Article published online: 2022-09-20

ORIGINAL ARTICLE

Evaluation of modified Kumar and Kalra myelopathy scoring system in sub-axial spinal pathologies

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ABSTRACT

Background: Various pathologies affect the spine, but these lesions present with more or less similar clinical profile. The present functional scoring systems are inadequate and insensitive to changes in neurological status of the patient.

Objective: Our study aims to assess the modified Kumar and Kalra (K and K) scoring system in patients with pathologies in the sub-axial spine.

Materials and Methods: A total of 78 consecutive patients from the period of January 2009 to June 2010 were prospectively included in the study. These patients were operated by the senior author at our institute. The mean Modified Japanese Orthopaedic Association (MJOA) score and the mean modified K and K score were calculated in the preoperative, at the time of discharge (post-surgery), and at 3 months and 6 months follow-up.

Results: There were 57 male (73.01%) patients and 21 female patients (26.92%), with the mean age of presentation of 39.20 years (±14.12 years) and a range of 9-75 years. Out of the total 78 patients, 60 patients had pathology in the cervical spine (sub-axial spine) and 18 patients had pathology in the dorsal spine. Majority of the patients had motor and sensory symptoms. The mean preoperative modified K and K score was 17.38 (±3.18) and the mean preoperative MJOA score was 11.21 (±2.12). The K and K score was able to predict the correct outcome in 70 patients (89.74%), whereas the MJOA score was able to predict correctly in 62 patients (79.49%).

Conclusion: The modified K and K score has a better predictive value than the MJOA score.

Key words: Kumar and Kalra, myelopathy, scoring system

Introduction

Various pathologies can affect the spine like degenerative disease, congenital lesions, tumors, or inflammatory lesions. Despite such varied pathologies affecting the spine, these lesions present with more or less similar clinical profile. These lesions present with variable involvement of motor weakness, spasticity, sensory involvement, and sphincteric involvement while in affliction of cranio-vertebral junction, the respiratory system can also be involved. The aim of the surgery in majority of the conditions is appropriate decompression of the spinal cord and stabilization if needed. Various scoring systems have been used in the past,[1-9] but there is paucity of literature on the assessment of neurological status and precise and accurate outcome of such patients. Present functional scoring systems are inadequate and insensitive to changes in neurological status of the patient.[5] A comprehensive and precise neurological examination may be valuable in postoperative evaluation, studying the postoperative course, following up the response to treatment, and picking up even the slightest change in neurological status. The scoring system should be based on the clinical and neurological parameters affecting the spine and should be sensitive enough to identify even the slightest of change in the neurological status as proper outcome assessment could be done. The scoring system should also be applicable in young children. Although the scoring system should be sensitive enough to pick up the slightest of change in the clinical and neurological status, it should not be cumbersome enough to preclude its utility as a scoring system. Our study aims to assess the modified Kumar and Kalra (K and K) scoring system in patients with pathologies in the sub-axial spine.

Access this article online	
Quick Response Code:	Website: www.asianjns.org
	DOI: 10.4103/1793-5482.144150

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Materials and Methods

A total of 78 consecutive patients from the period of January 2009 to June 2010 were prospectively included in the study. These patients were operated by a single experienced surgeon (the senior author) at the Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, from the period of January 2009 to June 2010. There were a total of 97 patients out of whom 78 patients were included in the study as these patients fulfilled the study criteria decided at the beginning of the study.

Inclusion criteria

- Compressive myelopathy [including degenerative diseases, intradural (both intramedullary and extramedullary) and extradural pathologies]
- Cervical and dorsal lesions (causing compression over the cord).

Exclusion criteria

- Non-compressive myelopathies
- Follow-up less than 6 months
- Involvement of cranio-vertebral junction anomalies, either soft tissue (e.g., Chiari malformation) or bony abnormalities (e.g., atlanto-axial dislocation)
- Death
- Patients with simultaneous cauda equine syndrome
- Previous diseases of lower/upper limb, e.g., poliomyelitis affected lower limbs.

