

Original Article

Comparison of Postoperative Recovery rates in Cervical Spondylotic Myelopathy Patients Based on Spinal Cord Signal Changes

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ABSTRACT

Background: Cervical spondylotic myelopathy is associated with pathological changes in the spinal cord which is often reflected by the change in the signal intensity of the spinal cord observed on Magnetic Resonance Imaging (MRI). The prognostic significance of this signal intensity changes in preoperative patients remains controversial.

Objectives: To compare the recovery rate on the 30th postoperative day, between the cervical spondylotic myelopathy patients with and without preoperative hyperintensity changes in the cervical cord in MRI T2 weighted images.

Materials and Methods:

The type of the study was surgical prospective study. The place of the study was Bangladesh Medical University, Dhaka. The study population consisted of cervical spondylotic myelopathy patients of all ages and both sexes. Only the patients with a single level disc prolapse were included. All patients underwent anterior cervical discectomy and fusion (ACDF) with titanium cage. Purposive sampling was used as the sampling technique. Sample size was 32. Interviewer administered questionnaires and data collection sheets were used as data collection tools. There was no loss to follow up patients.

Statistical analysis:

Data were processed and analyzed by using computer software SPSS (Statistical Package for Social Sciences) version 26. Unpaired t test, Fisher's exact test and Mann-Whitney U test were done for data analysis. Statistical significance was set at p-value <0.05.

Results:

In this study, the patients were divided into Group A and Group B based on the presence or absence of hyperintensity changes in T2 weighted MRI images. There was a statistically significant difference between groups A and B regarding the recovery rate of the patients (p-value 0.043). The median recovery rate of Group A and Group B were 33% and 75% respectively. Fifteen (93.8%) and thirteen (81.3%) patients were male in Group A and Group B respectively. Eight (47.1%) and nine (52.9%) patients in groups A and B respectively were symptomatic for shorter than a year.

Conclusion: The study had revealed that patients with increased signal intensities in preoperative T2 weighted cervical MRI images had significantly less recovery rates than the patients without any signal change in their preoperative T2 weighted cervical MRI images resulting in their decreased alleviation of symptoms and relatively unfavourable quality of life after surgery.

Introduction:

Cervical spondylosis is a progressive disease that frequently causes cervical spondylotic myelopathy (CSM) which is the most common cause of spinal cord dysfunction in adults commonly resulting in slow, progressive neurological deterioration. The sequences of degenerative changes that constitute cervical spondylosis include intervertebral disc degeneration, disc space collapse, osteophyte formation, and hypertrophy of the ligamentum

flavum, lamina, and facets occurring often in conjunction with a narrow spinal canal. Additionally, the compromise of parenchymal blood flow compounds the effect of compression in CSM resulting in degeneration of the ascending and descending tracts of the cord^{1,2,3,4}.

Magnetic resonance imaging (MRI) is an invaluable examination tool in patients with compressive cervical myelopathy as it depicts the mechanism and

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severity of spinal cord compression. Intramedullary signal intensity changes on MR images in CSM patients are considered myelomalacia or cord gliosis due to a long-term, continuous compressive effect on the spinal cord. The increased signal intensity (ISI) of spinal cord on axial T2 weighted MRI images, also known as “snake-eye appearance,” is often observed in CSM patients^{4,5}.

The prognostic significance of signal intensity changes remains controversial. Some researches revealed that CSM patients presented with increased signal intensity (ISI) preoperatively have poor outcomes after surgery, while others reported no correlation between prognosis and preoperative ISI. Some studies even showed worse outcome in patients without ISI than patients with ISI on the preoperative MRI^{1,3,4,5,6,7,8}. Although the presence of hypointensity changes of the cervical cord in T1 MR Images indicates poor outcome, its clinical utility is questionable in routine clinical settings. A study on CSM patients showed that T1-WI signal hypointensity in the cervical spinal cord was present in only 26.9% (29/108) of the CSM patients⁹.

