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Original Research Article

Prognosticating Neurological Recovery in Patients with Spinal Cord Injury without Radiological Abnormality (SCIWORA) - One Year Follow Up Study

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ABSTRACT

Background: Magnetic resonance Imaging (MRI) allows early assessment of spinal cord lesion in SCIWORA, but its prognostication for recovery yielded conflicting results in previous studies.

Objective: Study was aimed to assess the clinico - radiological parameters that influence neurological recovery in patients admitted with spinal cord injury without radiographic abnormality (SCIWORA).

Methods: Patients above the age of eighteen years hospitalized with SCIWORA and neurological impairment as per American spinal injury association (ASIA) score, analyzed by MRI evaluation were included and followed up to one year and the relationship between MRI abnormality and neurological outcome were analyzed at presentation and at one year follow up.

Results: Fourteen adult patients (14 males) with SCIWORA were identified (mean age of 44.86 ± 11.56 years). Significant negative correlation was seen with MRI score (score one to four indicative of increasing severity of cord damage) and ASIA score (A to E) at presentation (Pearson' coefficient -0.664:95% CI -0.88 - -0.21; p=0.004), and improvement in ASIA score (neurological recovery) at one year (Pearson' coefficient -0.834:95% CI -0.95 - -0.54; p=0.00003). Bivariate analysis of factors which favored neurological recovery at one year were age less than 50 years (p=0.05), spinal cord edema in MRI at presentation (100% recovery) and spinal cord contusion (66.6% recovery; p=0.029). Cord hemorrhage had the least chance of recovery (25%).

Conclusion: In patients with SCIWORA, spinal cord edema, cord contusion and age at presentation were the best predictors of neurological recovery and worst outcomes occurred with cord hemorrhage.

Key Words: Spinal Cord Injury, SCIWORA, Neurologic Recovery, ASIA Score, Magnetic Resonance Imaging.

Key Message: Arbitrary scoring of cord pathology in MRI used in this study is an easy tool to prognosticate neurological recovery in SCIWORA. Score one (cord edema) has favorable prognosis and score three (cord hemorrhage) has guarded prognosis.

INTRODUCTION

Neurological impairment resulting from blunt or penetrating trauma to the spinal cord with or without surrounding soft and osseous tissues constitutes Traumatic Spinal cord Injury. Among these patients, however, a subgroup of patients presents with a clinico-radiological mismatch, termed spinal cord injury without radiological abnormality (SCIWORA).[1] Magnetic resonance imaging (MRI) allowed the observation of spinal soft-tissue lesions and intramedullary abnormalities and there remained a significant fraction of patients presenting with a discrepancy between neurological impairment and detectable MRI findings.[2,3,4] Further, the prognostic value of extra- and intramedullary MRI findings in SCIWORA is a questianable matter.

The aims of the present study were to characterize the clinical features of adult patients presenting with SCIWORA, and to assess the prognostic value of MRI abnormalities in the prediction of the early neurological outcome in this population.

MATERIALS AND METHODS

Study design & settings

Present Prospective Clinical Study included the in-patients above the age of 18 years admitted to orthopedic ward of a tertiary care center with features of traumatic spinal cord injury with neurological impairment at admission to the hospital and exclusion of major fractures or dislocations to the spine by radiological and computerized tomographic evaluation. The study duration was 18 months for recruitment and these patients were followed up for a period of one year.

Exclusion Criteria

- Any fracture or dislocation related to the spine
- Failure to give a valid consent
- Any head injury
- Any long bone fracture which hinders rehabilitation
- Patients unlikely to complete the stipulated one year follow up.
- Patients undergoing any surgical intervention
- Immature skeleton
- Non-existent or missing radiograph and/or CT and/or MRI of the spine
- Incomplete clinical data

For all included patients, the following data were archived: case number, name, sex, age at admission, date of admission and discharge, mechanism of trauma, therapeutic interventions, MRI finding, ASIA score at initial presentation, ASIA score at one year of follow up. In this study neurological improvement was considered to be present, if the patient on follow up at the end of one year, showed improvement in ASIA score by at least one grade compared to baseline. The MRI findings were classified as spinal cord edema (scored as one), spinal cord contusion (scored as two), spinal cord hemorrhage (scored as three), and spinal cord transection (scored as four). We conducted this study in compliance with the principles of declaration of Helsinki. Study protocol was reviewed and approved by the Institutional research committee and Human ethics committee (HEC.No.01/33/2018/MCT). Written informed consent were obtained.