Among the 97 cases, 15 patients did not match the follow-up criterion, 2 patients had associated atlanto-axial dislocation, 1 patient had associated L5-S1 prolapsed intervertebral disc (PIVD) presenting with cauda equine syndrome, and in another patient the limbs were affected by poliomyelitis.

All patients had initially come to our Out-Patient Department (OPD) with features suggestive of thecal sac compression/myelopathy. Our institute, being a tertiary care institute, some patients had visited our OPD with magnetic resonance imaging (MRI) already done. In those patients with features of myelopathy or cord compression, a non-contrast MRI of the spine (depending upon the clinical localization – cervical, dorsal, lumbar, or a combination of these) was advised (except in those patients who had already undergone MRI). If the lesion was suspected to be inflammatory or neoplastic, a gadolinium-enhanced MRI of the concerned region was advised. Incentive spirometry and limb physiotherapy was initiated on OPD basis.

Preoperatively, routine hematological, biochemical, and coagulation profile, and Chest X-ray were done. In patients of cervical PIVD, a flexion and extension lateral view was advised to rule out spondylolisthesis. Preoperatively, the patients were assessed by modified K and K [Table 1] scoring system and the Modified Japanese Orthopaedic Association (MJOA) score [Table 2] by a single resident and verified by the senior-most resident or faculty in charge of the patient. The K and K score also includes the respiratory system as one of its parameters. We modified it by not including the respiratory system as in our cases the pathology was in the sub-axial spine and respiratory involvement was unlikely.

Postoperatively, the patients were mobilized as early as possible. They were discharged on the 7th postoperative day. Postoperatively, all the patients were assessed at the time of discharge, at 3 months follow-up, and at 6 months follow-up with the help of modified K and K score and MJOA score.

The means of the score at each follow-up were calculated along with the standard deviation. The predictive value was also calculated. SPSS version 16.0 was used for statistical analysis.

Results

There were 57 male (73.01%) patients and 21 female patients (26.92%) [Table 3], with the mean age of presentation of 39.20 years (±14.12 years) and a range of 9-75 years [Table 4]. The duration of symptoms in our series varied from 1.5 to 120 months, with a mean of 29.72 months [Table 4]. Majority of the patients had motor and sensory symptoms with spasticity and motor weakness present in 65 patients (83.3%) and 63 patients (80.8%), respectively. Sixty-three (80.8%) patients had sensory symptoms. Other major symptoms included sphincteric involvement in 38 patients (48.7%) and respiratory

Table 1: Modified Kumar and Kalra score

Score	1	2	3	4	5
Motor power	Contraction without movement or plegia	Movement with gravity	Movement against gravity	Movement against resistance	Normal power
Gait	Wheelchair-bound or bedridden	Restricted mobility despite using aid	Mobility using aid	Slight disturbance, no aid required	Normal
Sensory involvement	Total loss of function	Restriction of function of daily living	Significant (>25%), but no dysfunction of daily living	Insignificant	No sensory loss
Sphincteric involvement	Retention requiring indwelling catheter	Occasional CIC* required with hesitancy	Hesitancy with residual urine not requiring catheter	Hesitancy, but no residual urine	Normal
Spasticity	Affected part rigid in flexion or extension	Passive movements difficult	Passive movements easy	Slight increase, a catch felt	No increase in tone

*Clean intermittent catherisation

difficulty in 6 patients (7.7%). The mean preoperative modified K and K score was 17.38 (±3.18) and the mean preoperative MJOA score was 11.21 (±2.12).

Out of the 78 patients, 38 patients had cervical PIVD. Out of these 38 patients, 22 patients had single-level disc prolapse and the remaining 16 patients had two-level PIVD. Among the patients who had single-level PIVD, 14 patients had C5-C6 PIVD, 6 patients had C4-C5 PIVD, and 1 patient each had C3-C4 PIVD and C6-C7 PIVD. Eleven patients had intradural extramedullary (IDEM) lesions, with six patients having neurofibroma and the remaining five had meningiomas. Eleven patients had spondylolisthesis (all patients had cervical spondylolisthesis). Eight patients operated had Pott's spine.