The purpose of this study was to evaluate if presence of spinal cord signal intensity changes in T2 weighted MRI images results in a less favourable outcome following surgery for CSM. This study would facilitate to ascertain the prognostic magnitude of the cord signal intensity change as a preoperative predictor of surgical outcome of cervical spondylotic myelopathy (CSM) patients. Moreover, this would be useful to establish T2 hyperintensity as a crucial preoperative prognostic factor for the surgery of patients with CSM. Comprehending the degree of benefit from surgical treatment would enable CSM patients to deliver instantaneous approval for surgery and any unwarranted operative treatments can be avoided. Hence, this would be effective in making a positive influence on the future neurosurgical outcome. This study would clarify discordant outcomes of prior related studies. Moreover the number of identical research accomplished in the past in Bangladesh is very few. Therefore, the result of this study would pave the way for novel research in future on this topic.

METHODOLOGY

This prospective interventional study was conducted over 18 months, from September 1, 2020, to February 28, 2022, at Bangabandhu Medical University (BMU), Shahbag, Dhaka, involving 32 patients with cervical spondylotic myelopathy (CSM), selected through purposive sampling. Inclusion criteria encompassed patients of all ages and sexes with CSM caused by single-level disc prolapse, while exclusion criteria included conditions such as ossified posterior longitudinal ligament (OPLL), traumatic cervical myelopathy, absence of clinical features of myelopathy, presence of cervical cord signal changes in T1-weighted imaging, surgical decompression via posterior approach, prior surgery for CSM, craniovertebral junction diseases (e.g., atlantoaxial dislocation or basilar invagination), arthritis (e.g., rheumatoid arthritis or ankylosing spondylitis), and other comorbidities such as diabetes mellitus or vitamin D deficiency. Data was collected using an interviewer-administered questionnaire and a data collection sheet, with no loss to follow-up, as all 32 patients reported on the 30th postoperative day. Some important operational definitions are -

$$\text{Recovery rate}^{10} = \frac{\text{myelopathy score at 30th postoperative day} - \text{preoperative myelopathy score}}{18 - \text{preoperative myelopathy score}} \times 100\%$$

Myelopathy score¹¹: It is the score of a cervical spondylotic myelopathy patient according to CSM functional assessment scale of Benzel et al. where scoring is done as follows -

Score

- A. Motor dysfunction score of the upper extremities:
- 0 : inability to move hands
 - 1 : inability to eat with a spoon but able to move hands
 - 2 : inability to button shirt but able to eat with a spoon
 - 3 : able to button shirt with great difficulty
 - 4 : able to button shirt with slight difficulty
 - 5 : no dysfunction

B. Motor dysfunction score of the lower extremities:

- 0 : complete loss of motor and sensory function
- 1 : sensory preservation without ability to move legs
- 2 : able to move legs but unable to walk
- 3 : able to walk on flat floor with a walking aid
- 4 : able to walk up and/or down stairs with hand rail
- 5 : moderate to significant lack of stability but able to walk up and/or down stairs without hand rail
- 6 : mild lack of stability but walk unaided with smooth reciprocation
- 7 : no dysfunction

C. Sensation:

- 0 : complete loss of hand sensation
- 1 : severe sensory loss or pain
- 2 : mild sensory loss
- 3 : no sensory loss

D. Spincter dysfunction score:

- 0 : inability to micturate voluntarily
- 1 : marked difficulty with micturition
- 2 : mild to moderate difficulty with micturition
- 3 : normal micturition

Spinal canal, dural sac and spinal cord diameters:

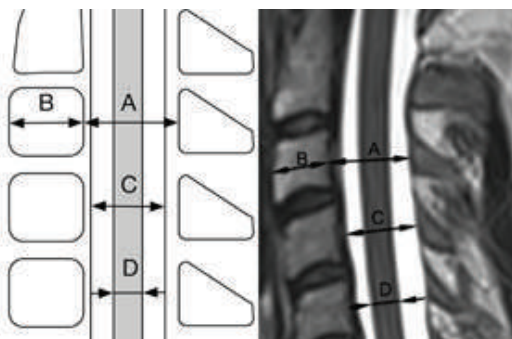


Figure 1: Line A – Canal diameter (from the posterior marginal line to the nearest point on the corresponding spinolaminar line), Line B – Vertebral body diameter, Line C – Thecal sac diameter (measured perpendicular to the dural sac), Line D – Cord diameter (measured perpendicular to the spinal cord)¹².

