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Radiodiagnosis

MRI FINDINGS IN SPINAL TRAUMA - A 10 YEAR RETROSPECTIVE STUDY IN INDIAN POPULATION

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ABSTRACT

Background: Spinal Injuries produce considerable morbidity among young population. An accurate assessment of the spinal injury by MRI is essential for managing these cases.

Material & Methods: All cases who underwent MRI for spinal trauma during the ten-year period formed the study group.

Results: 260 cases of spinal trauma were studied. Age ranged from 18-58 years with maximum number of cases in 31-40 yr (39.6%) followed by 21-30 yr (32%) age group. Fall from height was the leading cause of spinal trauma affecting 132(50.7%) cases, followed by road traffic accident (RTA) 115 (44.2%). Lumbar spine injury was seen in 108 (41.5%) cases, Dorsal 74 (28.5%) and cervical spine in 66 (25.4%) cases. Commonest injury was wedge compression fracture seen in 57.3% cases, followed by burst fracture 25%.

Conclusion: MRI is the investigation of choice in not only delineating the bony, ligamentous and cord injury but also helps in planning the surgical management.

KEYWORDS : MRI, Spinal trauma

Introduction

Trauma to spinal column leads to morbidity of considerable proportion, and if associated with spinal cord injury it not only impacts the patient physically but also affects the families economically and burdens the health care system, as the management and physical rehabilitation of these patients is long and telling economically. The causes of spinal trauma are varied with blunt trauma due to fall from height and road traffic accidents being the major culprits1. Apart from radiography, CT scan is the initial investigation of choice as it is fast and can delineate the bony injury better than the MRI. However, MRI plays a foremost role in assessing the soft tissue and ligamentous injuries and the injury to the spinal cord. It not only helps in planning surgical intervention but is also helpful in prognosticating the cases. Therefore, the aim of this study was to identify the various injury patterns and the MRI findings in spinal trauma in Indian population.

Materials and Methods

Setting

The study was carried out at the department of Radiodiagnosis and Imaging of a tertiary care hospital and teaching institution.

Study design

Retrospective Observational Study

Study period: Jan 2007 to Dec 2016

Inclusion criteria

All cases undergoing MRI for spinal trauma during the ten-year period formed the study group.

Data acquisition

The study population was selected from the database available with the MRI center using search term 'Spinal', 'injury', 'trauma'. MRI reports of all cases meeting the inclusion criteria were studied and images were retrieved from the archives.

Imaging Parameters

All cases of spinal trauma underwent MRI examination on 1.5T Siemens (Germany) Somatom symphony MRI scanner. All MRI examinations were done as per institutional MR Protocol for spinal trauma which included Sagittal T2W screening of whole spine, Sagittal T1W, T2W, STIR and MEDIC, Axial T1W and T2W, MEDIC (Cervical spine), Coronal STIR of affected spine.

Image analysis

All the cases of spinal trauma were retrieved from the archives and were interpreted by two radiologists with more than 10 years' experience

in Neuroimaging. They were blinded to each other and the discrepancy, if any was resolved with consensus. The vertebral bodies were evaluated for marrow oedema on T1W and STIR images (Short T1 inversion recovery), wedge or burst fracture, listhesis or any other bony injury on Sag and Cor T1W, T2W and STIR sequences. Retropulsion or posterior bulge and canal compromise was noted. The spinal cord was assessed for cord oedema or compression. Integrity of posterior ligamentous complex was assessed in Sag T2W, STIR and axial T2W images. MR myelogram in sag and coronal planes was done to see significant canal compromise.

Statistical Analysis

Personal and clinical details were documented, and MRI findings were recorded in each case. All observations were tabulated in excel sheet and then analysed.

Informed consent

Institutional Ethical committee waiver was obtained for the study of retrospective data. Permission from the institution was also obtained for analysing the data. Identity of patients was kept confidential.

