Acute Traumatic Spinal Cord Injury; does a Low Tesla Magnetic Resonance Imaging Features Correlates with Neurological Status and Predict Early Outcome?

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Abstract

Background: Traumatic spinal cord injury (TSCI) is a devastating disease, hence the need to identify clinical and radiological injury features that predict neurological improvement. **Aims:** The aim is to determine the correlations between American Spinal Injury Association (ASIA) Impairment Scale (AIS) and magnetic resonance imaging (MRI) features in patients with TSCI and identify predictors of neurological improvement. **Settings and Design:** This is a prospective cohort study. **Subjects and Methods:** Seventy-three patients with TSCI managed over a period of 18 months were studied. Neurological assessment of these patients was done at admission and 3-month post-injury using the AIS score form. The various MRI (0.3 Tesla Machine) features of these injuries were identified and measured using a RadiAnt DICOM Viewer 4.0.3 (64-bit). **Statistical Analysis:** Correlation and regression analysis were done using Spearman's rank correlation, and logistic regression, respectively. A $P < 0.05$ was used as the level of significance. **Results:** Spinal cord edema (26.0%) and cord contusion (34.2%) were seen in most patients with incomplete injury, while spinal cord hemorrhage and transection were observed in patients with ASIA A injury. A significant correlation exists between maximum canal compromise (MCC) ($\rho = -0.39$, $P < 0.001$), maximum spinal cord compression (MSCC) ($\rho = -0.44$, $P < 0.001$), and length of spinal cord lesion ($\rho = -0.77$, $P < 0.001$) with AIS at admission. The independent predictors of AIS improvement include MSCC, MCC, length of spinal cord signal change, and cord contusion. **Conclusions:** MRI features significantly correlate with the neurological status of TSCI and can be used to predict early neurological improvement in these patients.

Keywords: American spinal injury association impairment scale, magnetic resonance imaging, neurological improvement, spinal cord injury, trauma

Introduction

Acute traumatic spinal cord injury (TSCI) is one of the most devastating injuries encountered in trauma care all over the world. There are only a few injuries suffered by humans that are more incapacitating, than TSCI.[1-3] In the past, this was further complicated by our inability to directly visualize the different types of injury pattern that occurs within the spinal cord following trauma, this makes the management of these injuries challenging.[4-7]

With the advent of magnetic resonance imaging (MRI) in the late 1970s, it is possible to accurately characterize the underlying spinal cord injury even when X-rays and computerized tomography (CT) scans appear normal, which makes MRI superior in tissue characterization.[6,8-14] Extensive research work to investigate the prognostic value of MRI features, in patients with TSCI has been reported widely in literatures. This imaging modality is now considered by many authors, as a routine imaging procedure for patients with traumatic injury to the spine.[6,9,15-21]

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These studies described several types of traumatic spinal cord lesions (intramedullary hemorrhage, spinal cord contusion, cord edema, extrinsic compression by a bone fragment, traumatic disc herniation, and complete spinal cord transection) seen on MRI following TSCI.[6,11-14] However, the question persists can these MRI features be used to predict clinical outcome in patients with TSCI?[6,8,9,12-14,21,22] These MRI features are largely grouped into qualitative (cord hemorrhage, edema, contusions, and traumatic disc herniation) and quantitative spinal canal compromise, spinal cord compression, and length of cord signal change) have been used by some authors to correlate with the clinical outcome of TSCI.[8,12,15,23]

With the increased use of MRI as an imaging modality in the evaluation of patients with TSCI, efforts are being made to accurately define features that correlate with the severity of neurological deficits and also predict neurological recovery.[21,23] The value of this association will help in identifying predictors of neurological recovery, especially, in patients whose AIS could not be done in the immediate post-injury period. It will also enable clinicians, to accurately provide information to the patients and their families concerning prognosis and treatment options. It will help design a specific rehabilitation program for patients based on their prognosis, justify treatment decisions, and help them to anticipate treatment outcomes. From a research perspective, it will provide a platform for a comprehensive prognostic stratification of injury derived from both clinical and MRI features of TSCI.