MRI grading of cervical stenosis due to single level disc prolapse:

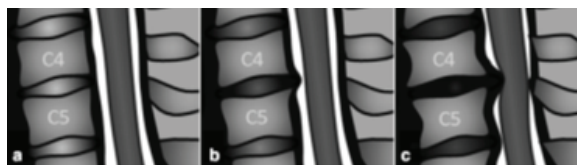


Figure 2- Schematic representation of the MRI Grading System on sagittal T2-WI. Grade 0, absence of canal stenosis (a); Grade 1, subarachnoid space obliteration exceeding 50% (b); Grade 2, spinal cord deformity (c); Grade 3, spinal cord signal change (d) in T2 MR image^{13,14}

Group A: This group includes cervical spondylosis patients with hyperintensity changes of the cervical cord in T2 weighted MR images (Fig. 3).

Group B: This group includes cervical spondylosis patients without hyperintensity changes of the cervical cord in T2 weighted MR images (Fig. 4).

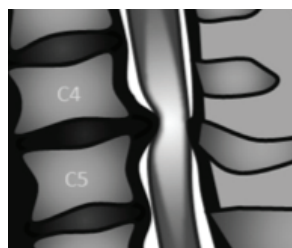


Figure 3: Hyperintensity cord change in Schematic midsagittal T2 MR image¹⁴

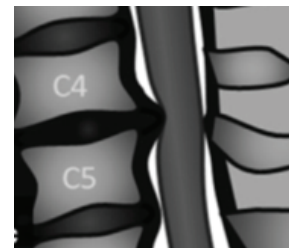


Figure 4: Schematic midsagittal T2 MR image showing no hyperintensity cord change¹⁴

Data were processed and analyzed using computer software SPSS (Statistical Package for the Social Sciences) version 26. Statistical tests done for data analysis were unpaired t test, Fisher’s exact test and Mann-Whitney U test. Statistical significance was set at p-value <0.05. After collection, data was checked for inadequacy, irrelevancy and inconsistency. Irrelevant and inconsistent data was discarded.

The variables in this study included hyperintensity changes of the cervical spinal cord in T2-weighted MR images, preoperative myelopathy scores, postoperative myelopathy scores (on the 30th postoperative day), and postoperative recovery rates (on the 30th postoperative day). Ethical clearance was obtained from the Institutional Review Board and BMU, with authorization from the neurosurgery department. All participants were thoroughly informed about the study's objectives, nature, potential risks, and benefits, ensuring their welfare, freedom, and health were safeguarded. Confidentiality was maintained, and participants were assured of their right to withdraw at any time. Written consent was obtained from all participants or their legal guardians voluntarily, without coercion or exploitation of vulnerabilities.

RESULTS: Patients ranged from 25 to 68 years old (mean age 48.8 ± 11.8). Most (34.4%) were aged 34–43. Of the 32 patients, 87.5% were male (male:female ratio 7:1). Symptoms lasted less than 1 year in 53.1%, 1–2 years in 28.1%, and over 2 years in 18.8%. The most common disc prolapse site was C5/6 (56.3%).

Table I: Age distribution in the patient groups with and without hyperintensity change (N=32)

Age (years)	Group A** (n=16)		Group B** (n=16)	
	Frequency(n)	Percentage (%)	Frequency(n)	Percentage (%)
25 – 34	1	6.25	1	6.25
34 – 43	9	56.25	2	12.50
43 – 52	1	6.25	4	25.00
52 – 61	1	6.25	6	37.50
61 – 70	4	25.00	3	18.75
Total	16	100.00	16	100.00

	Group A** (n=16)	Group B** (n=16)
Mean age±SD (in years)	45.7 ± 11.6	52 ± 11.6

*Unpaired t test was done (p-value was 0.133).
 ** Group A and B are patient groups with and without hyperintensity changes of the cervical cord in T2 weighted MR images respectively.

Out of 16 patients of group A, 15 (93.8%) patients were male and 1 (6.3%) patient was female. Additionally out of 16 patients of group B, 13 (81.3%) patients were male and 3 (18.8%) patients were female. No statistically significant difference regarding gender distribution between groups A and B in Fisher's exact test; p value 0.600.

Also there was no statistically significant difference between groups A and B regarding the duration of symptoms (Fisher's exact test; p value 0.796). The means (\pm SD) of preoperative myelopathy scores in groups A and B were 9.88 ± 2.66 and 10.50 ± 1.75 respectively. The unpaired t test revealed a p value of 0.438 implying no statistically significant difference. The means (\pm SD) of postoperative myelopathy scores in groups A and Group B were 13.25 ± 3.00 and 15.69 ± 1.89 respectively. The unpaired t test revealed a p value of 0.010 implying a statistically significant difference.