Results

During the study period from Jan 2007 to Dec 2016, a total of 260 cases of spinal trauma were studied. 238 cases were males and 22 cases were females. Age group ranged from 18-58 years with maximum number of cases in 31-40 yr (39.6%) followed by 21-30 yr (32%) age group (Table 1).

Table 1-Age wise distribution of cases

Age group (Years)	No of Cases
18-20	13(5%)
21-30	83(32%)
31-40	103(39.6%)
41-50	45(17.3%)
51-58	16(6.1%)
Total	260

Fall from height was the leading cause of spinal trauma affecting 132(50.7%) cases, followed by road traffic accident (RTA) 115 (44.2%). Other causes were diving 6 (2.3%), sports 6 (2.3%) and blast injury 01 (0.38%). Lumbar spine was most commonly affected with injury in 108 (41.5%) cases, followed by Dorsal 74 (28.5%), cervical 66 (25.4%), Dorso-lumbar 10 (3.8%), cervicodorsal spine in 2 (0.8%) of cases (Table 2)

Table 2- Vertebrae affected

Vertebrae	Cases
Cervical	66 (25.4%)
Cervicodorsal	02 (0.8 %)
Dorsal	74 (28.5%)
Dorsolumbar	10 (3.8 %)
Lumbar	108 (41.5%)
Total	260

Commonest type of injury was wedge compression fracture seen in 57.3% cases, followed by burst fracture 25%, Anterior/retrolisthesis 5%, fracture posterior elements 5%, odontoid 3.1%, Jefferson 2%, Hangman 1.5%. The injury to posterior ligament complex (PLC) was seen in 53 (20.4%) cases, cord injury in 47 (18%) cases and vertebral artery injury in 02 (0.7%) cases (Table 3).

Table 3-Types of Injury

Injury	Cases
Burst fracture	65 (25%)
Wedge compression fracture	149 (57.3%)
Antero or retro- listhesis	13 (5%)
Odontoid fracture	8(3.1%)
Jefferson fracture	5(2%)
Hangman fracture	4(1.5%)
Fracture Posterior elements	13(5%)
Posterior ligament complex	53 (20.4%)
Cord injury	47 (18%)
Vertebral artery injury	02 (0.7%)
Misc injury (Tear drop fracture, Locked facet, traumatic disc herniation)	03 (1.1%)

Discussion

It is difficult to estimate the incidence of spinal trauma in India as there is no existing national spinal injury program or spinal cord injury database2. However, a few single center Indian studies are available in literature which have estimated the incidence of spinal cord injury to be 20 per million per year populations3, therefore the incidence of spinal trauma is likely to be much higher as all cases of spinal trauma do not result in spinal cord injury (SCI). The SCI was seen in 47 (18 %) cases in this study.

Spinal trauma assumes great importance as it affects the young and economically productive population of the country in the age group of 20-40 yr2. In this study maximum number of 103 (39.6%) of cases were seen in 31-40 yr, followed by 83 (32%) case in 21-30 yr age group (Table 1) which together accounted for 71.6% of cases which is in similar to the national data. The reason for higher incidence in these age groups is high risk behavior, mobility for job, sporting activities. The road traffic accident (RTA) is the commonest mode of injury in developed world whereas in Southeast Asia including India fall from height was more common2. Fall from height was the most common cause for spinal trauma in this study which accounted for 50.7% of the cases, followed by RTA which was the cause in 44.2 % of the cases. However, Chhabra et al (2012) in their study identified RTA as the most common cause in India4.

Injury to lumbar spine was more common than dorsal or cervical spine injury, 108 (41.5%) cases had fracture or injury of the lumbar vertebrae, 74 (28.5%) cases were seen in dorsal spine, 66 (25.4%) cases in cervical spine and 10 (3.8%) cases in dorso-lumbar spine (Table 2). Cervicodorsal spine was the least affected with only 02 cases. The trauma to dorsal and cervical spine assumes greater importance due to possibility of spinal cord injury in these cases.

