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Original Research Paper

Radiodiagnosis

ROLE OF MAGNETIC RESONANCE IMAGING IN SPINAL INJURIES AND IT'S NEUROLOGICAL STATUS

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ABSTRACT INTRODUCTION: MRI is a non-invasive imaging technique which plays a crucial role in evaluating spinal trauma. soft tissue, ligaments and spinal cord abnormalities, which may not be apparent on other imaging modalities, can be readily detected on MRI. I t can differentiate between haemorrhagic and non haemorrhage spinal cord injuries for the prognostic significance as the presence of haemorrhage significantly worsen the final clinical outcome. AIMS: MRI is a non-invasive diagnostic tool in patients with spinal trauma and correlates with clinical profile according to ASIA impairment scale. MRI sequences provide us with useful information. MATERIAL AND METHODS: Fifty patients alleged for spinal trauma underwent clinical and neurological examination. MRI was performed on 1.5 tesla scanner following close reduction of spinal injury and fixation with external spinal stabilization devices. RESULTS AND DISCUSSION: Presence of long length of intra-axial hematoma and cord edema are associated with poor neurological outcome. We demonstrated that the presence of a more substantial cord compression, length of lesion and intramedullary hemorrhage are associated with a poor prognosis for neurological recovery. T2 FSE sagittal images are the best images for the evaluation of spinal trauma. For evaluation of cord hemorrhage best images are gradient recalled echo (GRE).KEY WORDS: magnetic resonance imaging, spinal cord injuries, hematoma.

KEYWORDS :

INTRODUCTION

MRI has started to play an increasingly important role in the assessment of spinal trauma patients because of its inherently superior contrast resolution.

Ligaments and Soft tissue structure, disc, subtle bone trauma and cord abnormalities, which may not be apparent on other imaging modalities, can be readily detected on MRI. Early detection often leads to accurate diagnosis and, in many cases avoiding unnecessary procedures. It also provides adequate information about neural and extra neural injuries. Epidural hematomas and significant disc herniations require early surgical interventions.

The spine mainly consists of vertebrae stabilized by multiple ligaments including the anterior longitudinal ligament (ALL), posterior longitudinal ligament (PLL), ligamentum flavum, interspinous ligament, supraspinous ligament and the apophyseal joint capsules. Normal ligaments of the spine appear as low signal intensity bands on all the sequences. The most important finding to suggest spinal instability is the involvement of the two or more columns based on Denis classification.

Findings suggestive of ligamentous injury, such as prevertebral hematoma, spondylolisthesis, asymmetric disc space widening, facet joint widening on dislocation and interspinous space widening needs MRI for proper evaluation.

Most of the diagnostic information in spinal injuries is derived from the Sagittal images. Axial images serve as a supplement. Sagittal T1 weighted images offer an excellent anatomic overview. Disc herniations, epidural fluid collections, subluxation, vertebral body fractures, cord swelling and cord compression are also visualized. Sagittal T2 weighted images depict most of the soft tissue abnormalities including spinal cord edema and hemorrhage, ligamentous injury, disc herniations and epidural fluid collections. Axial and sagittal GE images aid in the identification of acute spinal cord hemorrhage, disc herniations and fractures.

Acute intraspinal hemorrhage is seen with cord injuries as decreased signal intensity on T2-weighted images obtained within 24 hours of injury. Cord edema and contusion had high signal intensity on T2-weighted images and were observed with cord injury. Patients with intraspinal hemorrhage did not have significant neurological recovery whereas patients with cord edema/contusion recovered significant neurological function.

AIMS AND OBJECTIVES

- To evaluate the role of MAGENETIC RESONANCE IMAGING as a non-invasive diagnostic tool in patients with spinal trauma.
- To compare and correlate the MRI findings with those of patient's clinical profile according to ASIA impairment scale.
- To determine which MRI sequences, provide the most useful information.

MATERIAL AND METHODS

Present study was conducted in department of radio diagnosis in collaboration with Orthopedics surgery between October 2017 and August 2018. The cases either admitted or seen in OPD or emergency in Orthopedics surgery alleged to have spinal trauma were enrolled for study after taking the informed consent.

