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Original Article

Surgery Section

Comparison of Nurick Score and Modified Japanese Orthopaedic Association Score as Prognostic Indices for Surgical Outcome in Cervical Spondylotic Myelopathy Cases: A Prospective Observational Study

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ABSTRACT

Introduction: Cervical Spondylotic Myelopathy (CSM) is a leading cause of spinal cord dysfunction, particularly in elderly populations. It presents with diverse motor, sensory and autonomic symptoms. Surgical decompression is the standard treatment, with prognostic tools such as the Nurick score and modified Japanese Orthopaedic Association (mJOA) score used to assess outcomes.

Aim: To compare the Nurick and mJOA scores in predicting functional outcomes following surgical intervention for CSM.

Materials and Methods: A prospective observational study was conducted over three years in the Neurosurgery Department of Dr. D. Y. Patil Medical College, Hospital and Research Centre, Pune, Maharashtra, India, from December 2021 to December 2024, including 40 patients diagnosed with CSM. Pre- and postoperative evaluations were performed using the Nurick score, mJOA score and Odom's criteria. Surgical interventions included anterior or posterior decompression. Statistical analyses included Wilcoxon signed-rank tests and Spearman's correlation to assess changes in scores and relationships with Odom's criteria.

Results: The mean age of participants was 52.88±15.17 years. The median pre- and postoperative Nurick scores were 3 and 1, respectively (p-value <0.0001), while mJOA scores improved from 14 to 16 (p-value <0.0001). Both scores demonstrated a strong correlation with Odom's criteria after surgery, with the mJOA score showing a greater association (ρ=-0.599 vs. ρ=0.502). Out of 40 cases, 35 patients (87.5%) showed improvement in their mJOA scores, while 29 patients (72.5%) demonstrated improvement in their Nurick scores at follow-up.

Conclusion: The mJOA score provides a more comprehensive evaluation of functional recovery in CSM patients, while the Nurick score remains valuable for rapid assessments. A tailored use of these tools based on clinical context and healthcare settings is recommended.

Keywords: Neurological deficits, Neurosurgery, Odom's criteria, Spinal cord dysfunction

INTRODUCTION

The CSM is a leading cause of spinal cord dysfunction, predominantly affecting the elderly population [1-3]. It arises from degenerative changes in the cervical spine, resulting in progressive spinal cord compression and associated neurological deficits [1]. The clinical presentations of CSM vary widely, including motor and sensory dysfunctions, pain and autonomic disturbances such as bladder and bowel control issues [2,3]. Early diagnosis and intervention are critical in preventing irreversible damage.

Surgical decompression remains the cornerstone of treatment for CSM, aiming to halt disease progression and improve neurological function. Prognostic indices play a vital role in guiding surgical decision-making and evaluating outcomes. Among these, the Nurick Score, which focuses on gait and mobility [4] and the mJOA Score, are widely used to assess a broader range of motor, sensory and bladder functions [5]. While both provide valuable insights into a patient's neurological status, they measure recovery differently, leading to an ongoing debate about which score offers superior predictive accuracy.

The present study aimed to directly compare the Nurick and mJOA scores in predicting functional outcomes following surgical intervention for CSM. By identifying the more accurate prognostic tool, this study seeks to improve surgical decision-making and optimise patient outcomes in CSM.

MATERIALS AND METHODS

A prospective observational study was conducted in the Neurosurgery Department of Dr. D. Y. Patil Medical College, Hospital and Research Centre, Pimpri, Pune, Maharashtra, India, from December 2021 to December 2024. Ethical clearance (IESC/S. SP/2022/21) was obtained and informed consent was secured from all participants.

Sample size calculation: The sample size was calculated based on the findings of Dalitz K and Vitzthum HE, which reported that the JOA score was 81% with the mJOA score at 95%, with a precision of 13% [6]. Using these parameters, the required sample size was determined to be 35. To ensure adequate representation and account for potential dropouts, the sample size was rounded up to 40. The calculation was performed using WinPEPI software version 11.65, a statistical tool commonly used for epidemiological and clinical research. The study employed a purposive sampling technique.

Inclusion criteria: Patients diagnosed with CSM based on clinical and radiological evidence who were medically fit for surgery and had no prior cervical spine operations were included.

