Evaluation of five scoring systems for cervical spondylogenic myelopathy

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Abstract

BACKGROUND CONTEXT: Comparison of measured clinical deficits and outcomes is vital for international discussion about the identification and treatment of cervical spondylotic myelopathy (CSM). There is currently little information comparing outcomes as assessed by different CSM scoring systems.

PURPOSE: To qualitatively and quantitatively analyze five specific CSM outcome scores that are frequently used to assess the grade of severity and outcome after operative decompression.

STUDY DESIGN: This retrospective study evaluated the Nurick score, the Japanese Orthopedic Association score (JOA score), the Cooper myelopathy scale (CMS), the Prolo score, and the European myelopathy score (EMS).

PATIENT SAMPLE: The study included 43 patients with clinical and morphological signs of CSM, who underwent ventral decompression. Data were evaluated in sufficient detail to objectively assess the scores.

OUTCOME MEASURES: Clinical findings (funicular and radicular symptoms), recovery rate, symptom duration, age, economic situation, time away from employment, somatic-evoked potentials, and radiological findings were assessed.

METHODS: Scores were assessed using both pre- and postoperative clinical data. Correlations between scores, score improvement, and how well the scores reflected the clinical, diagnostic, and anamnestic data were analyzed using nonparametric, descriptive statistical tests. The recovery rate, as a measure of cumulative outcome, was also assessed and compared for each scoring system.

RESULTS: All five scores were suitable for qualitatively assessing the clinical characteristics and progression of cervical myelopathy. All showed a statistically significant correlation ($p<.05$), and measured postoperative improvement ($p<.001$). All scores also reflected clinical deficits except for the Prolo score, which rates the severity of CSM with an emphasis on data related to the economic impact on the patient's situation rather than on clinical symptoms per se. Quantitative assessment of clinical symptom improvement varied greatly among the scores, for example, Nurick score (33%) versus JOA score (81%). The recovery rates, as a measure of cumulative improvement, showed less variation among most of the scores. The Nurick score and the EMS measured clinical deficit improvements in significantly fewer patients than did the JOA score ($p<.05$).

CONCLUSIONS: Evaluating the recovery rate is essential for comparing the results of the five CSM scores evaluated in this study. There was a large quantitative difference among the scores as the result of the different criteria used to produce each score. Qualitatively, all five scores allowed evaluation of cervical myelopathy, but only the recovery rate allowed for statistical comparison. Advancements in the treatment of CSM depend on the ability of clinicians to evaluate the therapeutic results of CSM studies. This study suggests that using the recovery rate to assess outcome is best for comparing studies that use different scores.   © 2008 Elsevier Inc. All rights reserved.

Keywords: Cervical myelopathy; Scores; Outcome; Recovery rate; Comparison of different score results; Quality; quantity

Introduction

Cervical spondylotic myelopathy (CSM) is characterized by complex radicular and funicular symptoms. The patterns of clinical symptoms lead to a great variety of different treatment methods, ranging from conservative treatment to surgical procedures. It is therefore not surprising that a

Table 1
Nurick score

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

The higher the grade, the more severe the deficit.

variety of scores exist that use different criteria to evaluate the grade of severity and the outcome after therapeutic intervention. The ability to compare results after surgery for CSM is a necessity for international discussion among CSM researchers. The study presented here compares the Nurick score [1], the Japanese Orthopedic Association score (JOA score) [2], the Cooper myelopathy scale (CMS) [3], the Prolo score [4], and the European myelopathy score (EMS) [5]; these scores were analyzed to determine how well they reflected the clinical symptoms of CSM and outcome after operative decompression.