Statistics

Statistical analysis was performed using IBM SPSS Statistics 22 (IBM Corporation, Armonk, NY, USA). Descriptive analysis included analysis of absolute mean values and ranges of the measured variables. ASIA grades were transformed into numbers (A=one=complete, B=two=incomplete, C=three=incomplete, D=four=incomplete, E=five=normal: and a score one to four indicative of decreasing order of neurological impairment) and correlation with the MRI score was done using Pearson's correlation coefficient. A p value below 0.05 was considered significant.

RESULTS

Demographic and clinical characteristics of patients-A total of 14 adult patients (14 males, zero females) with SCIWORA were included. Mean age was 44.86 ± 11.56 years (range 29 to 67 years), median age 45 years.

The MRI observations are shown in table 1.

MRI Finding	Frequency	Percentage
Spinal cord edema	7	50
Spinal cord contusion	3	21.4
Spinal cord Hemorrhage	4	28.6
Spinal cord Transection	0	0
Total	14	100

Table 1: MRI findings

The ASIA score at initial presentation and follow up (FU) at one year is shown in figure

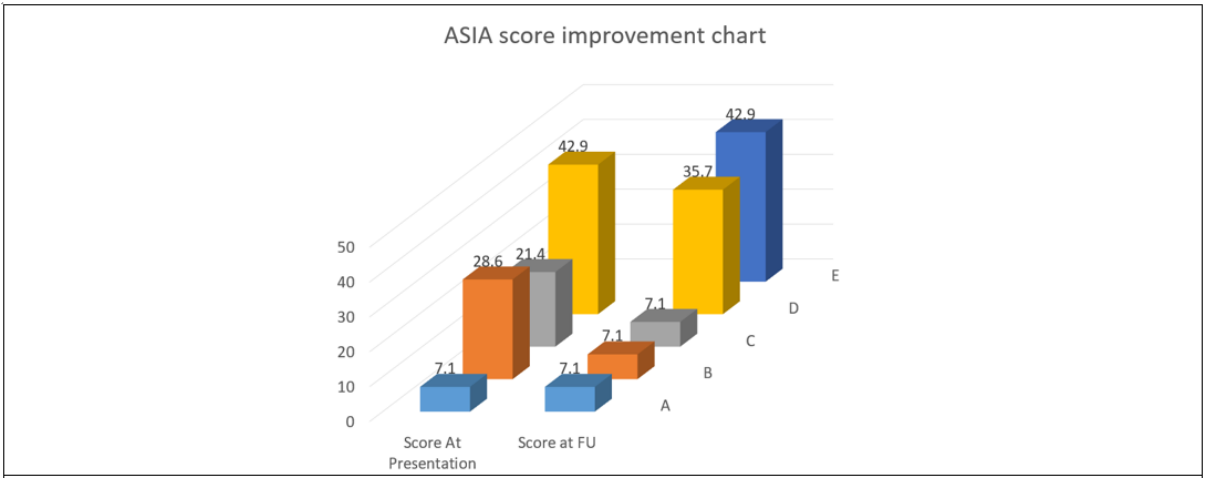


Figure 1: ASIA score improvement chart

There was significant improvement in ASIA score in overall study group at one year of follow up. (See figure 1).

Figures 2A to 2C shows the score at presentation and score at one year follow up in various categories of MRI abnormalities.