Exclusion criteria: Patients with conditions such as amyotrophic lateral sclerosis, multiple sclerosis, or traumatic myelopathy, those exhibiting radiographic evidence of cervical compression without corresponding clinical manifestations, medically unfit patients, those

with radiculopathy without CSM, or any active infections, neoplastic diseases, rheumatoid arthritis and ankylosing spondylitis were excluded.

Study Procedure

Data were collected using a standardised form covering patient demographics, clinical presentations, imaging findings, surgical approaches and outcomes. The surgical techniques involved both anterior and posterior approaches to the cervical spinal cord. Anterior surgical approaches, such as cervical discectomy and corpectomy, were employed. These procedures were performed at single or multiple levels and were often combined with strut reconstruction, which involved bridging the space between the vertebral end plates using bone grafts or synthetic materials along with plate fixation for added stability. Posterior approaches, including laminectomy and laminoplasty, focused on decompressing the spinal cord by removing or reconstructing the laminae. Patients underwent decompression surgery via anterior or posterior approaches based on their individual clinical and radiological profiles. Preoperative and postoperative evaluations were performed using the Nurick Score, mJOA Score and Odom's criteria. Postoperative care included pain management, physiotherapy and follow-up evaluations over one month.

The Nurick score: Introduced by Nurick S in 1972, the Nurick Score [Table/Fig-1] is one of the oldest and most established tools for evaluating the severity of myelopathy. It was developed specifically to assess the degree of disability caused by spinal cord compression, focusing on a patient's ability to walk independently [4]. The score ranges from 0 (no symptoms of myelopathy) to 5 (severe disability, unable to walk).

Score	Description
0	Signs or symptoms of root involvement but without evidence of spinal cord disease
1	Signs of spinal cord disease but no difficulty in walking
2	Slight difficulty in walking which did not prevent full time employment
3	Difficulty in walking which prevented full-time employment or the ability to do all housework, but which was not so severe as to require someone else's help to walk
4	Able to walk only with someone else's help or with the aid of a frame
5	Chair bound or bedridden

[Table/Fig-1]: Nurick score.
The higher the score, the more severe the deficit

The modified Japanese Orthopaedic Association (mJOA) score: The mJOA Score [Table/Fig-2] offers a more comprehensive evaluation of neurological function in patients with CSM. Originally developed by the JOA, the mJOA Score was adapted to better suit Western patient populations [7]. This scoring system assesses motor function in both the upper and lower extremities, sensory deficits and bladder function, making it more detailed than the Nurick Score. The mJOA Score ranges from 0 (severe disability) to 18 (normal function), with each function (motor, sensory, bladder) rated individually.

Score	Motor dysfunction score of the upper extremity
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
Motor dysfunction score of the lower extremity	
0	Complete loss of motor and sensory function
1	Sensory preservation without ability to move leg
2	Able to move legs, but unable to walk
3	Able to walk on flat floor with a walking aid (cane or crutch)
4	Able to walk up and/or down stairs w/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 walks unaided with smooth reciprocation
7	No dysfunction
Sensory dysfunction score of the upper extremities	
0	Complete loss of hand sensation
1	Severe sensory loss or pain
2	Mild sensory loss
3	No sensory loss
Sphincter dysfunction score	
0	Inability to micturate voluntarily
1	Marked difficulty in micturition
2	Mild to moderate difficulty in micturition
3	Normal micturition

[Table/Fig-2]: Modified Japanese Orthopaedic Association scoring system.
The lower the score, the more severe the deficits

Odom's criteria: Odom's criteria [Table/Fig-3], first introduced by Odom GL et al., provide a simple and widely used method for evaluating the outcomes of surgical interventions, particularly in spinal surgeries. Initially designed to assess cervical spine surgery, these criteria remain relevant due to their straightforward grading system, which allows clinicians to assess functional outcomes based on patient-reported improvements in neurological function and overall quality of life [8].

Score	Rating	Description
1	Excellent	No symptoms related to cervical disease. Able to perform daily activities without limitations
2	Good	Moderate symptoms related to cervical disease. Able to perform daily activities without significant limitations
3	Satisfactory	Slight improvement in symptoms related to cervical disease. Significant limitations in daily activities
4	Poor	No improvement in, or aggravation of, symptoms related to cervical disease. Not able to perform daily activities

[Table/Fig-3]: Odom's criteria.