Wedge compression fractures are caused by hyperflexion of spine which results in axial loading of anterior aspect of the vertebral body leading to anterior wedging. They are stable single column injuries. Wedge compression fracture was the most common injury in this study seen in 149 (57.3%) cases, it is normally seen in dorsal or lumbar vertebrae and is uncommon in cervical spine. There is decrease in anterior height of the vertebral body and the marrow shows edema which is hypointense on T1W and hyperintense on T2W/STIR (Fig 1a & b). They are usually seen in cases of fall from height but were also seen in sports injuries.

Fig 1a - Sag T1W and STIR images showing anterior wedging of LV1 with marrow hypointensity on T1WI (1a) and wedging and marrow edema of D12 and L1 vertebral bodies (1b) in a case of fall from height.

If the axial loading to the spine is of great energy it leads to loss of integrity of posterior cortex of the vertebral body with bony fragments extending into the spinal canal this results in Burst fractures. They typically occur following fall from a greater height with feet first fall or from a high-speed RTA. They most commonly occur at upper lumbar vertebrae with the majority occurring from D9-L3. Two-level burst fractures are much less common than single-level burst fractures5. In this study burst fracture was seen in 65 (25%) of cases. MRI findings in burst fracture include loss of height, comminuted fracture (Fig 2a), interpedicular widening, extension of bony fragments into the spinal canal (Fig 2b) and injury to posterior ligamentous complex (Fig 2c). The retropulsion of bony fragments into the spinal canal can cause spinal cord injury which was seen in 47 (18%) of the cases.

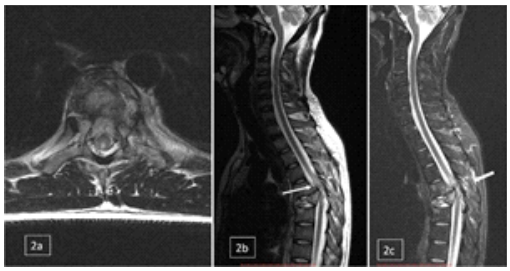

Fig 2a, b &c- Axial & Sag T2WI showing comminuted fracture of D6 vertebra (2a), retropulsion of bony fragments with cord compression and edema (2b). Note the disruption of posterior longitudinal ligament (arrow) in a case of RTA (2c).

The thoracolumbar injury classification and severity score (TLICS) proposed by the Spine Trauma Group is used for determining treatment6. The score is based on three main parameters which include morphological type of injury, intactness of posterior ligamentous complex and patients neurological condition assessed clinically. This score should be used in all cases of thoracolumbar injury for deciding the management of cases. The cases with score less than 4 are usually treated conservatively and those with score greater than 4 are usually considered for operative management.

Facet dislocation and anterior or posterior retrolisthesis was seen mainly in cervical spine but can also be seen in dorsolumbar spine (Fig 3a) and they result from hyperflexion or hyper extension injury. The RTA and diving were the common cause for these injuries in this study which were seen in 13 (5%) of the cases. The anterior shift of the vertebral column can lead to severe cord injury and damage to posterior ligament complex making it the most unstable of the spinal injuries (Fig 3b). The cord injury invariably leads to quadriplegia /paraplegia in these cases.

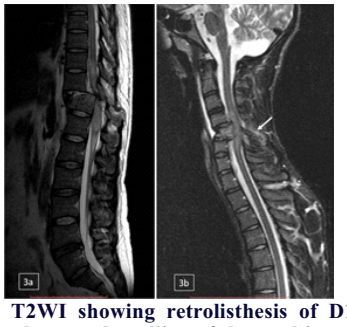

Fig 3a- Sag T2WI showing retrolisthesis of D11 with cord compression, edema and swelling of the cord in a case of motor vehicle accident.