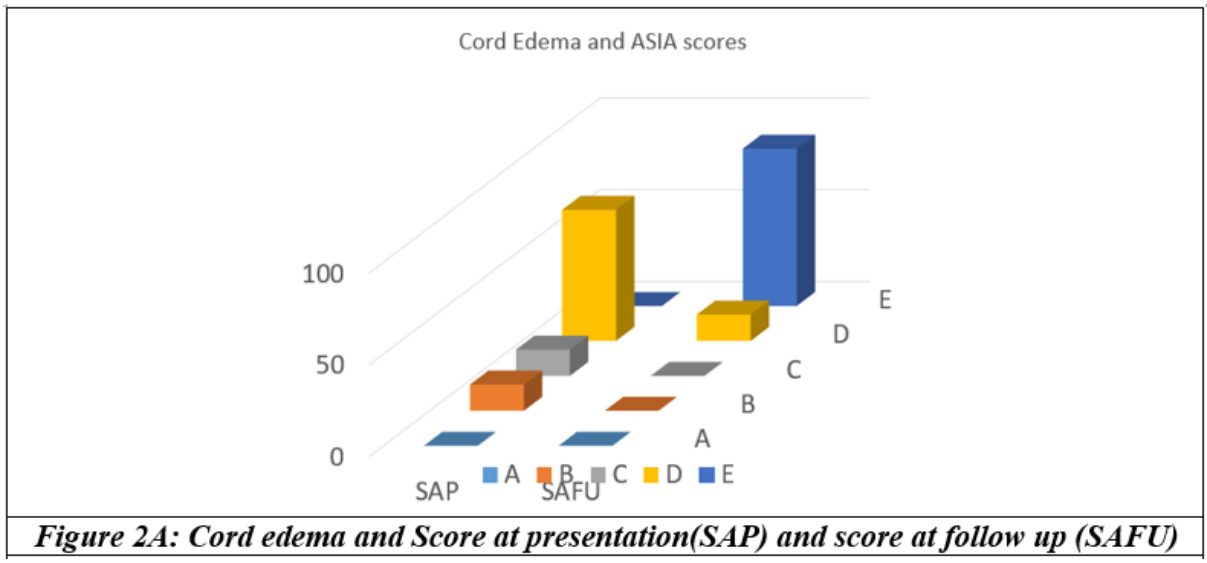


Figure 2A: Cord edema and Score at presentation(SAP) and score at follow up (SAFU)

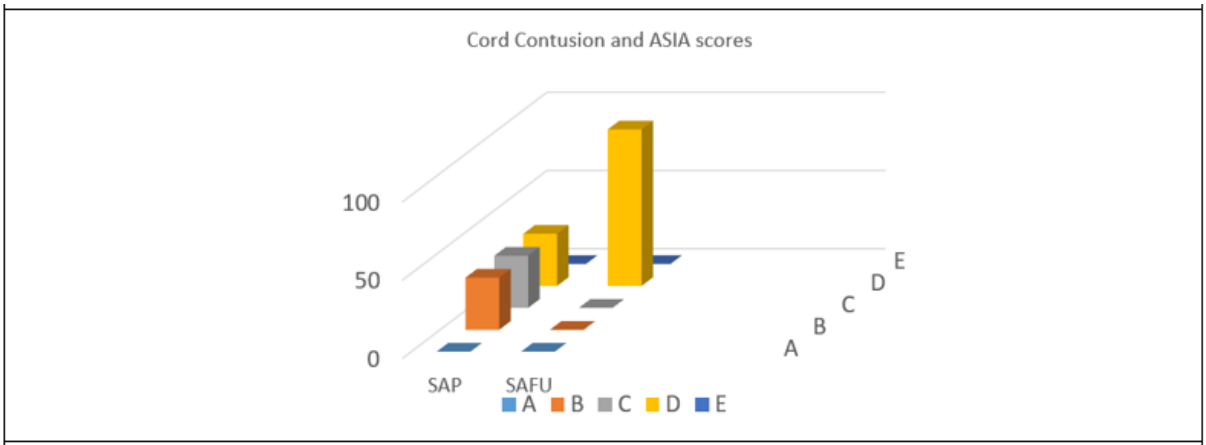


Figure 2B: Cord contusion and Score at presentation(SAP) and score at follow up (SAFU)

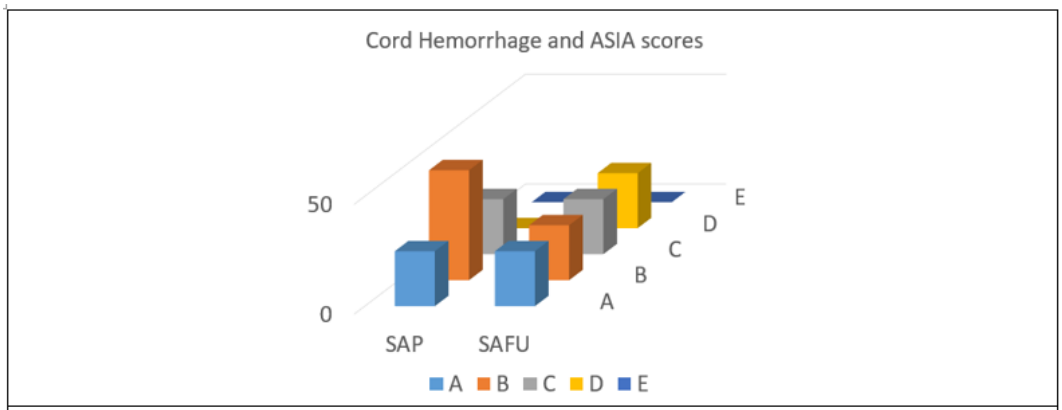
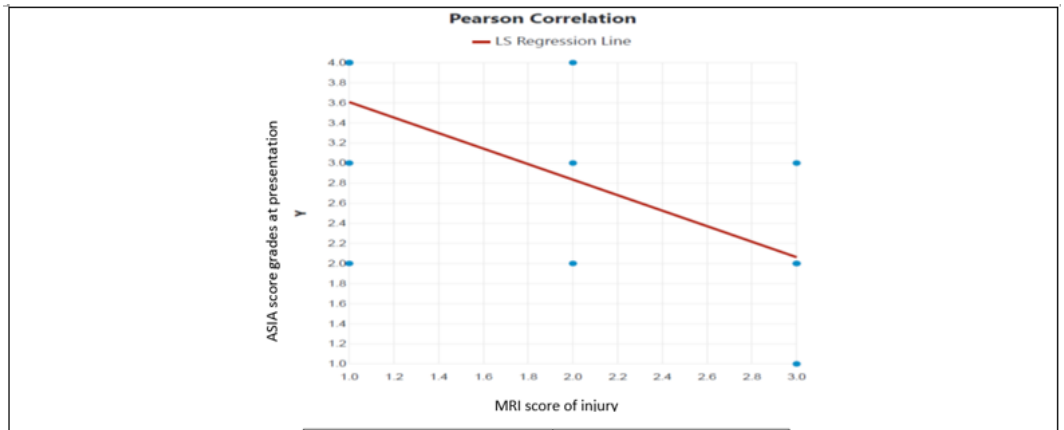