STATISTICAL ANALYSIS

Data were analysed using Statistical Package for Social Sciences (SPSS) version 27.0. Continuous variables were expressed as mean±Standard Deviation (SD) or median with Interquartile Range (IQR), while categorical variables were presented as proportions. Wilcoxon signed-rank tests compared pre- and postoperative scores. Spearman's correlation was used to assess the relationships between Nurick, mJOA and Odom's scores. Statistical significance was set at p-value <0.05. We compared the Nurick score and mJOA score with Odom's criteria after one month of surgery. Cohen's criteria were used to determine the effect size (the strength of the relationship) (Cohen J. Statistical Power Analysis for the Behavioural Sciences. 2nd ed. Lawrence Erlbaum Associates; 1988). Correlation coefficients between 0.10 and 0.29 represent a small association, coefficients between 0.30 and 0.49 represent a medium association and coefficients of 0.50 and above represent a large association or relationship.

RESULTS

In the present study, a total of 40 patients underwent surgical intervention for CSM. Among them, 30 patients (75%) were treated using the anterior approach, while the remaining 10 patients (25%) underwent surgery via the posterior approach. The duration of symptoms among the study participants ranged from two months to four years.

The mean age of participants was 52.88±15.17 years, with a male predominance (75%). The majority of the cases, i.e., 13 (32.5%), were in the age group of 51 to 60 years, followed by 11 patients (27.5%) in the age group of over 60 years [Table/Fig-4].

Variables	n (%)
Age (years)	
≤20	1 (2.5)
21-30	1 (2.5)
31-40	9 (22.5)
41-50	5 (12.5)
51-60	13 (32.5)
>60	11 (27.5)
Gender	
Female	10 (25)
Male	30 (75)

[Table/Fig-4]: Age and gender distribution (N=40).
Value expressed in frequency (n) and percentage (%)

Out of 40 patients, 20 (50%) experienced nape of neck pain, followed by 17 (42.5%) who reported tingling in their limbs. Difficulty in walking was observed in only 10 patients (25%) [Table/Fig-5].

Symptoms	n (%)
Nape of neck pain	20 (50)
Tingling of limbs	17 (42.5)
Numbness of limbs	15 (37.5)
Weakness of limbs	14 (35)
Radiculopathy	13 (28)
Difficulty in walking	10 (25)

[Table/Fig-5]: Various presentations of CSM.
Values expressed in frequency (n) and percentage (%)

In the cohort of 40 patients, 29 patients (72.5%) showed improvement in their Nurick scores, while 35 patients (87.5%) demonstrated improvement in their mJOA scores at one month post-procedure.

The median preoperative Nurick score was 3, while the postoperative Nurick score was 1. The median preoperative mJOA score was 14 and the postoperative mJOA score was 16, which was statistically significant (p-value <0.0001) [Table/Fig-6].

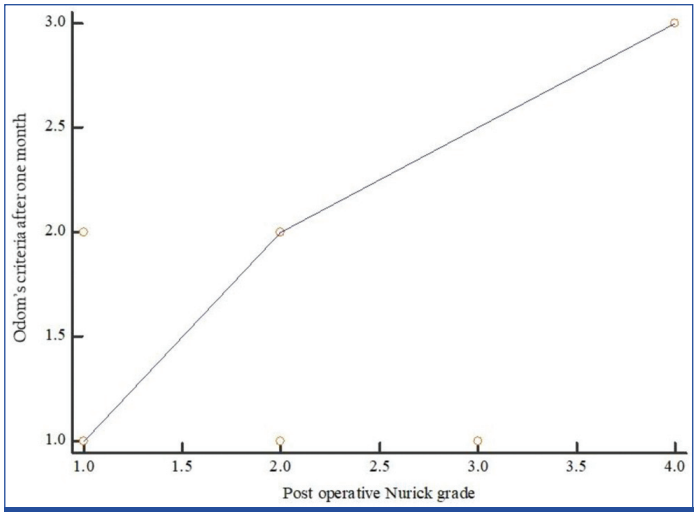
Variables	Mean±SD	Median (IQR)	Min-max	Significance
Nurick score				
Pre	2.40±0.98	3 (2-3)	1-5	Wilcoxon Z=4.7030, p<0.0001
Post	1.53±0.68	1 (1-2)	1-4	
mJOA				
Pre	14.20±2.09	14 (13-16)	9-17	Wilcoxon Z=-5.1594, p<0.0001
Post	15.85±1.31	16 (15-16)	11-17	

[Table/Fig-6]: Pre- and postoperative scores for Nurick score and mJOA score compared using Wilcoxon signed rank test.