Table II: Comparison of the recovery rate of the study subjects (N=32)

Parameters	Group A (with hyperintensity)	Group B (without hyperintensity)	p value*
	n = 16	n = 16	
Recovery Rate (%)	Median 33.33	75.0	0.043
	IQR ^a 3.57 – 83.33	51.78 – 87.5	

^a IQR: Interquartile range; *Mann-Whitney U test was done (p value 0.043)

DISCUSSION

The study was accomplished to compare the recovery rate between cervical spondylosis myelopathy patients with and without preoperative hyperintensity changes of the cervical cord in T2 weighted MR images. Total 32 patients of both sexes were included in the study and there was no loss to follow up. All the patients had single level disc prolapsed and underwent single level ACDF surgery with titanium cage. In this study, the patients were divided into group A and Group B based on the presence or absence of hyperintensity changes of the cord in T2 MR images respectively.

The median recovery rates of groups A and B were 33% and 75% respectively and the cervical spondylotic myelopathy patients without an increase in signal intensity had a better recovery rate (p value 0.043). Zhang et al. reported significantly higher recovery rates in Group B (0.77 ± 0.12) than Group A (0.51 ± 0.22 ; $p < 0.0001$)⁸. Chatley et al. found no significant difference (Group A: $43.18\% \pm 38.38$, Group B: $58.53\% \pm 32.45$; $p > 0.05$)³.

The mean (\pm SD) age of all the patients was 48.8 ± 11.8 years. Out of all patients, 28 (87.5%) patients were male indicating the presence of a male predominance. Moreover, amongst entire study population, the major share of the patients (53.1%) was symptomatic for less than 1 year. The commonest site of prolapsed disc was at C5/6 (56.3%). These results are similar with the findings of Suri et al., where the mean age was 47.1 years, male predominance (79.5%) was present and the major share of the patients (58.9%) presented with the symptom duration of less than a year¹. Also these results are similar with the findings of Chatley et al., where the commonest site of single level prolapsed disc was also at C5/6 (45.9%)³. Fewer female patients in both groups may be due to women in developing countries primarily doing household work and less physically demanding jobs. Additionally, the male neurosurgery ward at BMU has about 1.5 times more beds than the female ward, increasing the likelihood of male admissions. Most cervical myelopathy patients presented within a year of symptom onset, likely due to limb weakness affecting mobility, daily activities, or employment.

The most frequent age ranges of groups A and B were 34 to 43 years (56.25%) and 52 to 61 years (37.5%) respectively. In both groups A and B, most of the patients were symptomatic for less than 1 year. There was no statistically significant difference between groups A and B regarding the age (p-value was 0.133), gender distribution (p-value was 0.600) and the duration of symptoms (p-value was 0.796).

These results can be compared with the findings of Chatley et al., where the means (\pm SD) of age (years) were 48.5 ± 10.7 and 44.5 ± 9.6 in groups A and B and the duration of symptoms (months) were 12.41 ± 18.36 and 6.16 ± 8.36 in groups A and B respectively with no statistically significant difference between the groups in both the cases (p-value was >0.05)³.

Preoperative myelopathy scores showed no significant difference between groups A and B (9.88 ± 2.66 vs. 10.50 ± 1.75 ; $p = 0.438$). However, postoperative scores were significantly higher in Group B (15.69 ± 1.89 vs. 13.25 ± 3.00 ; $p = 0.01$), likely due to better neuronal recovery in patients without hyperintensity. Chatley et al. found no significant difference in pre- or postoperative myelopathy scores between groups A and B³. In contrast, Zhang et al. reported a significant difference in preoperative scores ($p = 0.006$), with Group B scoring higher⁸.

This study found that cervical spondylotic myelopathy patients without increased signal intensity had better early postoperative recovery ($p = 0.043$). However, limitations include a small sample size (32 cases), short study duration, single-center purposive sampling, and potential bias. Variability in surgeons and techniques also affects outcomes, limiting the generalizability and reliability of the findings.

CONCLUSION: Since patients with increased signal intensity on preoperative T2-weighted MRI showed poorer recovery, evaluating these changes is important for predicting outcomes. Preoperative MRI should be used to assess signal changes, with attention to the number and severity of affected levels. Longer follow-up is recommended for future studies.

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