At present, there is a paucity of information in literature regarding the use of MRI features in predicting outcomes in patients with TSCI, most especially in developing countries or environments with limited resources and low tesla MRI machines.[12,16] This study was conducted to evaluate the correlations between AIS and TSCI features of MRI and to identify predictors of neurological improvement at 3-month post-injury using a low tesla MRI in a resource-limited environment.

Subjects and Methods

This was a hospital-based, prospective cohort study, conducted from May 2016 to November 2017. Approval was obtained from the Research and Ethics Committee of our institution (Research code NHA/EC/005), and the desired sample size was estimated.[24] The participants enrolled for this study include all consecutive patients brought to the emergency room of our hospital with clinical and/or radiological features of acute TSCI. The patients were reviewed and those who met the inclusion criteria and gave consent were recruited and enrolled for the study. However, patients who were unconscious or those who could not follow or obey instructions and those who presented 2 weeks after injury or refuse to give consent were excluded. Patients who were unable to do MRI due to financial constraints or the presence of implants or foreign bodies that are not MRI compatible and those who leave against medical advice were also excluded from the study.

A structured pro forma was designed to obtain MRI features of injury, sex, age, and mechanism of injury; this was used alongside the AIS/International Spinal Cord Society or AIS form to document neurological examination findings performed on the patients at admission, at discharge, and at 3-month post-injury. A 0.3 Tesla MRI machine was used for imaging, and a RadiAnt DICOM Viewer 4.0.3 (64-bit) was used for viewing and measuring MRI features. The review of MRI injury features was done by one of the authors in collaboration with a radiologist simultaneously, with the radiologist completely blinded from the neurological status and outcome of treatment of the patients. Different patterns or types of spinal cord injury as described by Ramón *et al*.[14] were identified from a midsagittal and axial T2W sequence [Figures 1 and 2]. The maximum canal compromise (MCC) and MSCC were calculated from a midsagittal T2W, sequence as shown in Figure 2 using the formula; (i) $MCC = (1 - [Di/½(Da + Db)]) \times 100$, (ii) $MSCC = (1 - [di/½ (da + db)]) \times 100$, while the length of spinal cord lesion was measured.

The patients were managed based on the neurosurgical unit protocol used in the management of acute TSCI. This consists majorly of maintaining blood pressure above 90/60 mmHg, immediate spine stabilization with external orthosis depending on the spine region, adequate analgesia, early physiotherapy and rehabilitation, deep venous thrombosis prophylaxis and pressure ulcer prevention, radiological imaging; X-rays or CT scan and MRI as soon as possible. Patients whose radiological