Table 2
Japanese Orthopedic Association score (JOA score modified by Keller 1993)

Criterion	Clinical situation	Points
Motor function upper extremity	Paralysis	1
	Fine motor function massively decreased	2
	Fine motor function decelerated	3
	Discreet weakness in hands or proximal arm	4
	Normal function	5
Motor function lower extremity	Unable to walk	1
	Need walking aid on flat floor	2
	Need handrail on stairs	3
	Able to walk without walking aid, but inadequate	4
	Normal function	5
Sensory	Upper extremity/lower extremity/trunk	
	Apparent sensory loss	1
	Minimal sensory loss	2
	Normal function	3
Bladder function	Urinary retention	1
	Severe dysfunction	2
	Mild dysfunction	3
	Normal function	4
Total score		0−17

The lower the score, the more severe the deficits. Normal function: 16+17; Grade 1: 12−15; Grade 2: 8−11; Grade 3: 0−7. Weight of the criterion in % of 17 points: upper extremity 23.5%; lower extremity 23.5%; sensory 3×11.8% (total: 35.4%); bladder and bowel function 17.6%.

Table 3
Cooper myelopathy scale

Upper extremity function		
	Grade 0	Intact
	Grade 1	Sensory symptoms only
	Grade 2	Mild motor deficit with some functional impairment
	Grade 3	Major functional impairment in at least one upper extremity, but upper extremities useful for simple tasks
	Grade 4	No movement or flicker of movement in upper extremities; no useful function
Lower extremity function		
	Grade 0	Intact
	Grade 1	Walks independently but not normally
	Grade 2	Walks but needs cane or walker
	Grade 3	Stands but cannot walk
	Grade 4	Slight movement but cannot walk or stand
	Grade 5	Paralysis

The higher the grade, the more severe the deficit. Upper and lower extremities are analyzed separately, the grades are not summarized.

Materials and methods

Clinical data

Forty-three patients with CSM (average age, 53.9 years; average duration of symptoms, 20.7 months) were evaluated using five myelopathy scales. The patients were assessed preoperatively and 12 months postoperatively (range 6−24 months). Gait dysfunction, radiculopathy,

Table 4
Prolo score (modified for CSM)

Criterion	Clinical situation	Points
Economic status	Complete invalidity	1
	No gainful occupation, including ability to do housework, or continue retirement activities	2
	Able to work, but not at previous occupation; able to perform housework and retirement activities	3
	Working at previous occupation part-time or limited status	4
	Able to work at previous occupation with no restrictions of any kind	5
Functional status	Total incapacity (postoperative: worse than before operation)	1
	Difficulty in walking, needing a cane or crutch or persistent moderate motor weakness in upper limb (able to perform tasks of daily living)	2
	Slight difficulty in walking, but without help; slight motor weakness in upper limb, moderate pain, persistent paresthesia	3
	No difficulty in walking, no motor weakness in upper limb, no pain but persistent paresthesia	4
	No difficulty in walking, no motor weakness in upper limb, no pain, no paresthesia, able to perform sports activities	5
Total score		2−10

The lower the score, the more severe the deficits. Normal function: 9+10; Grade 1: 7+8; Grade 2: 5+6; Grade 3: 2−4. Weight of the criterion in % of 10 points: economic status 50%; functional status 50%.

Table 5
European myelopathy score

Criterion	Clinical situation	Points
Upper motor neuron: gait function	Unable to walk, wheelchair	1
	Walking on a flat ground only with cane or aid	2
	Climbing stairs only with aid	3
	Gait clumsy, but no aid necessary	4
	Normal walking and climbing stairs	5
Upper motor neuron: bladder and bowel function	Retention, no control over bladder and/or bowel function	1
	Inadequate micturition and urinary frequency	2
	Normal bladder and bowel function	3
Lower motor neuron: hand function	Handwriting and eating with knife and fork impossible	1
	Handwriting and eating with knife and fork impaired	2
	Handwriting, tying shoe laces, or a tie clumsy	3
	Normal handwriting	4
Posterior column: proprioception and coordination	Getting dressed only with aid	1
	Getting dressed clumsily and slowly	2
	Getting dressed normally	3
Paresthesia/pain	Invalidity because of pain	1
	Endurable paresthesia and pain	2
	No paresthesia and pain	3
Total score		5−18

The lower the score, the more severe the deficits. Normal function: 17 +18; Grade 1: 13−16; Grade 2: 9−12; Grade 3: 5−8. Weight of the criterion in % of 18 points: upper extremity 27.8%; lower extremity 22.2%; coordination 16.7%; paresthesia/pain 16.0%; bladder and bowel function 16.7%.

