Original Research Article

Role of magnetic resonance imaging in assessment of cervical spine injuries and clinico-neurological outcome at tertiary care centre

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Abstract

Background: MRI plays an important role in assessment of ligamentous injuries and spinal cord injury such as soft tissue, subtle bone marrow and spinal cord abnormalities which may not be visible on other imaging tools. **Aim:** To assess the pattern of cervical spine injuries by MR imaging and assess use of MRI findings in prognosis. **Material and Methods:** A hospital based descriptive longitudinal study was conducted on 30 cervical spinal cord injury patients. **Results:** Out of 30 cases, 87% were males and average age was 42 year. The most common mode of injury was motor vehicle accident (60%) and C6-C7 spinal level was most commonly involved (30%). Incomplete spinal cord injury and complete spinal cord injury found in 60% and 23.33% cases and 16.67% were neurologically normal. Cord contusion (86.67%) was the most common MRI finding followed by cord compression, disc injury, prevertebral hematoma and subluxation. Out of 7 cases with CSCI at admission, 28.57% patients expired and 71.43% patients improved neurologically after 3 months. Out of 18 patients with ISCI at admission, 44.44% cases were ICSI and 22.22% were neurologically normal after 3 month. **Conclusion:** MR imaging was useful tool for assessment of spinal cord injuries like especially ligamentous, soft tissue injuries and haemorrhages. MRI should be investigation of choice in suspected spinal cord injury for diagnosis as well as prognosis.

Key Words: American Spinal Cord Injury (ASIA) scale, MRI, Spinal trauma, Neck injury, RTA.

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INTRODUCTION

Indian estimates of Spinal cord injury (SCI) suggest incidence around 15-20 per million per year population.[1] SCI is very common injury with varied severity and prognosis which may range from asymptomatic condition to simple neck pain, to quadriplegia, or even death. The common causes of spinal trauma are road traffic accident, fall, recreational or sport activities and blunt trauma.[2] Radiological imaging is necessary to detect the presence or absence of lesions, to describe the characteristics, to decide a line of management and to assess the prognostic influence.[3] MRI plays pivotal role in the management of SCI cases due to its inherently superior contrast resolution and increasing availability in the emergency departments. It plays an important role in assessment and detection of ligamentous injuries and spinal cord injury as soft tissue, subtle bone marrow and spinal cord abnormalities which may not be visible on other imaging

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tools.[4,5,6] In cases of spinal cord contusion, edema, ischemia and haemorrhage, MRI findings may be utilised as prognostic indicators. The sagittal images gives most of the diagnostic information in SCI cases. Sagittal T1-weighted images shows an anatomic overview while Sagittal T2-weighted images gives most of the soft tissue abnormalities.[3] MRI is useful in diagnosis of the initial injury, which is critical step in order to decide line of management and predict an accurate functional prognosis. Delayed recognition of an injury or improper stabilization of the cervical spine may lead to irreversible spinal cord injury and permanent neurologic damage. The purpose of this study is to prospectively evaluate pattern of cervical spine injuries by MR imaging and assess use of MRI findings in prognosis.

MATERIAL AND METHODS

A hospital based descriptive longitudinal study was conducted for 2 years i.e. from October 2009 to October 2011 at Department of Radio-diagnosis at Kamineni Hospitals, Hyderabad. IEC (Institutional Ethics Committee) permission was taken before data collection. Inclusion criteria were known/ suspected cervical spine trauma cases who presented to the emergency department of hospital having isolated cervical spinal cord injuries on MR imaging, performed within 48 hours of injury. Hemodynamically unstable cases requiring immediate surgical intervention and cases with concomitant head injury were excluded. Thirty patients were enrolled in study. A valid, written informed consent was taken from patients or their relatives, if patient was unconscious, collecting an information. Patients or their relatives were interviewed about date of admission, time of MRI demographic profile, type and mode of injury and time of injury and information was recorded. The American Spinal Injury Association (ASIA) score was used to assess the degree of neurologic deficit and outcome measure at admission and follow-up visits. The ASIA impairment scale was used to classify the severity of SCI by means of assessment of motor and sensory impairments. ASIA grade B, C and D indicate incomplete SCI with evidence of sacral sensory sparing. Patients with ASIA grade B status have complete motor impairment, whereas those with ASIA grade status have motor function below the level of injury, with a muscle grade lower than 3 (on scale of 1 to 5) on the Medical Research Council scale. Patients with ASIA grade D have motor function below the injury level with key muscle group grade 3 or higher on the Medical Research Council scale ASIA grade E corresponds to no motor or sensory deficit. ASIA grade A indicates complete motor and sensory impairment below the level of injury.[7]