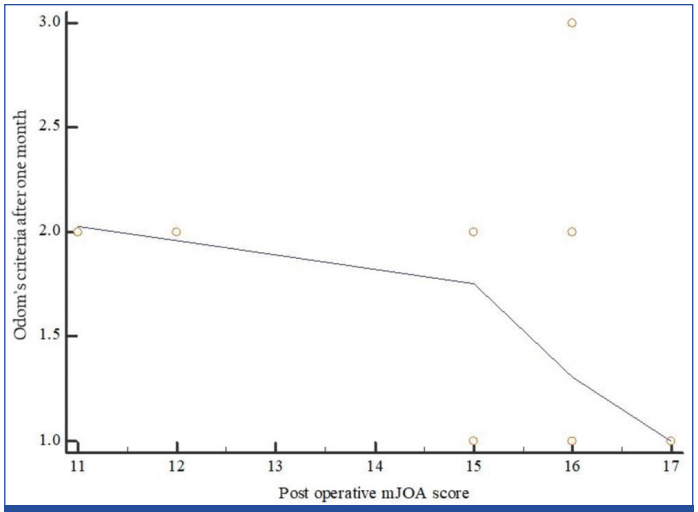
The mean Odom's criteria score after one month was 1.525, with a standard deviation of 0.554 and a range of 2. Comparison of the postoperative Nurick score with Odom's criteria after one month of surgery showed a strong positive correlation, while the postoperative mJOA score with Odom's criteria after one month exhibited a negative correlation between the two scores [Table/Fig-7-9].

Variable	Correlation	Nurick score after 1 month	mJOA score after 1 month
Odom's criteria after 1 month	Spearman's correlation coefficient (rho)	0.502 (0.226 to 0.703)	-0.599 (-0.768 to -0.354)
	Sig. (2-tailed)	0.001	<0.0001

[Table/Fig-7]: Correlation between Nurick and Odom's and mJOA and Odom's scores after 1 month of surgery.



[Table/Fig-8]: Scatter diagram comparing postoperative Nurick score and Odom's criteria after 1 month.



[Table/Fig-9]: Scatter diagram comparing postoperative mJOA score and Odom's criteria after 1 month.

DISCUSSION

The CSM represents a major cause of spinal cord impairment, frequently leading to disability, especially in the elderly population. The mean age in the present study was 56.8±11.2 years, which revealed a slight difference from the mean age (52.88±15.17 years) reported by King JT et al., [9]. The present cohort's average age was marginally higher, suggesting a potentially more advanced stage of the symptoms. However, the standard deviation in the cohort was notably smaller (11.2 vs. 15.17) compared to King JT et al., indicating a tighter clustering around the mean age [9].

The cohort exhibited a significantly skewed distribution toward males (30 males, 10 females), representing a 3:1 male-to-female ratio. In contrast, Yamazaki T et al., report a near-even distribution (33 males, 31 females) among their 64 participants, approximating a 1:1 ratio [10]. This difference underscores the importance of considering gender distribution when comparing studies and interpreting outcomes in CSM.

Cervicobrachial neuralgia was the most common symptom (50%) in the present study, which was similar to a study reported by Özkan N et al., [11]. Some patients experience neck pain that radiates to the shoulders or upper arms, while others report a diffuse, aching discomfort. Radicular pain may occur, if nerve roots are compressed along with the spinal cord. Interestingly, pain is not always present in all cases of CSM and the severity of pain does not necessarily correlate with the extent of spinal cord compression [12].

The second most common symptom reported by the patients was numbness, tingling, or "pins and needles" sensations in the hands and arms. This paresthesia may spread to the lower limbs as the

disease progresses. In some cases, there is a loss of proprioception, making it difficult for patients to sense the position of their limbs in space, which further contributes to balance issues. Perez T et al., found that this loss of proprioception can exacerbate gait disturbances and increase the likelihood of falls [13].