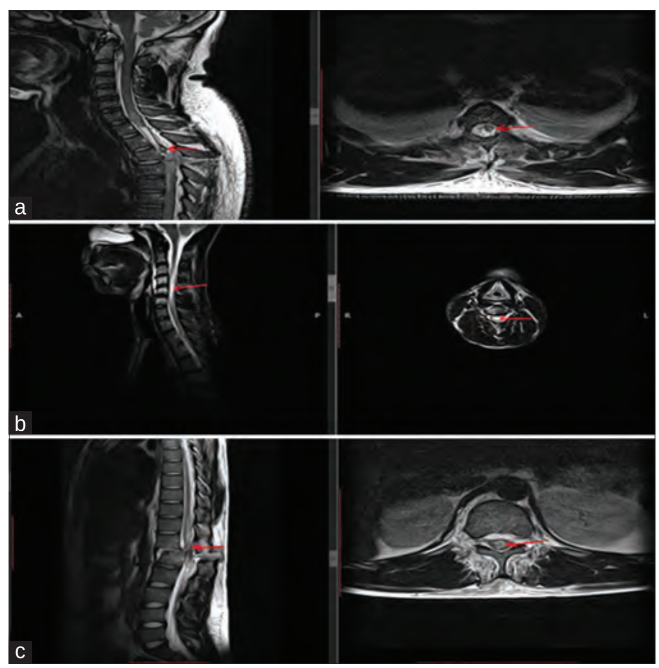

Figure 1: (a) is a sagittal and axial magnetic resonance imaging showing cord hemorrhage; a central large hypodensity with thin rim of hyperdensity within the spinal cord. (b) Is a sagittal and axial magnetic resonance imaging showing cord edema; a homogenous hyperdensity within the spinal cord. (c) Is a sagittal and axial magnetic resonance imaging showing cord contusion; a small hypodensity within the cord with a thick rim of hyperdensity

images X-rays/MRI or CT/MRI revealed cord compression or spine instability were counseled and managed surgically, the meantime from injury to surgery for these patients was 14 days and none of the patients was operated within 24 h.

The neurological status of these patients was assessed at admission, discharge, and at 3-month post-injury using the AIS forms in the emergency room, ward, and outpatient department, respectively. Patients who were still on admission as at 3-month post-injury were assessed on the ward. However, those patients who could not come to the outpatient department for follow-up were assessed through WhatsApp video call. Patients who died before 3 months were excluded in the analysis for neurological improvement at 3-month post-injury.

Data analysis was done using the statistical software; IBM SPSS Statistics for Windows, Version 25.0. (Armonk, NY: IBM Corp). Tables, bar charts, and pie charts were used for the descriptive analysis of demographics. Quantitative variables were expressed as mean and standard deviation. The test of statistical significance was done using Fisher's exact test and Spearman's rank correlation coefficient. Simple and stepwise binary logistic regression was used to determine potential predictors of neurological recovery. The level of significance was set at a $P < 0.05$.

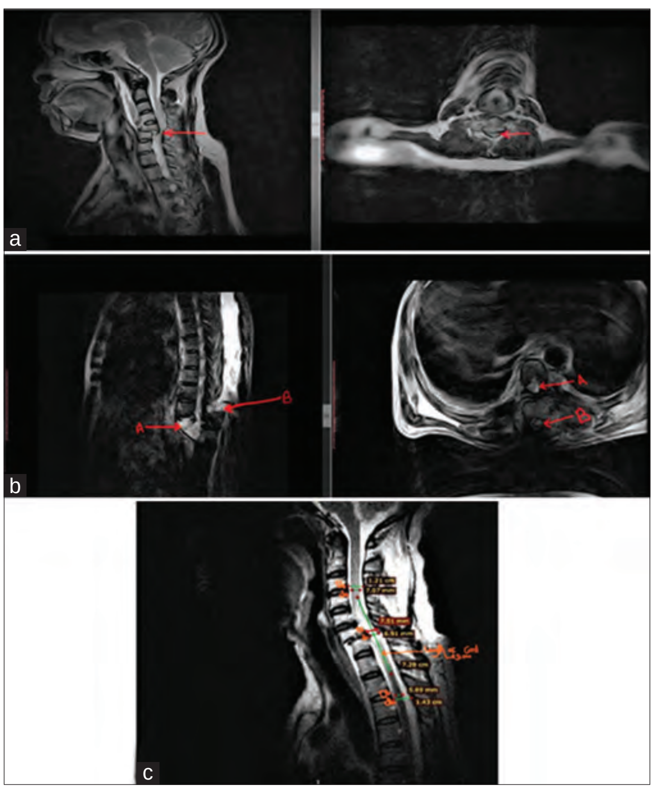

Figure 2: (a) Is sagittal and axial magnetic resonance imaging showing cord compression, (b) Is a sagittal and axial magnetic resonance imaging showing cord transection, a complete separation of proximal spinal cord (red arrow A) from distal cord (red arrow B). (c) Is a midsagittal, cervical magnetic resonance imaging showing how Di and di, Da and da, and Db and db were measured and used to calculate maximum canal compromise and maximum spinal cord compression and how the length of spinal cord lesion was measured