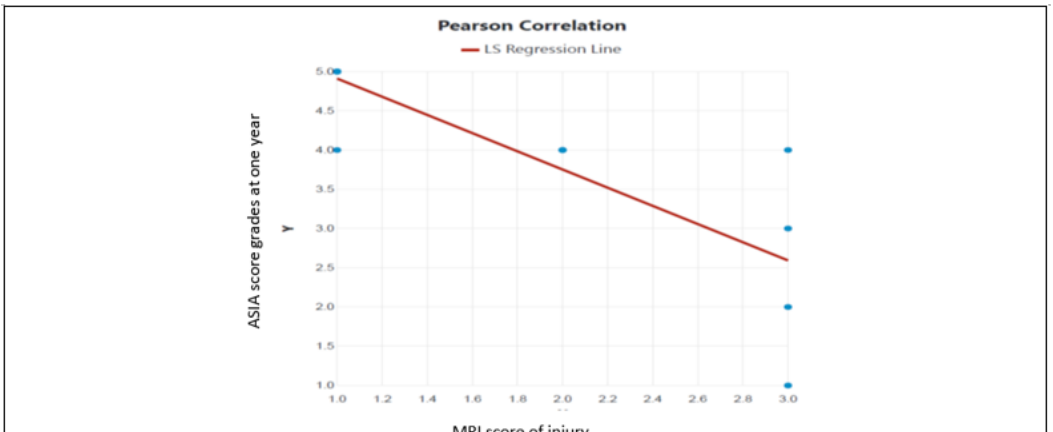
Figure 2C: Cord Hemorrhage and Score at presentation(SAP) and score at follow up (SAFU)

The MRI findings were analyzed to identify the correlation with the ASIA score at presentation and at follow up. The Pearson correlation coefficient was calculated as shown below.



Pearson's r	-0.664
Z score	-2.66
P value	0.004
95% confidence interval	-0.88- -0.21

Figure 3: MRI SCORE at presentation and ASIA score at presentation



Pearson's r	-0.834
Z score	-3.98
P value	0.00003
95% confidence interval	-0.95 - -0.54

Figure 4: MRI SCORE at presentation and ASIA score at follow up at one year

There was significant negative correlation between MRI score at presentation and ASIA score at presentation (i. e. higher MRI score had more severe neurological

impairment). Similarly MRI score at presentation had a negative correlation with ASIA score at one year follow up.

The Pattern of change in ASIA score at the base line and at the end of one year follow up is shown in table 2.

Baseline-→ Follow up	Frequency	Percent
ASIA A-->ASIA A	1	7.142857
ASIA B-->ASIA B	1	7.142857
ASIA B-->ASIA D	3	21.42857
ASIA C-->ASIA C	1	7.142857
ASIA C-->ASIA D	1	7.142857
ASIA C-->ASIA E	1	7.142857
ASIA D-->ASIA D	1	7.142857
ASIA D -->ASIA E	5	35.71429
Total	14	100

Table 2: Pattern of change in ASIA score on follow up

Nearly 72% of the SCIWORA patients admitted with neurological impairment improved and nearly 28% of the SCIWORA patients had no improvement in the neurological status at follow up at one year. MRI profile at admission and the recovery in neurological profile is given in table 3.