The spinal trauma patient requires special consideration before MR imagining with regard to patient transfer, life support, monitoring of vital signs and fixation devices. All potential risks for imaging the medically unstable patients were carefully weighted against the need for the diagnostic information provided by MRI.

Each patient underwent complete clinical and neurological examination and was classified according to the ASIA impairment scale.

In the ASIA scale, severity of neural deficit as reflected by score depends upon the level of involvement in addition to the severity of cord compression at the involved level. Higher the level of affection of the spinal cord, lower the score.

MRI was performed on a 1.5T scanner (Siemens, Germany)

MRI EXAMINATION:

MRI was performed on the patients in supine position with quiet breathing and with abdominal band compression obtaining sagittal T2 and T1 Weighted fast spin echo images, STIR and fat suppression images, coronal STIR and axial T2, T1 Weighted fast spin echo images and GRE images for proper evaluation of cord hemorrhage.

We performed the imaging of injured spine both in the axial and sagittal planes using a combination of pulse sequences. Both T1- and T2- weighted FSE information are necessary to completely assess the spinal axis and the spinal cord. Fast spin-echo (FSE) and the gradient-echo pulse sequences (GE/GRE) were used most often. In the evaluation of SCI, T2 weighted FSE images demonstrated as most diagnostic information with fewer artifacts and improved resolution.

In our study we found that MRI should be done as early as possible preferably within 7 days to provide the most useful information. Shimada et al (83) concluded that the best time of performing MRI for prognostic imaging is at the time of trauma and 2-3 weeks later. However, in India it is not possible to perform repeated MRI examination so best time to perform MRI is as early as possible after trauma.

OBSERVATIONS

We performed this prospective study in 50 patients of spinal trauma. Radiographs of spine were taken in all patients, who were referred for MRI.

- Most of the patients of the spinal injuries were from 21-40 years old. Mean age distribution was 31.27 years.
- Out of 50 patients of spinal trauma, 36 patients i.e. 72% were male and 14 i.e. 28% were female.
- Modes of trauma in patients of spinal trauma were- fall from height (32), RTA (14), fall of weight over patient (3) and fall on ground (1).
- Level of injury in patients of spinal trauma was also noted. Involvement of Dorsolumbar region (D12-L1) was noted in 17/50 i.e. 34% patients and was found to be the most common site. The 2nd most common site of injury was cervical region, C5-C6 vertebral involvement was noted in 11/50 i.e. 22% patients.
- In case of fall from height, D12-L1 involvement was noted in 9/32 i.e. 28.13% patients. In case of fall from height C5-C6 involvement was noted in 6/32 i.e. 18.57% cases.
- In case of RTA C5-C6 involvement was noted in 6/14 i.e. 42.86% of patients. Involvement of D12-L1 was noted in just 3/14 i.e. 21.43% of patients.
- Single wedge compression/ collapse was seen in 42 /50 (84%) patients. Secondary wedge compression collapse was seen in 8 /50 patients (16%).
- Complete injury was seen in 22 cases (44%), incomplete injury in 20 cases (40%) and normal in 8 cases (16%).

All patients with evidence of sizable focus hemorrhage were having complete SCI. 17/50 patients i.e. 34 % of patients were having complete SCI. Patients with edema pattern also had complete SCI.
In our study we found that in patients with severe cord compression are usually associated with complete SCI. 18/50 patients with severe cord compression i.e. 36 % of patients were associated with complete SCI.

MRI FINDINGS OF SPINAL TRAUMA, ITS COMPARISON AND CORRELATION WITH CLINICAL PROFILE ACCORDING TO ASIA IMPAIRMENT SCALE (AIS) AND PROGNOSTIC VALUE OF MRI IN SPINAL TRAUMA

- In our study we found out that the most common finding which was invariably present was bone marrow edema.
- In most of the patients type of involvement was wedge collapse.