Results

A total of 108 patients with TSCI were seen and reviewed over the period of this study, however, 35 patients were excluded, for not meeting the inclusion criteria. Seventy-three of the patients were studied, out of which, four of the patients could not turn up for follow-up at 3-month post-injury and were reviewed through WhatsApp video call. Majority (40, 54.7%) were young adults aged, 20–39 years, with an average age of 37.0 ± 13.6 years, the male-to-female ratio was 4.2:1. Road traffic accident (RTA) was the most common cause of injury (53, 72.6%) [Table 1]. Cervical spine injury was seen in more than half of the patients (47, 64.4%) followed by thoracic spine (13, 17.8%) [Figure 3].

At admission, complete spinal cord injury (American Spinal Injury Association [ASIA] A) was the most common type of injury seen (31, 42.5%), with ASIA D (7, 9.6%) being the least type of injury. At 3-month post-injury, 65 (89%) of the patients survived, while 8 (11%) of the patients died, this mortality occurred only in patients with ASIA A cervical TSCI. At 3-month postinjury, 19 (29.2%) of the patients remained ASIA A, (four of the patients with ASIA A at admission improved by at least one level) whereas more than half of the patients 40 (61.5%) had ASIA D and E at 3-month postinjury [Table 1].

The mean time from injury to MR imagining was 69.1 ± 59.0 h, and more than half (46, 65. 01%) of the patient performed their MRI within the 1st week of injury. The most common pattern of spinal cord lesion seen on midsagittal, T2W image was cord contusion (pattern III) 34.2%, followed by spinal cord edema (pattern II) 26.0%, while spinal cord hemorrhage (pattern I) 5.5% and cord transection (pattern V) 5.5% were the least common pattern seen. All the patients with spinal cord hemorrhage and cord transection had ASIA A injury. However, patients with normal spinal cord (pattern 0) 12.3% had incomplete spinal cord injury with transient or absent neurological deficit (ASIA E), this association was also significant ($P < 0.001$). Spinal cord compression (pattern IV) was seen in 12 (16.4%) patients, with 58.3% having ASIA A and 41.7% having ASIA C, this association was also found to be significant with $P = 0.005$ [Table 2].

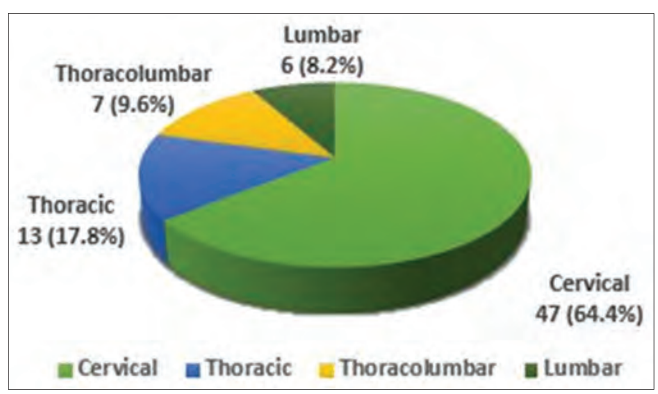

Figure 3: A pie chart showing the distribution the different segment of spinal cord affected

At 3-month post-injury, it was observed that the patients with complete TSCI at admission, who had spinal cord hemorrhage, cord compression, and cord transection, remained neurologically complete, this relationship was significant for spinal cord compression with $P = 0.019$ [Table 3]. Anterior longitudinal ligament and/or posterior longitudinal ligament injury was not significantly associated with and change in AIS at admission and at 3-month post-injury ($P > 0.05$).