and/or myelopathy paresis and pain were assessed, as were the patient's economic situation and the patient's absences from work caused by CSM. Postoperative clinical status was compared with preoperative status as follows: worse, unchanged, regressive, or normalized. Unilateral deterioration of paresis or sensibility was graded as "worse," whereas unilateral improvement was graded as "regressive." The results were analyzed using nonparametric, descriptive statistical tests to determine how the scores qualitatively and quantitatively reflected the clinical patterns of CSM and whether the results were comparable.

Scores

The following scores were analyzed: Nurick score, JOA score, CMS, Prolo score, and EMS. The versions of the scores that we used are shown in Tables 1 to 5; each score measures objective data. The clinical and anamnestic data allowed a retrospective and objective evaluation of the scores. The criteria assessed by each score are shown in Table 6. The Nurick score is the oldest existing score for CSM, and together with the JOA score, is the score most often used in published reports. The Nurick score mainly focuses on gait dysfunction, whereas the JOA score assesses functional deficits of the upper and lower extremities and differentiates among sensitivity disorders. The EMS was developed based on the JOA score. It reveals funicular deficits by additionally assessing proprioception and coordination. The CMS evaluates the grade of severity of the upper and lower extremities separately. Finally, the Prolo score evaluates the economic situation of the patient in addition to the clinical symptoms.

Results

Score correlation

Score correlation was highly statistically significant (p<.05 preoperatively and p<.01 postoperatively). For example, patients with a poor Nurick score also had poor scores using the other scoring systems. After surgery, approximately 50% of the patients reported improvement of their clinical symptoms. Investigating the clinical dynamics, further improvement was found in radicular symptoms and dysfunctions of the upper extremity, rather than in funicular symptoms (Fig. 1). The improved scores reflected the regression of cervical myelopathy symptoms (Table 7). Considering age, we found that patients who had retired preoperatively tended to have worse score values than younger patients (p<.015), but both groups showed significant postoperative improvement. Similar results were reported by Yamazaki et al. [6] and Fessler et al. [7]. Patients who

Table 6
Criterions evaluated by the scores; the cross + indicates the criterions taken into account by each score

	Nurick	JOA	CMS	Prolo	EMS
Gait dysfunction (1. motor neuron/signs of spastic)	+	+	+	+	+
Fine motor function (2. motor neuron)	+ (Grade 1)	+	+		+
Paresthesia upper extremity (Funiculus posterior)	+ (Grade 0+1)	+	+	+	+
Paresthesia lower extremity		+		+	
Paresthesia trunk		+			
Radicular pain (Funiculus posterior)	+ (Grade 0+1)	+		+	+
Proprioception and coordination (Funiculus posterior/afferent ataxia)					+
Vegetative symptoms (1. motor neuron/afferent system)		+			+
Economic situation	+ (Gait dependent)			+	

JOA = Japanese Orthopedic Association; CMS = Cooper myelopathy scale; EMS = European myelopathy score.
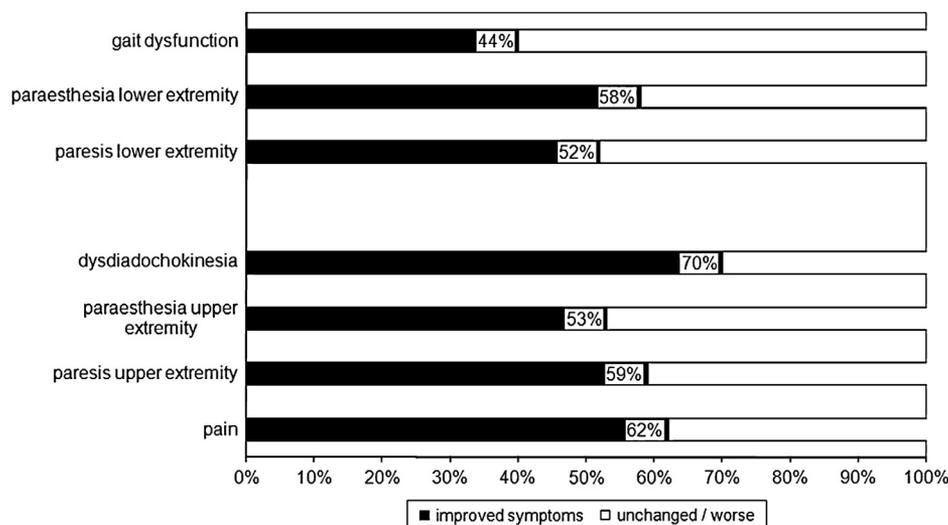
Fig. 1. Improvement of clinical symptoms.