Table 2: Modified Japanese Orthopaedic Association scale

Motor dysfunction upper extremity
Cannot perform daily activities
Severe difficulty in daily activities/motor weakness
Moderate difficulty in daily activities/hand clumsiness
No difficulty in daily activities/mild hand clumsiness
Normal daily activities/abnormal reflexes
Motor dysfunction of lower extremity
Unable to walk/bedridden
Can walk on flat floor with walking aid/cannot ascend or descend stairs
Can walk on flat floor with difficulty/need support for ascending and descending stairs
No difficulty on flat surface/mild difficulty in ascending or descending stairs
Normal walk
Sensory deficit
Upper extremity severe sensory loss or pain
Upper extremity mild sensory loss
Upper extremity no sensory loss
0-2 Lower extremity
0-2 Trunk
Sphincteric dysfunction
Unable to void
Marked difficulty in micturition (retention)
Difficulty on micturition (frequency, hesitation)
None

Table 3: Sex distribution

	Frequency	Percent
Male	57	73.07
Female	21	26.93
Total	78	100.0

Among these eight patients, five had lesions in the dorsal spine and three had lesions in the cervical spine. Seven patients had intramedullary lesions (five in the dorsal region, one in the cervical region, and one in the cervico-dorsal region). Three patients had arterio-venous malformation (AVM) (all in dorsal region) and four had intramedullary tumors (three astrocytomas and one ependymoma). Three patients had ligamentum flavum hypertrophy (all in dorsal region). Out of the total 78 patients, 60 patients had pathology in the cervical spine (sub-axial spine) and 18 patients had pathology in the dorsal spine [Table 5].

For patients with single-level cervical PIVD, anterior cervical discectomy was done, and for patients with two-level PIVD or spondylolisthesis, anterior cervical corpectomy, grafting, and plating (with titanium plate and screws) was done. For two patients of cervical Pott's spine, anterior cervical corpectomy, grafting, and plating (with titanium plate and screws) was done, and for one patient with lesion at the cervico-dorsal junction (C7-T1), transmanubrial approach with corpectomy, caging, and screw fixation was done. Among the patients with Pott's spine of dorsal spine, three patients underwent transthoracic decompression, caging, and plating, and two patients underwent laminectomy and decompression. Laminectomy and tumor excision was done for the IDEM lesions and the intramedullary tumors Laminectomy and excision of the hypertrophied ligamentum flavum was done for ligamentum flavum hypertrophy in the dorsal region [Table 6].

On clinical neurological evaluation, 69 patients (88.46%) improved after the surgery, 5 patients showed no improvement, and 4 patients deteriorated. All the four patients who deteriorated were having pathology in the dorsal spine. One patient had ligamentum flavum hypertrophy and another had AVM. Two patients had intramedullary tumor (astrocytoma). Among the four patients who deteriorated, two patients improved till the last follow-up and both these patients had reached the preoperative status [Table 7].

The mean K and K scores at the time of discharge, at 3 months follow-up, and at 6 months follow-up were 18.59 (±2.60), 19.62 (±3.18), and 21.51 (±3.98), respectively, and the mean MJOA scores at the time of discharge, at 3 months follow-up, and at 6 months follow-up were 11.92 (±2.35), 12.32 (±3.12), and 13.31 (±3.09), respectively. The K and K score was able to predict the correct outcome in 70 patients (89.74%), whereas the MJOA score was able to predict correctly in 62 patients (79.49%). Among the patients who improved, the K and K score correctly predicted improvement in

Table 4: Age and duration of symptoms

	n	Range	Minimum	Maximum	Mean	Std. deviation
Age (years)	78	66	9	75	39.20	14.121
Duration of symptoms	78	118.5	1.5	120	29.72	20.368

65 patients (94.20%) and the MJOA scoring correctly predicted improvement in 58 patients (84.06%). There was significant difference between the predictive value of modified K and K and the MJOA ($P < 0.019$) [Table 8].