Table 1: Sociodemographic characteristics, etiology, and American Spinal Injury Association Impairment Scale

Variables	Frequency (*n*=73), *n* (%)
Age	
<20	8 (11.0)
20-29	15 (20.5)
30-39	25 (34.2)
40-49	10 (13.7)
50-59	11 (15.1)
≥60	4 (5.5)
Total	73 (100)
Sex	
Male	59 (80.8)
Female	14 (19.2)
Total	73 (100)
Etiology	
MVC	54 (74.0)
Falls	12 (16.4)
Gunshot	1 (1.4)
Stab	1 (1.4)
Falling object	5 (6.8)
Total	73 (100)

ASIA impairment scale	Frequency (%)	
	Admission, *n* (%)	3 months, *n* (%)
A	31 (42.5)	19 (29.2)
B	10 (13.7)	3 (4.6)
C	10 (13.7)	3 (4.6)
D	7 (9.6)	14 (21.5)
E	15 (20.5)	26 (40.0)
Total	73 (100)	65 (100)

ASIA: American Spinal Injury Association, MVC: Motor Vehicular Crash

Patients with complete spinal cord injury had higher mean values of MCC, MSCC, and length of spinal cord lesion when compared to patients with ASIA E who had lower values of MCC, MSCC, and length of spinal cord lesion, which represent a significant correlation between MCC ($\rho = -0.39$, $P < 0.001$), MSCC ($\rho = -0.44$, $P < 0.001$), and length of spinal cord signal change ($\rho = -0.77$, $P < 0.001$) with the AIS at admission [Table 3 and Figure 4].

At 3-month postinjury, 26 (35.6%) of the patients improved in their AIS, whereas 24 (32.9%) did not, four (6.1%) patients, who had complete TSCI at admission, that improved in their AIS, had spinal cord edema or cord contusion, but none of the patients with spinal cord hemorrhage (4, 16.7%, $P = 0.046$) or cord transection (3, 11.5%, $P = 0.103$) did improve in their AIS. Most of the patients 23 (88.5%) that improved in their AIS had cord edema ($P = 0.148$) or cord contusion ($P = 0.016$), and all of these patients had incomplete spinal cord injury (ASIA B, C, or D) [Tables 2 and 3].

A significant relationship also exist between MCC ($P = 0.022$), MSCC ($P = 0.021$), and length of spinal cord lesion ($P = 0.001$) with neurological improvement at 3-month postinjury [Table 3].

In a simple logistic regression analysis, spinal cord contusion was shown to be an independent predictor of neurological improvement ($P = 0.020$, odds ratio [OR]: 4.43, 95% confidence interval [CI]: 1.27, 15.49). Likewise, higher mean value of MCC ($P = 0.023$, OR: 0.97, 95% CI: 0.95, 0.99), MSCC ($P = 0.021$, OR: 0.96, 95% CI: 0.93, 0.99),

Table 2: Qualitative magnetic resonance imaging features and American Spinal Injury Association Impairment Scale at admission and at 3-month postinjury

MRI pattern	AIS at admission					Total (*n*=73), *n* (%)	*P*
	A (*n*=31), *n* (%)	B (*n*=10), *n* (%)	C (*n*=10), *n* (%)	D (*n*=7), *n* (%)	E (*n*=15), *n* (%)		
O	0	0	0	0	9 (100)	9 (12.3)	<0.001*
I	4 (100)	0	0	0	0	4 (5.5)	0.372
II	6 (31.6)	3 (15.8)	2 (10.5)	4 (21.1)	4 (21.1)	19 (26.0)	0.370
III	10 (40.0)	7 (28.0)	3 (12.0)	3 (12.0)	2 (8.0)	25 (34.2)	0.066
IV	7 (58.3)	0	5 (41.7)	0	0	12 (16.4)	0.005*
V	4 (100)	0	0	0	0	4 (5.5)	0.373
MRI pattern	**AIS at 3 months**					**Total (*n*=65), *n* (%)**	***P***
	A (*n*=19), *n* (%)	**B (*n*=3), *n* (%)**	**C (*n*=3), *n* (%)**	**D (*n*=14), *n* (%)**	**E (*n*=26), *n* (%)**		
O	0	0	0	0	9 (100)	9 (13.8)	0.029*
I	4 (100)	0	0	0	0	4 (6.1)	0.052
II	3 (17.6)	0	1 (5.9)	6 (35.3)	7 (41.2)	17 (26.2)	0.400
III	3 (14.3)	3 (14.3)	0	8 (38.1)	7 (33.3)	21 (32.0)	0.007*
IV	6 (54.5)	0	2 (18.2)	0	3 (27.3)	11 (16.9)	0.019*
V	3 (100)	0	0	0	0	3 (4.6)	0.124