Technical specifications

Standard operating definitions, protocols and procedures were formulated before start of study and followed till end. Cord haemorrhage, cord contusion, cord compression, epidural hematoma, vertebral body fracture, posterior element fracture, disc injury, ligament injury, prevertebral hematoma, subluxation, foreign body and vertebral artery thrombosis were assessed on MRI and findings were recorded. MRI was conducted within 24-48 hours after the injury. Standardized MR imaging protocols for acutely injured spine were used. Gradient recalled echo sequence determine the presence of cord haemorrhage was also performed. All patients were examined with use of a close-design standard 1.5 T high field strength MR imaging system (Siemens Symphony Magnetom, Maestro class 1.5T machine). T1-weighted images were obtained with an echo time of 10 milliseconds and a pulse repetition time of 590 milliseconds, while T2-weighted images were obtained with echo time of 120 milliseconds and repetition time of 2800 milliseconds. The thickness was 4 mm was used. FOV was 320*320. Both T2-weighted axial imaging and T1 and T2-weighted sagittal were done on all the patients. Data was managed in Microsoft Excel 2007 and analysed by using MedCalc, version 12.1.0.0 software. Descriptive statistics like frequency, proportion and mean was used. Comparisons were made among three groups; Complete SCI (CSCI), Incomplete SCI (ISCI) and neurologically normal patients. For all Statistical testing, significance was set at 5% level. Inferential statistics was used to find out potential predictor of admission and 3 months ASIA score. Graphs and tables were used at appropriate places to summarize the data.

RESULTS

Figure no. 1 shows male predominance over female with male to female ratio of 6.5:1. Out of 30 cases, 87% were males and 13% were females. The average age of the patients was 42 years (Range 22 to 62 years). Table no. 1 highlights injury profile of study subjects. The most common mode of injury among 30 patients was motor vehicle accident (60%) followed by fall (40%). The C6-C7 spinal level was most commonly involved (30%). Out of 30 patients, 13 (43%) were operated and 17 (57%) were not operated. Most patients had an incomplete spinal cord injury (ISCI) at admission (n= 18; 60%) while 23.33% had complete spinal cord injury (CSCI) and 16.67% were neurologically normal (NN). Out of 7 patients with CSCI, 5 (71.43%) underwent surgery and out of 18 cases with ISCI, 8 (44.44%) underwent surgery. None of the patients who were neurologically normal required surgery. Various MRI findings in patients with cervical spine injury is shown in table no. 2. Cord contusion (86.67%) was the most common MRI finding seen in patients with cervical spine injury (CSI) followed by cord compression, disc injury, pre vertebral hematoma and subluxation (n=18; 60% each). Epidural hematoma was the least common finding seen only in 2 (6.67%) patients. Multiple bar diagram shown in fig. no.2, explained outcome of spinal cord injury cases after 3 months. Out of 7 cases with CSCI at admission, 2 (28.57%) patients expired and 5 (71.43%) patients improved neurologically after 3 months. Out of 18 patients with ISCI at admission, 4 (22.22%) patients expired, lost to follow-up of 2 (11.12%) cases, 8 (44.44%) cases were ICSI and 4 (22.22%) were neurologically normal after 3 month. As depicted in table no. 3, all 4 patients with ISCI who expired during 3 months follow up had ligament injury, soft tissue injury, subluxation, disc injury, prevertebral hematoma and cord contusion on admission. However of all 4 patients with ISCI who became neurologically normal at 3 months, 1 patient had soft tissue injury, 2 patients had disc injury and 4 patients had cord contusion on admission. None of them had ligament injury, subluxation or prevertebral hematoma.