Table 5: Diagnosis

Diseases	Frequency	Percentage
Prolapsed intervertebral disc	38	48.72
C_5-C_6	14	17.95
C_4-C_5	6	7.69
C_3-C_4	1	1.28
C_6-C_7	1	1.28
Two-level PIVD	16	20.51
Spondylolisthesis (all cervical spine)	11	14.10
Intradural extramedullary lesions	11	14.10
Neurofibroma	6	7.69
Cervical	4	5.13
Dorsal	2	2.56
Meningiomas	5	6.41
Cervical	2	2.56
Dorsal	3	3.85
Pott's spine	8	10.26
Cervical	3	3.85
Dorsal	5	6.41
Arterio-venous malformation (all dorsal)	3	3.85
Intramedullary tumors	4	5.13
Cervical	2	2.56
Dorsal	2	2.56
Ligamentum flavum hypertrophy (dorsal spine)	3	3.85

Table 6: Procedure performed

Surgery	Frequency	Percentage
Ant. cervical discectomy	22	28.21
Ant. cervical corpectomy with grafting and plating	29	41.03
Laminectomy and decompression/excision of ligamentum flavum	5	3.86
Laminectomy and tumor excision	18	23.08
Transthoracic decompression, caging, and screw fixation	3	2.56
Transmanubrial decompression, caging, and screw fixation	1	1.28

Table 7: Results (on clinical neurological evaluation)

Results	Frequency	Percentage
Improved	69	88.46
Same	5	6.41
Deteriorated	4	5.12

Four patients had postoperative wound infection and three patients had cerebrospinal fluid (CSF) leak. Among the three patients who had CSF leak, one patient had meningitis. The patient was started on antibiotics as per culture sensitivity. Two patients had pneumonia which responded to antibiotics. There was no mortality till the last follow-up [Table 9].

Discussion

Various scoring systems for myelopathy grading have been used including the Nurick's score,[1,2] Cooper-myelopathy-scale (CMS),[3] Prolo-score,[4] Barthel's score,[6] and Harsh's score,[7] to name a few. An outcome measure to evaluate the neurological function of cervical myelopathy was proposed by the Japanese Orthopaedic Association in 1975 (JOA score), and has been widely used in Japan.[8] After Hirabayashi *et al*. reported in *Spine* in 1981 the surgical results of patients with ossification of the posterior longitudinal ligament in the cervical spine using the JOA score, the modified JOA (MJOA) score has been developed and used to evaluate cervical myelopathy in other countries.[9-11]

The MJOA scoring includes motor system in the upper limb, motor system in the lower limb, sensory system (in the upper limb, lower limb, and trunk), and sphincteric involvement. A maximum of 17 points can be given based upon the above-mentioned factors, with the minimum score being 0. Lower the score, more disabling is the disease, and higher the score, lesser is the disability.[11] In a study by Vitzthum *et al*., they compared five scoring systems for patients with cervical spondylotic myelopathy.[12] They evaluated the Nurick's score, JOA score, CMS, Prolo-score, and European-myelopathy-score (EMS)[13] using the data of 43 patients, all of whom showed clinical and morphological signs of Cervical spondylotic myelopathhy (CSM) and underwent operative decompression. According to them, the JOA score best measures the outcome when compared to the other scores.[12]

Although the MJOA score is frequently used, it does not include the important clinical feature of spasticity and also lacks objectivity in assessment. The K and K scoring system has been developed at our institute and has been successfully used in pediatric patients with atlanto-axial dislocation [Table 1].[5] It is based purely on neurological evaluation rather than being functional. It includes six parameters, namely motor power,

Table 8: Mean modified K and K and MJOA scores

Scoring system	Preoperative	Postoperative (at discharge)	Postoperative (at 3 months follow-up)	Postoperative (at 6 months follow-up)
Kumar and Kalra	17.38 (±3.18)	18.59 (±2.60)	19.62 (±3.18)	21.51 (±3.98)
MJOA	11.21 (±2.12)	11.92 (±2.35)	12.32 (±3.12)	13.31 (±3.09)

MJOA – Modified JOA

Table 9: Complications

Complications	Frequency	Percentage
CSF leak	3	3.86
Meningitis	1	1.28
Wound infection	4	5.12
Pneumonia	2	2.56

CSF – Cerebrospinal fluid

gait, sensory involvement, sphincteric involvement, spasticity, and respiratory system. Each parameter is given a maximum of 5 points and the maximum score is 30. In our study, we did not include respiratory system as patients with sub-axial cervical spine and dorsal spine are unlikely to involve the respiratory system. Thus, in our study, the maximum score possible was 25. The patient can be graded from 1 to 4.