Fig 3b- 20-year-old man with diving injury resulting in quadriplegia, STIR Sag image of cervical spine shows retrolisthesis of C5 causing cord compression and edema. Also note STIR hyperintensities in posterior ligamentous complex (arrow).

MRI is done to assess the soft tissue injury and the damage to the cord, it is also used to rule out vascular injury to the vertebral artery. The incidence of vertebral artery injury is highly variable in literature with reported incidence of 0.5 to 2% in all spinal trauma cases7. The vertebral artery injury was seen in 0.7 % cases in this study (Table 3). The vertebral artery flow void on T2W sagittal images is easily identified within the foramen transversarium in the cervical vertebrae.

If there is loss of T2W flow void it should be considered as injured and 3D Time of Flight angiography (TOF) should be done in same sitting to see the extent of thrombosis (Fig 4a & b).

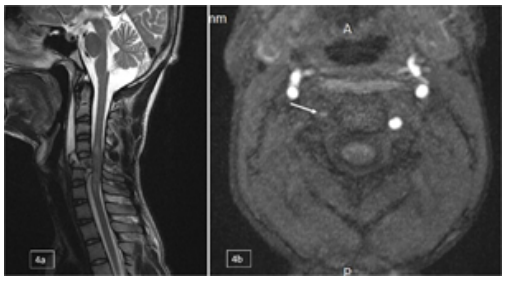

Fig 4a &b – 18-year-old with fall from horse, Sag T2WI (4a) showing burst fracture C5 vertebra with retropulsion of bony fragment with cord compression and edema. 3 D TOF MIP image (4b) showing loss of flow signal intensity of V2 segment of right vertebral artery in foramen transversarium (arrow).

Other injuries which were seen in the cervical spine were fracture of odontoid process which are classified as type I to III fractures depending upon the level of fracture line (Fig 5a), Jefferson's fracture is eponymous name of burst fracture of C1. Diving into shallow water head first is the usual mechanism of injury. Axial loading of the cervical spine forces occipital condyles into the lateral masses of C1 resulting in four parts fracture, two parts both through anterior and posterior arches. It was seen in 5 (2%) cases in this study. Fracture involving the pars interarticularis of C2 on either side is known as Hangman fracture, it occurs due to hyperextension and distraction and was seen in 4 (1.5%) cases. The odontoid fracture, Jefferson's fracture and hangman fracture are better seen on plain film/ CT than MRI (Fig 5b).

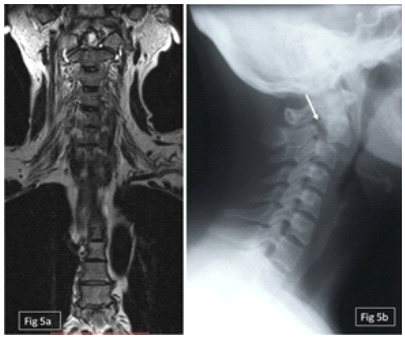

Fig 5a &b – T2W Coronal image (5a) shows type II fracture of odontoid process. Radiograph (5b) showing hangman fracture with break in pars interarticularis (arrow) of C2 and anterior subluxation of C2 over C3.

The fracture of posterior elements involving transverse process, spinous process and lamina were seen in 5% of the cases. These injuries are considered stable and are usually managed conservatively. Other miscellaneous injury such as tear drop fracture, locked facet joint and traumatic disc herniation was seen in 3 cases of cervical spine trauma.

In conclusion, Spinal trauma is a prominent cause of morbidity as it affects the most productive and active age group as was seen in this study. Burst fracture and listhesis are the main causes of ligamentous and cord injury. MRI in spinal trauma is the investigation of choice in not only delineating the bony, ligamentous and cord injury but also helps the surgeon in planning the surgical management and prognosticating the cases. Therefore, it is recommended that MRI of spine should be carried out in all cases of spinal trauma to assess the severity of injury which can be underestimated on CT.

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