Table 1: Injury profile of study subjects (n=30)

Characteristics	Number of Patients (n= 30)
Mode of Injury	
Motor Vehicle Accident	18 (60%)
Fall	12 (40%)
Level of SCI#	
Cl-C2	2 (7%)
C2-C3	4 (13%)
C3-C4	3 (10%)
C4-C5	6 (20%)
C5-C6	6 (20%)
C6-C7	9 (30%)
Severity of SCI	
Complete (ASIA grade A)*	7 (23.33%)
Incomplete (ASIA grade B, C or D)	18 (60%)
Neurologically Normal (ASIA grade E)	5 (16.67%)
Surgical Status	
Operated	13 (43%)
Not Operated	17 (57%)

*ASIA: American Spinal Injury Association; # SCI: Spinal Cord Injury

Table 2: Various MRI findings in patients with cervical spine injury

MRI Parameter	Frequency (%)
Body Fracture	6 (20%)
Cord Contusion	26 (86.67%)
Cord Compression	18 (60%)
Cord Hemorrhage	7 (23.33%)
Disc Injury	18 (60%)
Epidural Hematoma	2 (6.67%)
Ligament Injury	15 (50%)
Posterior Element Fracture	6 (20%)
Prevertebral Hematoma	18 (60%)
Soft Tissue Injury	17 (56.67%)
Subluxation	18 (60%)
Vertebral Artery Thrombosis	9 (30%)

Table 3: MRI features in patients with ISCI at admission who expired or who became neurologically normal (NN) after 3 months

MRI Parameters	Expired	Neurologically Normal
Ligament Injury	4	0
Soft Tissue Injury	4	1
Subluxation	4	0
Disc Injury	4	2
Prevertebral Hematoma	4	0
Cord Contusion	4	4

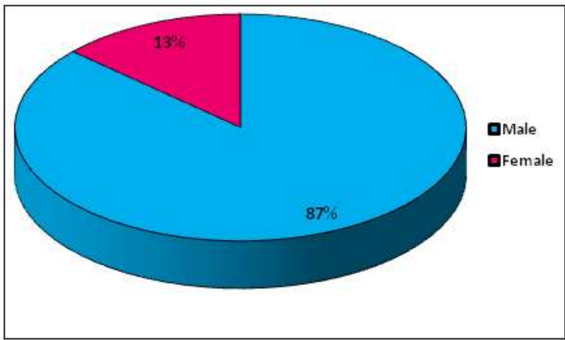

Figure 1: Gender wise distribution of study subjects (n=30)