TABLE- 1
ASIA IMPAIRMENT SCALE (AIS) IN PATIENTS OF SPINAL INJURY

AIS	NUMBER OF PATIENTS AT ADMISSION	NUMBER OF PATIENTS AT DISCHARGE
A	22	17
B	1	1
C	5	3
D	14	17
E	8	11
NOT APPLICABLE	0	0
TOTAL	50	50

- Initial paralysis was graded as AIS A in 22/50 patients i.e. 44% patients, B in 1/50 i.e. 2% patients, C IN 5/50 i.e. 10% patients, D In 14/50 i.e. 28% patients and E in 8/50 i.e. 16% patients.
- AIS in patients with presence of sizable focus of hemorrhage in cord (>1cm) AIS A in 16 patients out of 22. B in 1 patient out of 1.

TABLE – 2 AIS IN PATIENTS WITH PRESENCE OF SIZABLE FOCUS OF HAEMORRHAGE IN CORD (>1CM) (N=17)

AIS	NUMBER OF PATIENTS AT ADMISSION	NUMBER OF PATIENTS AT DISCHARGE
A	16	15
B	1	1
C	0	1
D	0	0
E	0	0
TOTAL PATIENTS	17	17

- AIS in patients with cord edema/non-hemorrhagic contusion (<3cm) (n=11)

Patients with cord edema/non-hemorrhagic contusion involving <3cm of cord initial paralysis was graded as AIS A in only 2/11 i.e. 18.18 % of patients, in 1/11 i.e. 9 % as ASI C and 8/11cases i.e. 72.73 % initial paralysis was graded as D.

TABLE-3 AIS IN PATIENTS WITH CORD OEDEMA/NON-HEMORRAGIC CONTUSION (<3CM) (N=11)

AIS	NUMBER OF PATIENTS AT ADMISSION	NUMBER OF PATIENTS AT DISCHARGE
A	2	1
B	0	0
C	1	2
D	8	8
E	0	0
TOTAL	11	11

- AIS in patients with presence of edema/contusion involving >3cm of cord

In patients with initial cord edema involving >3cm of cord 21/26 i.e. 80.77% patient's initial paralysis was graded as AIS A.

TABLE-4 AIS IN PATIENTS WITH PRESENCE OF EDEMA/CONTUSION INVOLVING >3CM OF CORD

AIS	NUMBER OF PATIENTS AT ADMISSION	NUMBER OF PATIENTS AT DISCHARGE
A	21	17

B	1	1
C	3	2
D	2	6
E	0	1
TOTAL	27	27

- AIS in patients without any finding in cord

In patients with no finding in cord 8/10 showed no clinical deficit. In 1/10 initial paralysis was graded as AIS D. In one patient initial paralysis was graded as AIS C.

TABLE-5 AIS IN PATIENTS WITHOUT ANY FINDING IN CORD

AIS	NUMBER OF PATIENTS AT ADMISSION	NUMBER OF PATIENTS AT DISCHARGE
A	0	0
B	0	0
C	1	0
D	1	1
E	8	9
NOT APPLICABLE	0	0
TOTAL	10	10

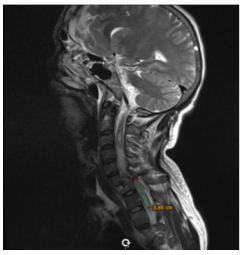
TABLE-6 VARIOUS ABNORMAL CORD FINDINGS

CORD ABNORMALITY	NUMBER OF PATIENTS
SIZABLE FOCUS OF HAEMMORHAGE IN CORD (>1 cm)	17/50 (34%)
CORD EDEMA/NON HAEMMORHAGIC CONTUSION), <3	11/50 (22%)
CORD EDEMA/CONTUSION (>3cm)	27/50(54%)
NO FINDING IN CORD	10/50 (20%)

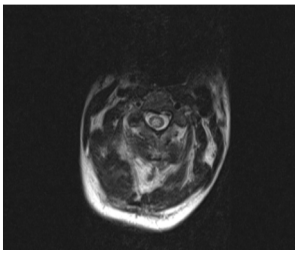
TABLE-7 NEUROLOGICAL OUTCOMES IN PATIENTS OF SPINAL TRAUMA(n=50)