*Statistically significant. ASIA: American Spinal Injury Association, AIS: ASIA Impairment Scale, MRI: Magnetic resonance imaging

Table 3: Spearman's rank correlation coefficient (ρ) of magnetic resonance imaging features and American Spinal Injury Association Impairment Scale at admission and at 3 months and American Spinal Injury Association Impairment Scale improvement at 3 months

Variables	Correlation coefficient (ρ)	*P*
AO type of spine injury versus ASIA at admission	−0.29	0.006*
MCC versus ASIA at admission	−0.39	<0.001*
MSCC versus ASIA at admission	−0.44	<0.001*
Length of cord lesion versus ASIA at admission	−0.77	<0.001*
ASIA at admission versus ASIA at 3 months	+0.49	<0.001*
AO type of spine injury versus ASIA at 3 months	−0.11	0.175
MCC versus ASIA at 3 months	−0.19	0.054
MSCC versus ASIA at 3 months	−0.16	0.082
Length of cord lesion versus ASIA at 3 months	−0.39	<0.001*
ASIA at admission versus AIS improvement at 3 months	+0.54	<0.001*
AO type of spine injury versus AIS improvement at 3 months	−0.166	0.248
MCC versus AIS improvement at 3 months	−0.322	0.022*
MSCC versus AIS improvement at 3 months	−0.325	0.021*
Length of cord lesion versus AIS improvement at 3 months	−0.438	0.001*

MRI features	Neurological improvement		*P*
	Improved, *n* (%)	Not improved, *n* (%)	
Qualitative			
I	0	4 (16.7)	0.046*
II	9 (34.6)	4 (16.7)	0.148
III	14 (53.8)	5 (20.8)	0.016*
IV	3 (11.5)	8 (33.3)	0.063
V	0	3 (12.5)	0.103
Total	26 (100)	24 (100)	
Quantitative			
MCC (%)	28.89±22.81	47.81±30.55	0.022*
MSCC (%)	15.01±14.79	33.82±31.27	0.021*
Length of cord changes (mm)	47.41±36.35	78.04±35.70	0.001*

*Statistically significant. Interpretation of correlation: 0: No correlation, 0.01–0.20: Negligible, 0.21–0.50: Mild, 0.51–0.80: Moderate, 0.81–0.99: Strong, 1: Perfect. ASIA: American Spinal Injury Association, MCC: Maximum canal compression, AIS: ASIA Impairment Scale, MSCC: Maximum spinal cord compression, AO: Arbeitsgemeinschaft für Osteosynthesefragen

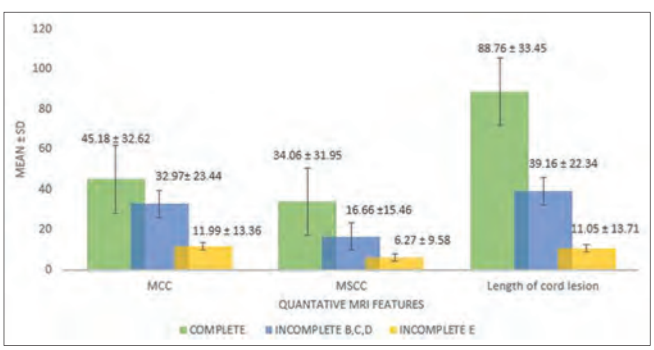

Figure 4: A bar chart showing the mean ± standard deviation distribution of maximum canal compromise, maximum spinal cord compression at admission, in patients with complete spinal cord injury, incomplete spinal cord injury without neurological deficit and in incomplete spinal cord injury without neurological deficits

and length of spinal cord lesion (P = 0.009, OR: 0.98, 95% CI: 0.96, 0.99) were also found to be independent predictors of poor neurological improvement at 3-month post-injury. However, only the length of spinal cord lesion and pattern III cord injury were observed to be better predictors of neurological improvement in stepwise regression analysis model [Table 4].