Motor impairment is an early symptom of CSM, frequently affecting fine motor skills and gait. Patients often report difficulty with tasks requiring manual dexterity, such as buttoning shirts or writing, due to weakness and stiffness in their hands. As the disease progresses, patients may develop spasticity in the lower extremities, resulting in a spastic gait and an increased risk of falls due to difficulty walking. Gait disturbance is often one of the earliest and most prominent complaints, where patients experience an unsteady, broad-based, or "wobbly" walk [14]. While difficulty in walking was the least common complaint among our patients, it is important to note that this symptom can significantly impact a patient's quality of life and physical independence.

In more advanced stages of CSM, patients may develop autonomic dysfunctions, including bladder and bowel issues. Urinary urgency, frequency and retention are the most common autonomic symptoms, which may significantly affect quality of life. Significant cord compression might lead to erectile dysfunction or faecal incontinence, although these were observed in rare instances [15]. None of the patients in the present study presented with autonomic dysfunctions.

Among the patients in the present study, the median preoperative Nurick score was 3, indicating moderate disability, while the median postoperative Nurick score was 1, representing only minor signs or symptoms of myelopathy. This indicates a significant improvement, which was statistically significant. The median preoperative mJOA score was 14 and the postoperative mJOA score was 16 among the patients with CSM, indicating a statistically significant improvement in functional outcomes following surgical treatment.

Several studies have directly compared the Nurick score and mJOA scores in predicting surgical outcomes for CSM [6,16-18]. Revanappa KK and Rajshekhar V found that 83.9% of patients improved in their Nurick scores, whereas 94.6% showed improvement in their mJOA scores at follow-up [16]. Dalitz K and Vitzthum HE observed that 33% of patients showed improvement in their Nurick scores. In contrast, a significantly higher proportion—81%—exhibited improvement in their mJOA scores [6]. Cheung WY et al., reported that 39 out of 55 patients (71%) demonstrated improvement in their JOA scores following surgical decompression [17]. Ikenaga M et al., found that the JOA score showed significant improvement (61%) following anterior corpectomy and fusion for multilevel cervical myelopathy and this improvement was maintained until the latest follow-up at 10 years [18].

Some studies suggest that the mJOA score demonstrates greater sensitivity in detecting postoperative improvements and may be a more reliable predictor of long-term functional outcomes [16,19,20]. This could be attributed to its multidimensional nature, capturing a wider range of functional domains affected by CSM. The complexity of the mJOA score, compared to the Nurick score, can make it more time-consuming to administer and may require specific training for accurate scoring [21]. This factor might limit its practicality in certain clinical settings.

The Nurick score and mJOA score each have their strengths and limitations. The choice between these two scoring systems should be made based on the specific requirements and goals of the healthcare setting. Factors such as the availability of resources, the complexity of the assessment and the desired level of evaluation for surgical outcomes should be carefully considered when selecting the appropriate tool for assessing patients with CSM. In some settings, the simplicity and clinical intuitiveness of the Nurick score may be preferable, while in others, the more comprehensive evaluation provided by the mJOA score may be more valuable. Ultimately, a tailored approach that considers the unique needs of the patient population and the healthcare environment is recommended when choosing between these two prognostic indices.

Limitation(s)

The study was conducted at a single centre, potentially limiting the applicability of the results to other settings. Variability in surgical techniques and postoperative rehabilitation protocols, which were not standardised across all patients, may have influenced the outcomes. Lastly, the subjective nature of scoring systems like the Nurick score and the mJOA score introduces a degree of observer bias, which may have affected the accuracy of outcome assessments.

CONCLUSION(S)

The choice between the Nurick score and mJOA score as prognostic indices for surgical outcomes in patients with CSM should be guided by careful consideration of the unique needs, resources and objectives of the healthcare setting. The evidence from the current study suggests that the mJOA score may have a stronger correlation with clinical outcomes in our cohort of patients, potentially offering a more clinically relevant and intuitive assessment of surgical outcomes. The mJOA score's broader evaluation of functional domains, including upper and lower extremity motor function, sensory disturbances and bladder function, may provide a more nuanced understanding of the impact of surgical intervention on a patient's overall quality of life.

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