AIS	IMPROVEMENT	MORTALITY	NOT APPLICABLE	TOTAL NUMBER OF CASES
A	04	01	-	22
B	01	-	-	01
C	03	-	-	05
D	09	-	-	14
E	-	-	08	08
TOTAL	17	01	08	50

- In 10/50 i.e. 20% of patients no abnormality was noted in cord.
- In a similar study by Kulkarni et al (1978) cord abnormalities were present in 70% patients while skeletal abnormalities were present in 78% of patients.
- Sizable focus of hemorrhage (>1cm) involving cord was present in 17/50 patients i.e. 34% of patients. In 66% no significant hemorrhage was seen.
- Cord edema / non-hemorrhagic contusion involving less that 3cm in cord was present in 11/50 patients i.e. 22%. Cord edema/ contusion involving more than 3cm of cord was present in 27/50 patients i.e. 54%. So, cord edema/contusion involving more than 3cm of cord was most common cord finding in our study.
- Severe cord compression (MSCC) was present in 19/50 patient i.e. 38%.
- Epidural hematoma was present in 2 patients out of 50 patients i.e. 4%.



SAGITTAL FSE T2



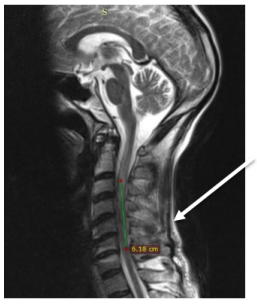
AXIAL FSE T2

The patient presented with fall from height 2 days prior to date of MRI. On MRI grade 4TH spondylolisthesis of C6 over C7 with fracture of bilateral facets jt, associated posterior extrusion of C6-7 disc and subluxation of C6 vertebral body (long segment contusion of cord along with sizable focus of hemorrhage) causing severe cord compression clinical examination shows initial AIS A. There is rupture of ALL and PLL with transection of cord.

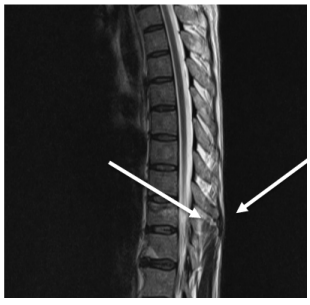
SAGITTAL FSE T2

CORONAL FSE T2

30 yrs old man had fall from height 3days prior to mri . On mri there is partial wedge collapse of T5,T6 of vertebral body and posterior elements with reduction in height of T6 vertebra height .There is associted retropulsion of D6 vertebral body Causing compression of cord leading to hyperintensity of cord .Small pre.& para v collection is seen.On clinical examination shows initial AIS A.

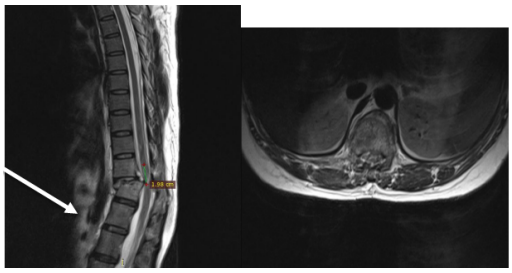


SAGITTAL FSE T2



SAGITTAL FSE T2

31 yrs old male had RTA one day prior to MRI. On MRI there is evidence of altered signal intensity in central part of cervical cord between C2 TO C7 S/O cord contusion/edema seen as hyperintensity of cord. On T2, there is partial fracture with wedge collapse of D10 vertebrae. Clinical examination shows initial ASIA A.



SAGITTAL FSE T2 **AXIAL FSE T2**

32 yrs old Female had RTA 4 days prior to MRI. On MRI, there is grade II anterolisthesis of D11 over D12 vertebral body seen with fractures of the bilateral facets jts and associated posterior displacement of D12 vertebral body causing severe compression of the spinal cord with associated cord contusions, edema and myelopathy with resultant secondary canal stenosis at this level. There is asso rupture of ALL and PLL. Clinical examination shows initial ASIA D.