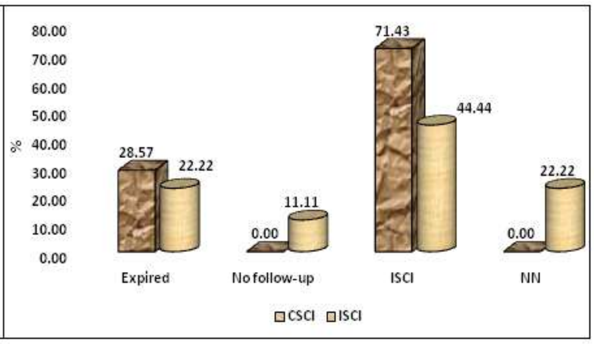

Figure 2: Status of CSCI and ISCI Patients after 3 months

DISCUSSION

In study done by M ter Haar *et al*[8], female to male ratio was 1:6.69 and average age of cases was 37 years while in a study conducted by Miyanji *et al*[9], female to male ratio was 1:3.76 and average age of patients was 45 years. In Current study female to male ratio was 1:6.5 and average of patients was 42 years which was quite similar to above two studies. In Current study, C6-C7 was most commonly (30%) affected followed by C4-C5 and C-C6 and vehicular accident was most common mode of injury. Concurrent findings reported by M ter Haar *et al*[8] with C5-C6 as most common spinal level of injury and motor vehicle as most common mode of injury. Study done by Miyanji *et al*[9] reported motor vehicle was most common mechanism of injury and C5-C6 as a most common spinal level of injury, similar to current study. In studies done by Miyanji *et al*[9] and M ter Haar *et al*[8], most common neurological status on admission was ISCI in 51% cases and 44% cases, respectively. Current study reported slightly higher proportion of ISCI cases (60%). In a study done by Naik *et al*[10], majority of the patients were males (86%) with age group of 21–40 years (45.6%).In their study, most common cause of injury was fall from height (56.14%) followed by road traffic accident (RTA) (36.84%) and fall of weight (7.02%) and level of injury was cervical level (43.86%) followed by dorsal and lumbar levels (21.05%;each) and eight patients (14.04%) had dorso-lumbar injury.Bondurant *et al*[11] reported that type III (region of hypo-intensity mixed with a peripheral region of high signal intensity, consistent with contusion) abnormality patterns were seen in patients with incomplete injuries or in neurologically healthy subjects, type II (a region of high signal intensity, representing cord edema) and type I lesions (a region of decreased signal intensity, consistent with intra-spinal haemorrhage) represent the most severe form of SCI (ASIA grade A). Naik *et al*[10] reported ASIA A (39%) as a most common neurological status followed by ASIA C (23%), ASIA D (21%), ASIA E (14%) and the least common being ASIA B (3.5%). Concurrent findings were reported by Andreoli *et al*[12], Magu *et al*[13] and Parashari *et al*[3] with ASIA A being the most common neurological status. In current study, Out of 18 cases with ISCI (ASIA B, C and D), 4 (22.22%) expired and improvement seen in 14 (78%) cases while in 7 cases of CSCI (ASIA A), 2 (28.57%) expired and improvement observed in 5 (71.43%) cases as they progressed to ISCI level. Study conducted by Naik *et al*[10] reported that cases with ASIA A had lower chances of recovery (41%) when compared with recovery rate associated with low-grade ASIA C and D (61.5% and 83%, respectively). Concurrent findings were reported by Rao *et al*[14], as none of the patients with ASIA A showed neurological improvement whereas all patients in ASIA D showed improvement in their study. Harrop *et al*[15], reported 94.3% improvement in patients with initial ASIA D score and 7% improvement in patients with initial ASIA A score. Magu *et al*[13] reported improvement in 86% cases who had cord edema. Naik *et al*[10] reported cord edema (40%) as most common MRI followed by cord contusion (17.5%), spinal cord stenosis (12.3%), cord transection, cord haemorrhage and epidural hematoma. Parashari *et al*[3] and Andreoli *et al*[12] also reported similar findings. In current study, cord contusion (86.67%) was most common finding followed by cord compression, disc injury, subluxation and prevertebral hematoma. Study done by Naik *et al*[10] reported, neurological improvement in half of cases with cord contusion and cord edema. Similar findings were reported by other studies done by Ramón *et al*[16] and Gupta *et al*[17]. Cord edema is a good chance of neurological recovery and usually has a favourable outcome as cord edema is indicative of the ISCI as the cellular level damage is reversible to some extent. Study done by Flanders *et al*[18] reported that patients without spinal cord haemorrhage had significant improvement in their neurological status. Andreoli *et al*[12] reported that patients with cord edema had a better prognosis compared to cord haemorrhage. Similar findings were reported by other authors also.[19,20,21] These authors agree that the size of the haemorrhage influence the severity of SCI. The presence of a small area of haemorrhage is often associated with incomplete SCI.[17] Liao *et al*[22] found MR imaging patterns to have substantial prognostic correlations with neurologic outcomes. They reported normal spinal cord appearance was prognostic of complete recovery, and intramedullary lesions correlated with permanent deficits and functional disability. In present study, cord haemorrhage, contusion, post. element fracture, disc injury, prevertebral hematoma, subluxation and soft tissue injury significantly affected the severity of neurological deficit. Study done by M ter Haar *et al*[8] reported cord contusion and haemorrhage were associated statistically with neurological deficit while Miyanji *et al*[9] reported cord haemorrhage, cord contusion and soft tissue injury were associated with neurological deficit.

CONCLUSION

In present study, MR imaging was useful tool for prompt and accurate assessment of spinal cord injuries like cord haemorrhage, cord contusion, cord compression, epidural hematoma, vertebral body fracture, posterior element fracture, disc injury, ligament injury, prevertebral hematoma, subluxation, foreign body and vertebral artery thrombosis. MRI findings in SCI cases were also useful as prognostic indicator as they associated well with degree of neurological deficit assessed with American Spinal Cord (ASIA) scale. So, MRI should be investigation of choice in all patients with suspected spinal cord injury for diagnosis as well as prognosis.

