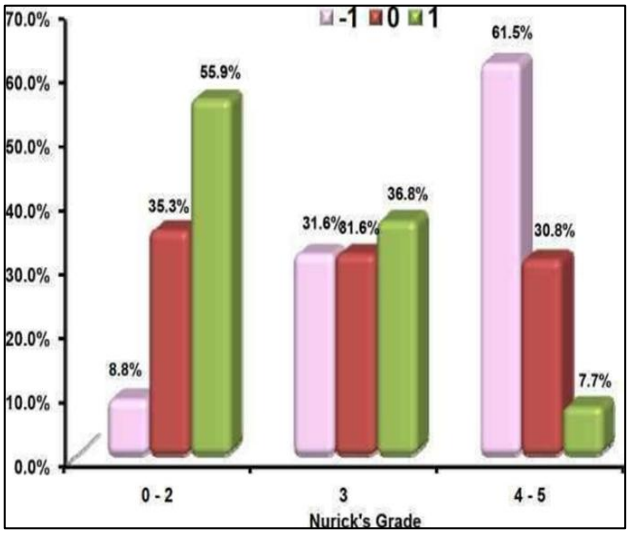

Figure 3: Nurick's grade vs. outcome.

The average Nurick's grade was 2.2±0.7. There was statistically significant difference between Nurick's grade and outcome (p=0.000<0.05) (ANOVA test).

The 55.9% with Nuricks grade between 0-2 improved while 36.8% improved with a grade of 3 while 61.5% with Nuricks grade 4-5 had a poor outcome and only 7.7% improved.

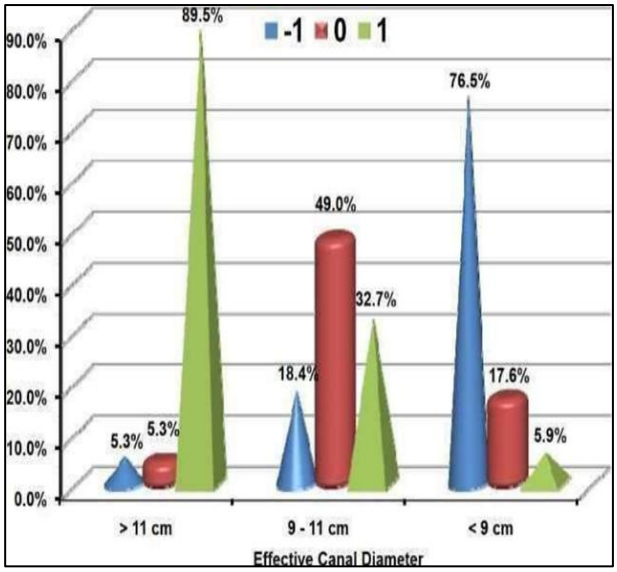

Figure 4: Effective canal diameter vs. outcome.

The average effective canal diameter was 10.0±1.3 mm. There was statistically significant difference between effective canal diameter and outcome (p=0.000<0.05) (ANOVA test). The 89.5% of those with canal diameter more than 11 mm improved with only 5.3% showing no improvement. The 76.5% of those with canal diameter less than 9 mm had a poor prognosis while only 5.9% improved.49% with canal diameter 9-11 mm had an intermediate prognosis.

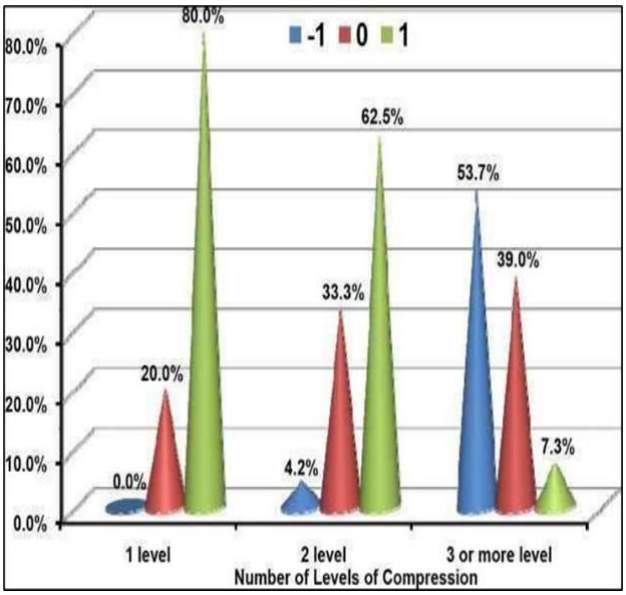

Figure 5: Number of levels of compression vs. outcome.