Discussion

In this study, TSCI occurred more in patients aged 20–39 years, with RTA being the major cause of injury. The cervical spinal cord was the most affected, this demographic is similar to reports from local and global publications.[2,3,16,25-36]

Similar patterns of spinal cord injury described by Bondurant *et al*. and Ramón *et al*. in patients with TSCI were observed in our cohort. In majority (64, 87.7%) of the patients, there were spinal cord signal intensity changes on MRI. Spinal cord transection and cord hemorrhage were observed only in patients with complete TSCI, while spinal cord edema and cord contusion were seen in most patients with incomplete injury. These injury patterns correlate significantly with AIS at admission and at 3-month post-injury.

The findings in this study are similar to publications by many other authors, who reported that traumatic intramedullary

Table 4: Simple binary and stepwise logistic regression of potential predictor of American Spinal Injury Association improvement at 3-month postinjury

Variable	β	SE	Wald statistic	*P*	Crude OR	95% CI	
						Lower	Upper
Simple logistic regression							
Incomplete injury (yes/no)	3.04	0.74	16.86	<0.001*	20.90	4.90	89.19
MRI pattern III (yes/no)	1.45	0.64	5.44	0.020*	4.43	1.27	15.49
AO grade of spine injury	−0.12	0.10	1.45	0.229	0.88	0.72	1.08
MCC	−0.03	0.01	5.20	0.023*	0.97	0.95	0.99
MSCC	−0.04	0.02	5.32	0.021*	0.96	0.93	0.99
Length of cord signal change	−0.03	0.01	6.79	0.009*	0.98	0.96	0.99
Stepwise logistic regression							
Step 1	**β**	**SE**	**Wald statistic**	***P***	**Crude OR**	**95% CI**	
						Lower	**Upper**
Length of cord signal change	−0.03	0.01	7.05	0.008*	0.98	0.96	0.99
MRI pattern III (yes/no)	1.68	0.72	5.45	0.020*	5.35	1.31	21.88
Step 2	**β**	**SE**	**Wald statistic**	***P***	**Crude OR**	**95% CI**	
						Lower	**Upper**
Length of cord signal change	−0.03	0.01	7.58	0.006*	0.97	0.96	0.99
MRI pattern III (yes/no)	1.27	0.75	2.86	0.091	3.57	0.82	15.60
MSCC	−0.04	0.02	3.68	0.055	0.96	0.92	1.00
Step 3	**β**	**SE**	**Wald statistic**	***P***	**Crude OR**	**95% CI**	
						Lower	**Upper**
Length of cord signal change	−0.03	0.01	7.87	0.005*	0.97	0.95	0.99
MRI pattern III (yes/no)	1.58	0.92	2.96	0.085	4.83	0.80	29.09
MSCC	−0.05	0.03	3.23	0.072	0.95	0.90	1.01
MCC	0.014	0.02	0.36	0.551	1.01	0.97	1.06

*Statistically significant. MCC: Maximum canal compression, MSCC: Maximum spinal cord compression, MRI: Magnetic resonance imaging, OR: Odds ratio, SE: Standard error, CI: Confidence interval

hemorrhage or hematoma and cord transection has a strong and significant correlation with complete TSCI, with those patients having poor chance of neurological recovery during follow-up.[4,6,11,12,14-16] While spinal cord edema and cord contusion, were predominantly seen, in patients with incomplete spinal cord injury with better chance of neurological improvement. These findings further support those of earlier publications and strengthen the overwhelming evidence that MRI features of spinal cord injury correlate well with clinical severity of acute TSCI.