were unable to work postoperatively because of persistent clinical symptoms had worse score values using all scoring systems, with the exception of the CMS for the lower extremity. This correlation was only of significance preoperatively using the Prolo score (p<.01), which assigns higher grades of severity to patients who are unable to work. When the patient is incapable of work, preoperative selection of patients with greater functional deficit versus those who are less incapacitated is missing using the Prolo score. The other scores evaluated severity according to the degree of dysfunction rather than according to the impact on the patient's economic situation, and preoperatively showed no correlation with the economic situation. There was no significant correlation between the score values and symptom duration or radiological or electrophysiological findings (p>.05).

Outcome and recovery rate

The number of patients with postoperative improvement is shown in Figure 2. The scores varied considerably. The largest difference was between the Nurick score (33%) and the JOA score (81%). To determine whether this difference was statistically significant, a formula was used to calculate the cumulative outcome of each score. This formula is the recovery rate, first published by Hirabayashi et al. in 1981 [8]. The recovery rate takes preoperative and postoperative score values into account; whether improved, worsened, or

unchanged. The result is the recovery rate for each score, which allows statistical comparison of the outcomes of the different scores. Figure 3 shows the recovery rates of the scores. The variance of the recovery rates between most of the scores was not of statistical significance. However, the Nurick score and the EMS measured significantly fewer patients with improvement of clinical symptoms after surgery than did the JOA score (p<.05).

Discussion

Of the scores in this study, the Nurick score is the oldest; like the JOA score, the Nurick score is well established and is used frequently worldwide. Changes in the upper extremity are difficult to detect using the Nurick score, because the main focus of this score is on gait function and therefore on funicular symptoms. The Nurick score shows the lowest recovery rate of all the scores. In terms of clinical dynamics, greater improvement was found in radicular symptoms than in funicular symptoms. The JOA score accurately reflects improvement of radicular symptoms by separately evaluating sensitivity disorders of the upper extremity. Compared to the other scores, the JOA score measures the best outcome. We found a significant difference between the recovery rates of the Nurick score and the EMS, and the recovery rate of the JOA score (p<.05), which must be taken into consideration when comparing studies using these scores. The

Table 7
Postoperative improvement of the scores

| | Nurick | JOA | CMS | | Prolo | EMS |
			Lower extremity	Upper extremity		
Mean score value preoperative	2.8	11.8	1.3	1.8	4.5	13.3
Mean score value postoperative	2.4	13.8	0.89	1.1	5.8	14.6
Improvement of the score value asymptomatic significance (two tailed)	p<.003	p<.000	p<.000	p<.000	p<.000	p<.000