There was statistically significant difference in the outcome between the number of levels of compression (p=0.000<0.05) (ANOVA test). The 80% with a single level compression improved while 62.5% with 2 levels of compression improved while in those with more than three levels involved only 7.3% improved with 53.7% showing a poor outcome and 39% with an intermediate result.

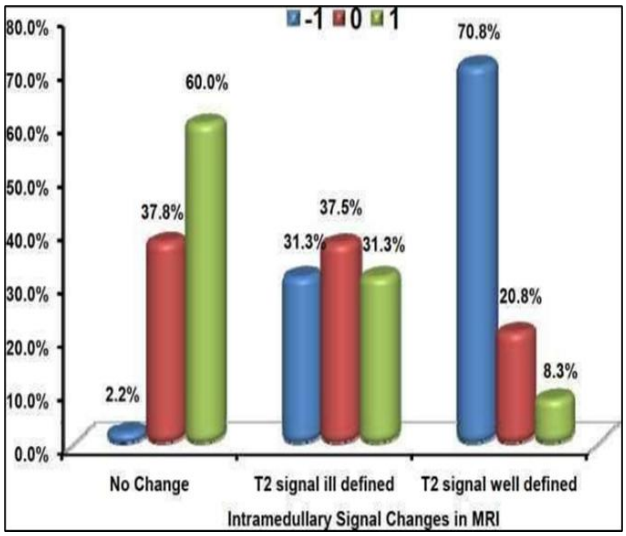

Figure 6: Intramedullary signal changes in MRI vs. outcome.

There was statistically significant difference in outcome between group of patients with and without intramedullary signal changes in MRI and also the type of T_2 signal change (p=0.000<0.05) (ANOVA test). The 60% of those with no intramedullary changes improved while with ill-defined changes 31.3% had a good outcome and equal percentage had a bad prognosis with 37.5% having an intermediate progress. The 70.8% with well-defined changes did not improve and only 8.3% showed a favourable outcome.

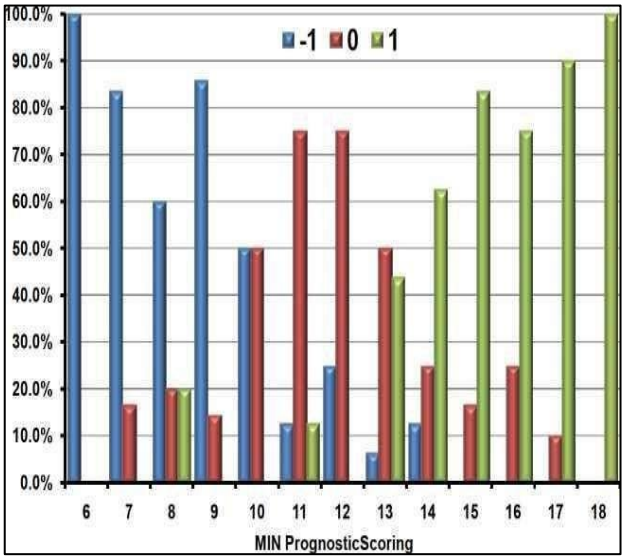

Figure 7: MIN prognostic scores and outcome.

Table 3: MIN score prognostic groups and surgical outcomes (including overall result).

MIN score range	N	Improved, N (%)	Stationary, N (%)	Deteriorated, N (%)	Comments
≤9	20	0 (0.0)	4 (20.0)	16 (80.0)	Poor prognosis
10-13	24	7 (30.0)	14 (59.0)	3 (11.0)	Intermediate prognosis
≥14	41	33 (81.0)	8 (19.0)	0 (0.0)	Favorable prognosis
Total/overall	85	34 (40.0)	28 (32.9)	23 (27.1)	Combined outcome data

There was statically significant difference between MIN prognostic scores and outcome (p=0.000<0.05) (ANOVA test). All subjects with MIN scores less than 10 had a poor outcome while those with score more than 13-18 had a favourable outcome. The 70% with MIN score within the 10-13 range had an intermediate progress with only 10% improving.

The 34 patients (approximately 40%)-showed improvement following surgery. A significant portion, 28 patients (about 33%), remained stationary, experiencing no notable change in their condition. Meanwhile, 23 patients (around 27%) deteriorated after the surgical intervention. Overall, the results suggest that surgery led to clinical improvement in a higher proportion of patients compared to those who worsened.

DISCUSSION

Managing CSM poses a challenge due to its multifactorial origins, unpredictable treatment responses, and diverse surgical approaches. Factors like age, symptom duration, neurological status, and radiological findings are known to impact outcomes, yet no extensive comprehensive study encompasses all these elements. This study evaluates 85 surgically treated CSM cases, analyzing the influence of each factor on the outcome. A comprehensive prognostic scale has been developed and assessed based on these factors.