MRI Findings	Improvement in ASIA score	No improvement in ASIA Score
Cord Edema	7 (100%)	0
Cord Contusion	2(66.6%)	1 (33.3%)
Cord hemorrhage	1(25%)	3(75%)

Table 3: MRI findings and ASIA score at one year

Lower MRI score denote minor cord abnormality such as edema and is indicative of better chance of neurological recovery and higher MRI score denotes more severe injury to cord such as hemorrhage and or transection and lower chance of neurological recovery.

Bivariate analysis of the factors which favors recovery of neurological impairment was done taking age, mode of injury and MRI detected spinal cord lesions (see table 4)

Variable	Category	Improvement in ASIA Score	No improvement in ASIA score	P value
Age	Less than 50	8 (80%)	1 (25%)	0.05
	More than 50	2 (20%)	3 (75%)	
Mode of Injury	Fall	8 (80%)	2 (50%)	0.43
	RTA[a]	1 (10%)	2 (50%)	
	Others	1 (10%)	0	
MRI Findings	Cord Edema	7 (70%)	0	0.029
	Cord Contusion	2 (20%)	1 (25%)	
	Cord hemorrhage	1 (10%)	3 (75%)	

Table 4: Bivariate analysis

[a]RTA road traffic accident

There was significant association between neurological recovery and MRI finding at presentation. Cord edema had a better prognosis. Moreover, there was significant association between neurological recovery and the age. Age less than 50 years had better prognosis. No association between neurological recovery and mode of injury.

DISCUSSION

The diagnostic and therapeutic approach to adult patients with SCIWORA presenting with a clinico-radiological mismatch remains to be an ongoing challenge. There is paucity of knowledge regarding its role in the prognostication of the neurological outcome. Though correlation between MRI abnormality and outcome of neurological impairment has

been described in previous studies.[5,6,7,8,9,10] This was not confirmed by others. Kulkarni et al[11] described three imaging patterns of intramedullary abnormalities (cord hemorrhage, edema and mixed type), and their prognostic value was evaluated in a number of studies.[12,13] In the present study, the MRI abnormalities detected were spinal cord edema, spinal cord contusion and spinal cord hemorrhage and spinal cord edema was the most frequent (50%) followed by spinal cord hemorrhage (28.6%).

The admission MRI abnormality was closely correlated with neurologic impairment and in this study, cord edema (as MRI score one), cord contusion (score two) and cord hemorrhage (score three) had a significant negative correlation with the ASIA score at presentation (Pearson's coefficient: -0.664 (95% confidence interval -0.88 - -0.21; p =0.004). Similarly in the present study, the neurological recovery based on at least one score improvement in the ASIA score at one year of follow up also had strong negative correlation with the degree of cord injury at presentation (Pearson's coefficient: -0.834 (95% confidence interval -0.95 - -0.54; p =0.00003).

All the seven patients (100%) with cord edema in this study at presentation had improvement in their ASIA score at one year and 66.6% of those patients with cord contusion had improvement in ASIA score whereas only 25% of patients with cord hemorrhage had improvement in ASIA score at one year.

Bivariate analysis of factors which determines neurological recovery after SCIWORA in this study compared the effects of age, mode of injury and the MRI detected severity of cord abnormality with the neurological recovery. This study showed that age below 50 years had a better chance of recovery than above the age of 50 years (P=0.05). The mode of injury did not affect the recovery of neurological impairment. Whereas various degrees of cord abnormality detected by MRI significantly correlated with favorable neurological outcome at one year. Present study showed that patients who had cord edema with neurological deficit at presentation had near complete recovery at one year and among those with cord contusion, about 67% had recovery of the neurological deficit at one year and in those with cord hemorrhage at presentation, only 25% had neurological recovery. 90% of those who had good neurological recovery had frequently cord edema or cord contusion. All patients received corticosteroids parenteral along with neurological rehabilitation during hospital stay and after discharge. None of the present patients underwent any surgical intervention.

The authors are aware of the limitations of the study. This is prospective study of a single center and included only a small number of patients and duration of follow up also was short. This cannot be generalized to other ethnic groups or population. We need multicentric study with advanced imaging facility in patients with SCIWORA to make strong recommendations. The major strength of the study was strict imaging by MRI of only SCIWORA patients and meticulous delineation of cord lesions in those patients and the strict follow up with assessment of ASIA score which improves study's exclusivity.

CONCLUSION

The findings of our study underline the prognostic role of early MRI abnormalities in adult patients with SCIWORA and predicts most favorable one year outcomes in patients with spinal cord edema at presentation followed by lesser degree of favorable outcomes with spinal cord contusion at presentation and cord hemorrhage had worst prognosis of recovery at one year.

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