REFERENCES

1. Srivastava RN, Singh A. Epidemiology of Traumatic Spinal Cord Injury: A SAARC Perspective. International Journal of Molecular Biology and Biochemistry 2015; Volume 3, Number: pp. 9-22.
2. Guarnieri G, Izzo R, Muto M. The role of emergency radiology in spinal trauma. Br J Radiol 2016; 89: 20150833.
3. Parashari UC, Khanduri S, Bhadury S. Diagnostic and prognostic role of MRI in spinal trauma, its comparison and correlation with clinical profile and neurological outcome, according to ASIA impairment scale. J Craniovertebr Junction Spine. 2011;2:17–26.
4. Kumar Y, Hayashi D. Role of magnetic resonance imaging in acute spinal trauma: a pictorial review. BMC Musculoskeletal Disorders (2016) 17:310.
5. Khandelwal S, Sharma GL, Saxena UD, Sakhi P, Gopal S, Saxena P. Prospective evaluation of cervical spine injuries by MRI and assessing role of MR findings in predicting prognosis. Indian Radiol Imaging 2004: 14:71-80.
6. Takahashi M, Harada Y, Inoue H, Shimada K. Traumatic cervical cord injury at C3-4 without radiographic abnormalities: correlation of magnetic resonance findings with clinical features and outcome. J. Ortho Surgery 2002; 10(2):129-35.
7. Roberts TT, Leonard GR, Cepela DJ. Classifications In Brief: American Spinal Injury Association (ASIA) Impairment Scale. Clin Orthop Relat Res. 2017;475(5):1499–1504.
8. M ter Haar, SM Naidoo, S Govender, P Parag. TM Esterhuizen. Acute traumatic cervical spinal cord injuries: correlating MRI findings with neurological outcome. SA Orthopaedic Journal Autumn 2011;10 (1), 35-41.
9. Miyanji F. Furlan JC. Aarabi B, Amoled PM, Fehlings MG. Acute cervical traumatic spinal cord injury: MR imaging findings correlated with neurological outcome-prospective study with 100 consecutive patients. Radiology 2007;243:820-827.
10. Naik BR, Sakalecha AK. Evaluation of Traumatic Spine by Magnetic Resonance Imaging and Its Correlation with Cliniconeurological Outcome. J Emerg Trauma Shock. 2019 Apr-Jun; 12(2): 101–107.
11. Bondurant FJ, Cotler HB. Kulkarni MV, McArdle CB, Harris JH Jr. Acute spinal cord injury: a study using physical examination and magnetic resonance imaging Spine 1990: 15(3): 161-168.
12. Andreoli C, Colaiacomo MC, Rojas Beccaglia M, Di Biasi C, Casciani E, Gualdi G, *et al*. MRI in the acute phase of spinal cord traumatic lesions: Relationship between MRI findings and neurological outcome. Radiol Med. 2005;110:636–45.
13. Magu S, Singh D, Yadav RK, Bala M. Evaluation of traumatic spine by magnetic resonance imaging and correlation with neurological recovery. Asian Spine J. 2015;9:748–56.
14. Rao KV, Vijaya Saradhi M, Purohit AK. Factors affecting long-term outcome in acute cervical cord injury. Indian J Neurotrauma. 2010;7:149–55.
15. Harrop JS, Naroji S, Maltenfort MG, Ratliff JK, Tjoumakaris SI, Frank B, *et al*. Neurologic improvement after thoracic, thoracolumbar, and lumbar spinal cord (conus medullaris) injuries. Spine (Phila Pa 1976) 2011;36:21–5.
16. Ramón S, Domínguez R, Ramírez L, Paraira M, Olona M, Castelló T, *et al*. Clinical and magnetic resonance imaging correlation in acute spinal cord injury. Spinal Cord. 1997;35:664–73. [PubMed: 9347595]
17. Gupta R, Mittal P, Sandhu P, Saggar K, Gupta K. Correlation of qualitative and quantitative MRI parameters with neurological status: A prospective study on patients with spinal trauma. J Clin Diagn Res. 2014;8:RC13–7.
18. Flanders AE, Spettell CM, Tartaglino LM, Friedman DP, Herbison GJ. Forecasting motor recovery after cervical spinal injury: Value of MR imaging Radiology 1996; 201:649-655.
19. Mahmood NS, Kadavigere R, Avinash KR, Rao VR. Magnetic resonance imaging in acute cervical spinal cord injury: A correlative study on spinal cord changes and 1 month motor recovery. Spinal Cord. 2008;46:791–7.
20. Demaerel P. Magnetic resonance imaging of spinal cord trauma: A pictorial essay. Neuroradiology. 2006;48:223–32.
21. Tewari MK, Gifti DS, Singh P. Diagnosis and prognostication of adult spinal cord injury without radiographic abnormality using magnetic resonance imaging: analysis of 40 patients. Surg Neurol 2005; 63(3):204-209.
22. Liao CC, Lui TN, Chen LR, Chuang CC, Huang YC. Spinal cord injury without radiological abnormality in preschool-aged children: correlation of magnetic resonance imaging findings with neurological outcomes. J Neurosurg 2005; 103

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