JOA= Japanese Orthopedic Association; CMS = Cooper myelopathy scale; EMS = European myelopathy score.
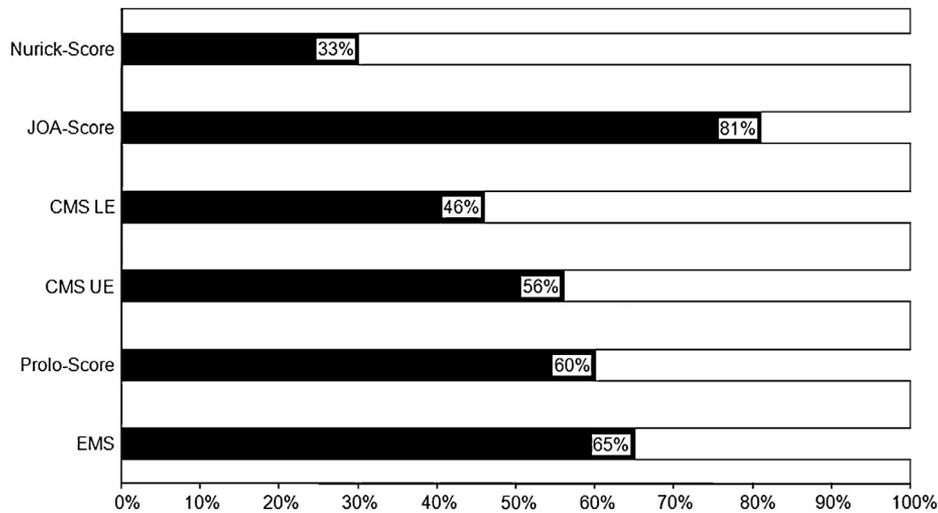
Fig. 2. Quantitative improvement of the scores.

variance of the recovery rates between the other scores was not of statistical significance, meaning that the outcomes measured by these scores are comparable. The Prolo score showed a recovery rate similar to that shown by the JOA score and the CMS. Therefore, the Prolo score is useful for assessing changes in CSM symptoms after operative intervention. Regaining the ability to work and being able to perform housework or retirement activities can be considered a measure of normalization and rehabilitation, which is of interest to public health officials and employers.

Conclusion

All five scores investigated in this study clearly have different advantages and disadvantages, and for each study the score must be carefully chosen that best reflects the particular symptoms the researcher wishes to evaluate. The study shows that all five scores—Nurick score, JOA score, CMS, Prolo score, and EMS—are suitable for qualitatively

evaluating the clinical symptoms, or diagnostic, and anamnestic data of CSM. However, quantitative assessment of changes after surgical intervention varies considerably depending on the score, as the result of the different criteria used by each scoring method. To compare the results of different scores, it is essential to evaluate the recovery rate. The recovery rate, as a measure of cumulative outcome, allows statistical comparison between different scores: Recovery rate can show whether the outcome after therapeutic intervention in two different studies using two different scores is similar. In light of these results, it does not seem necessary to develop a new score or use only a single score to evaluate cervical myelopathy. It would of course be preferably to have one standardized score, usable by all, that would be used to evaluate both objective and subjective symptoms of CSM. However, we realize that international implementation of such a score may be unrealistic. Therefore, in evaluating the results of conservative or invasive treatment of CSM, the recovery rate should be assessed.
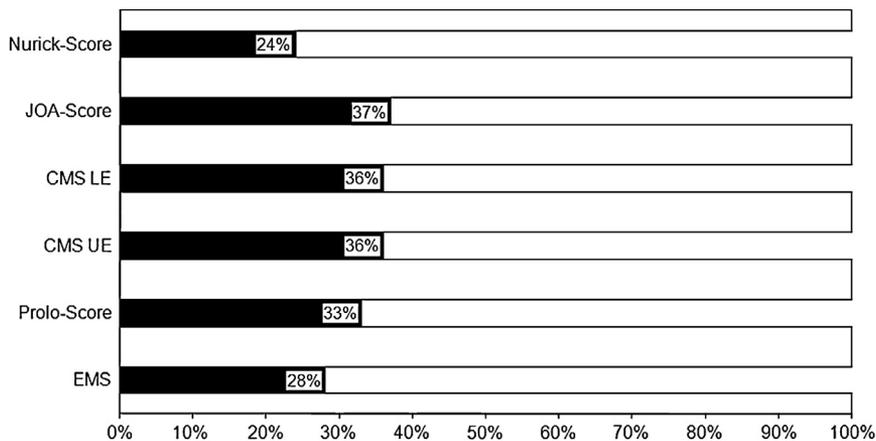

Fig. 3. Recovery rates of the Scores. RR=(postoperative score−preoperative score)/(total score−preoperative score).

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