Although we found that AO class of vertebral injury correlates with severe AIS at admission, it was not predictive of neurological improvement, while longitudinal ligament injury did not show any correlation at all. Gupta *et al*. in their series concluded that the presence of ligamentous injury, facetal dislocation or subluxation, and vertebral fracture or subluxation in addition to spinal cord contusion and hemorrhage were associated with complete spinal cord injury.[16]

The length of spinal cord lesion, MSCC, and MCC were parameters developed by Fehlings *et al*. to measure and determine the extent of TSCI and it correlation with AIS.[23,37] These parameters have been validated with good inter and intraobserver reliability.[12,15,23,37] In this study, patients who had ASIA A injury had a higher mean values of MCC, MSCC, and length of cord signal changes, the mean values of these parameters were found to be much lower in patients with ASIA E or spinal cord injury without neurological deficits. This observation significantly correlated with AIS at admission, however, only the length of spinal cord lesion correlated significantly with the AIS at 3-month post-injury.

There are several studies that correlated the qualitative MRI features with AIS, but only a few correlated the length of the lesion, MSCC, and MCC with AIS.[11,12,37] In recent times, some authors have shown that patients with complete TSCI tend to have significantly higher values of length of spinal cord signal changes, MSCC, and MCC, whereas those with incomplete TSCI had lower mean values, similar to the finding in our study.[4,15,16,37] This could easily be explained by the fact that, severe cord compression or spinal canal compromise from disc herniation, displaced or dislocated fractured vertebrae or hematoma, is more likely to cause ischemia or disruption of nerve fibers with severe and extensive damage to the spinal cord. This primary insult often predisposes the spinal cord to secondary injury, which may result in permanent cord damage with less likelihood of recovery.[9,38] This may be the reason why early surgical intervention in some published studies is associated with improvement in AIS.[39]

Most authors, in their respective series, showed a significant association between spinal cord hemorrhage and poor neurological recovery in patients with TSCI but were unable to demonstrate with regression analysis models, predictors of early neurological recovery.[6,11,13,14] This is an additional finding in our study, where a simple regression analysis model revealed that incomplete spinal cord injury at admission, spinal cord compression, and all the quantitative MRI features were independent predictors of early neurological improvement. However, in the stepwise regression model, only the length of spinal cord lesion and cord contusion were better predictors of neurological improvement. Although some researchers reported that the length of spinal cord lesion and MSCC were independent predictors of poor neurological recovery;[12,15] others found that MCC and MSCC were not predictive of long-term prognosis.[16] The dissimilarity in these observations could be due to the discordance in the regression model employed by different authors and the variability in reporting. Despite these differences, the role of MRI in predicting a neurological recovery in patients with TSCI is in no doubt overwhelming, and the report by Tarawneh *et al*., in a recently published systematic review, has further supported this assertion.[21]

Study limitation

The magnetic strength of our MRI machine is a 0.3 Tesla, spin-echo MR imaging, with a great deal of limitation in image quality and pathophysiological usefulness in trauma settings. However, studies have shown that higher tesla MRI with more advanced imaging technique such as diffusion tensor imaging has the ability to show axonal injury and additional shearing injuries that are not visible on low tesla and conventional MR images. We had occasional delays in carrying out MR imaging, for our patients, due to delays in financing the cost of imaging, this is because most of our patients fund their health services, which limits our ability to do follow-up MRI. In addition, frequent breakdown of the MRI machine caused a delay in acquiring these images.

Conclusions

The used of low tesla MRI to determine different types of spinal cord injury characteristics is valuable in predicting an early neurological recovery in patients with TSCI. Spinal cord hemorrhage, cord transection, and higher values of quantitative MRI features correlate significantly with severe neurological deficits and poor outcome, whereas spinal cord contusion and lower values of quantitative features of MRI correlate with less severe neurological deficits and better early outcome.

Ethical approval was obtained from the Research and Ethics Committee of our institution; NHA/EC/005.

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Conflicts of interest

There are no conflicts of interest.

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