- Grade 1 – 20-25
- Grade 2 – 16-19
- Grade 3 – 11-16
- Grade 4 – <10.

The advantages are the assessment and comparison of neurological status based on commonly occurring symptoms and signs. These specific parameters can also be analyzed and compared individually in terms of their severity and significance. The score can be used even retrospectively as it is based on the factors which are usually assessed in the neurological examination of the patients pre- and postoperatively and in the follow-up visits, provided the recording is accurate. The scoring system appears to be more objective than the other scoring systems with high statistical significance. The scoring system is more sensitive as it depends on a multitude of factors and has a wider range of points. The disadvantage, however, is related to the fact that the improvement in some symptoms may be overlapped by deterioration of the others, leading to no net change in the score. This, therefore, makes it difficult in these cases to translate it into a clinical picture.

In our study, out of 78 patients, 69 (88.46%) patients improved, 5 (6.41%) patients showed no improvement, and 4 (5.12%) patients deteriorated. Among the four patients who deteriorated, two reached their preoperative status at 6 months follow-up. The modified K and K score was able to predict correctly in 70 (89.74%) patients. Among these 70 patients, K and K score correctly predicted improvement in 65 patients (out of total of 69 patients who improved; 94.20%). Among the four patients in whom it was unable to predict improvement, one patient had marginal improvement in sensory symptoms (<25% improvement), which was not picked up by the K and K score as in sensory parameter, the difference between grades 2 and 3 is loss of sensation of >25%. The remaining three patients had pain as the predominant symptom, and as pain is not included in the scoring, any improvement was not picked up by the score. Out of the five patients who had no significant improvement, the K and K score was able to predict correctly in three patients. In the remaining two patients, the predominant symptom was pain. Although the patients had marginal improvement in spasticity, there was no significant improvement in pain, and so was misinterpreted by the score as improvement. K and K score was able to correctly identify deterioration in two patients, and in two other patients it was unable to detect deterioration. In these two patients, there was deterioration in the sensory loss in the postoperative period, but as the deterioration was <25%, it was not picked up by the score.

The MJOA score was able to correctly predict improvement in 58 patients (84.06%), and in 2 patients each, it was able to predict deterioration (out of 4 patients) and no change in neurological status (out of 5 patients who did not show any change in their status). The MJOA was unable to predict improvement in 11 patients (out of 69). Among these 11 patients, 3 patients had predominant symptom of pain and the MJOA score was unable to pick it up. Six patients had significant improvement in spasticity, but they were still walking with the support of a stick and the MJOA score was unable to identify the improvement. The remaining two patients had marginal improvement in sensory loss which the MJOA was unable to pick up. The two patients in whom the MJOA was unable to predict deterioration had deterioration in sensory loss; but these patients, even in the preoperative period, had severe sensory loss and so no change was detected by the MJOA score. Among the five patients who had no change in the neurological status, MJOA was able to predict correctly in two patients. The remaining three patients had severe pain in the postoperative period, restricting their activities, and were taken to be deteriorated by MJOA.

The K and K score includes six parameters which are a common manifestation of myelopathy. The K and K score, compared to the MJOA, fared better in predicting the outcome. The modified K and K score is based on the neurological evaluation and has a high predictive value, and is easily reproducible with minimal inter-observer variation. Although this score is not foolproof as reflected by its inability to be 100% sensitive, it appears to be the best bet to pick up even marginal change in the neurological status of the patient. It is important to have such a score at our disposal so that a proper preoperative assessment and any postoperative change in the neurological status can be ascertained.

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How to cite this article: Mehrotra A, Srivastava A, Sahu RN, Kumar R. Evaluation of modified Kumar and Kalra myelopathy scoring system in sub-axial spinal pathologies. Asian J Neurosurg 2016;11:378-83.

Source of Support: Nil, **Conflict of Interest:** None declared.