DISCUSSION

- The MRI findings were correlated with clinical findings according to ASIA impairment scale. The conclusions drawn were:
- Incidence of spinal trauma was more common in the males 36 (72%). Females accounted for 14 (28) % of patients
- Most of Spinal trauma patients are young people, most of them were from 21-40 years old.
- Level of injury in patients of spinal trauma was also noted. Involvement of Dorsolumbar region (D12-L1) was noted in 17/50 i.e. 34% patients and was found to be the most common site. The 2nd most common site of injury was cervical region, C5-C6 vertebral involvement was noted in 11/50 i.e. 22% patients.
- In 44% of patients have complete injury at admission while 40% of patients have incomplete injury. 16% of patients do not have any weakness.
- Two patients of SCIWORA were found in our study. In SCIWORA the demonstration of the ligaments and disc injuries support the hypothesis that the cord injuries are secondary to strain or partial tearing of stabilizing ligaments, allowing excessive intersegmental displacement.
- Three quantitative measures were used: Maximum canal compromise (MCC), maximum spinal cord compression (MSCC) and length of lesion. The length of the lesion was determined on T2-weighted images. This length was determined on the distance between the most cephalic and most caudal extent of the cord signal.
- The qualitative MRI findings that were used in addition to the quantitative variables as determined by T2-weighted imaging, included cord hemorrhage, cord edema, cord contusion, disc herniation and soft tissue injury (STI). MRI is the most sensitive modality for detecting spinal cord damage, disc herniation and para spinal soft tissue injuries. Patients with a more substantial MSCC, length of lesion, cord hemorrhage and cord edema/contusion had lower Frenkel gradings.
- The presence of a small area of hemorrhage is often associated with incomplete neurology. In a study by Boldin et al, the presence of hemorrhage of less than 4 mm was not associated with a complete SCI. Flanders et al showed that patients with cord hemorrhage had better motor recovery of the upper extremities with very little improvement of the lower extremities. The presence of cord edema represents a less severe form of cord damage and is often associated with incomplete injuries and a favorable prognosis. Evidence of extensive cord edema was associated with complete injuries and a poor outcome. Cord hemorrhage and cord edema were significantly more frequently associated with complete injuries.
- Our over study variable used are MSCC, length of lesion, cord hemorrhage, cord edema and epidural hematoma.
- Focus of hemorrhage involving >1 cm of the cord was present in 34% (16 in A and 1 in B) of the cases. In patients with presence of sizable focus of hemorrhage in cord initial paralysis was graded as AIS A. On follow up patients with initial AIS A showed no improvement. Only one patient had neurological improvement and recovered to
- ASI C.
- Cord edema and/or contusion >3 cm also shows relatively poor neurological outcome. 21/26 patients were graded as ASI A. Only two patients recovered to ASI C & two to ASI D. Cord edema <3 cm majority of patients belonged to class D. Only two patients in ASI A,2/11 18.18 %, 1/11 ie 9% in ASI C and 8/11 cases i.e. 72.73 %belonged to ASI D.
- Severe cord compression (MSCC) was present in 36% of patients.
- Epidural hematoma was present in just 4% of cases.
- Selden NR showed that severe cod compression by extra axial hematoma is associated with poor neurological function at presentation and follow up.
- Selden NR showed that emergency MRI after spinal cord injuries provides accurate prognostic information regarding neurological functions and aids in diagnosis and treatment of cases of persistent cord compression after vertebral alignment
- Andreoli C showed the co-relation between MRI appearance of traumatic spinal cord injuries in acute phase and long-term recovery of motor and sensory functions. It is concluded from the study that in a country like India where repeated MRI examinations are not possible, best time of performing MRI is as soon as possible after trauma for better evaluation and correlation with clinical features.
- In our study we found out that T2 FSE sagittal images are the best images for the evaluation of spinal trauma. For evaluation of cord hemorrhage best images were gradient recalled echo (GRE).

CONCLUSION

In our study we found MRI to be a very useful tool in evaluating the patient with an SCI and that MRI findings can be correlated to the neurological status of the patient. It can also be used as a prognosticator for possible neurological recovery. We demonstrated that the presence of a more substantial cord compression, length of lesion and intramedullary hemorrhage are associated with a poor prognosis for neurological recovery.

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