Age

CSM predominantly affects middle-aged and elderly individuals, rarely occurring before age 40. In a study by Naderi better neurological improvement was noted in patients under 60. Langston and Jae Sung also identified age as a significant prognostic factor, with younger patients (under 40) showing better outcomes. This was corroborated by Fujiwara, Kun, and Fouyas who highlighted age as crucial in prognosis. In our study, among 85 patients, 23 were under 40, 45 between 40-60, and 17 were over 60. Improvement was seen in 82.6% of those under 40, while 40-60 year-olds had mixed results, and the majority over 60 worsened. These findings align with other studies, confirming better outcomes for those under 40 compared to those over 60.[1-4]

Duration of symptoms

Prolonged spinal cord compression can cause irreversible changes and neuron loss. Early decompression surgery yields better outcomes. Suri reported significant motor recovery in patients with symptoms lasting less than a year. Tanaka recommended decompression even in patients over 80, provided symptom duration was under three years. Other studies also noted better outcomes with shorter symptom duration. However, some, like Arnasson et al found no correlation between symptom duration and clinical outcomes. In our study, 24 patients had symptoms for less than a year, 43 had symptoms for one to two years, and 18 had symptoms for over two years. Improvement was seen in 75% of those with symptoms under a year, while longer durations correlated with poorer outcomes. In our study confirms that shorter symptom duration predicts better prognosis.[5-8]

Preoperative neurological status (Nurick's grade)

Langston 58 emphasized the prognostic importance of preoperative Nurick's grade, alongside age, symptom duration, and sensory evoked potential. Patients with a Nurick's grade of two or less had better outcomes. In our study, 34 patients presented with Nurick's grade 0-2, 38 with grade 3, and 13 with grade 4-5. Improvement was seen in 56% of patients with grades 0-2, while 62% of those with grades 4-5 worsened.[9-12]

Effective canal diameter

Normal midsagittal canal diameter from C3 to C7 is 17-18 mm, with developmental stenosis considered at <13 mm. Studies by Handa and Kun identified canal stenosis as a key prognostic factor. Post-laminoplasty recovery was better with a postoperative canal diameter above 12 mm, as noted by Kohno. Other studies also highlighted the importance of effective canal diameter. In our study, 19 patients had a canal diameter above 11 cm, 49 had diameters of 9-11 cm, and 17 had diameters under 9 cm. Improvement was seen in 89.5% of patients with diameters over 11 cm, while 76% with diameters under 9 cm worsened. This confirms the critical role of canal diameter in CSM outcomes.[13-16]

Number of levels of compression

CSM commonly affects C5-6 and C6-7 levels. Crandall and Batzdorf found two levels of involvement most common.[5] Studies by Fujiwara and Jae Sung Abu showed better outcomes with one or two levels of compression compared to three or more levels. Fessler found no negative correlation between disease extent and clinical outcome. In our study, 20 patients had one level of

compression, 24 had two levels, and 41 had three or more levels. Improvement was seen in 80% with one level and 62.5% with two levels, while 53.7% with three or more levels worsened. This confirms that fewer compression levels predict better outcomes.[17-20]

Intramedullary signal change in T2 MRI

MRI abnormalities on T2 images are associated with greater clinical disability. Chi-Jen Chen divided high signal intensity into type 1 (faint, fuzzy border) and type 2 (well-defined border), with type 2 indicating poorer prognosis. In our study, 45 patients had no signal change, 16 had ill-defined changes, and 24 had well-defined changes. Improvement was seen in 60% without signal changes, while 70% with well-defined changes worsened. This underscores the prognostic significance of intramedullary signal changes.[21-24]

Prognostic scale for CSM in predicting outcome

The prognostic scale was devised using these factors. In our study, 80% with a score of 9 or less worsened; 59% with a score of 10-13 remained static; and 81% with a score of 14 or above improved. This scale shows a good correlation with patient outcome.[25-28]

CONCLUSION

Surgical outcome in CSM is multifactorial. Younger age, early symptom duration, mild preoperative disability, single-level compression, and no T2 signal change significantly predict a better recovery. The newly devised prognostic score effectively stratifies patients based on their recovery potential, thus aiding clinical decision-making. This study is limited by its single-center prospective design and moderate sample size. The follow-up period was short, and patients with complex comorbidities were excluded. Additionally, the absence of randomization or a control cohort restricts the generalizability of the results. Variability in surgical technique and postoperative rehabilitation may also influence outcomes. Further multicenter, long-term studies are required to validate our prognostic scoring model.

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