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# A Prospective Study of Role of Magnetic Resonance Imaging In Spinal Trauma With Surgical Correlation

Dr.Rupam Kumari[1], Dr.Kavita Tirkey[2*], Dr.Nisha Rai[3]
[1] *Junior Resident (Academic), Department of Radiodiagnosis, Rajendra Institute of Medical Sciences, Ranchi, Jharkhand.*
[2*] *Junior Resident (Academic), Department of General Surgery, Rajendra Institute of Medical Sciences, Ranchi, Jharkhand.*
[3] *Assistant Professor, Department of Radiodiagnosis, Rajendra Institute of Medical Sciences, Ranchi, Jharkhand*
*Corresponding Author: Dr.Kavita Tirkey*

***Abstract***
***Introduction:*** *Patients with Spine injuries are commonly seen in trauma and can be fatal, particularly if not identified in a short time. Most spinal injuries are due to Road Traffic Accidents (RTA) and sports injuries. Injuries in this region may produce neurologic defects, sometimes severe and fatal.*
***Materials and Methods:*** *We prospectively evaluated 85 patients with a history of spinal injury and who had undergone MR imaging of the spine from January 2018 to July 2019 were included in the study after informed consent. Inclusion criteria: All patients with traumatic spinal injuries were included in the study. Exclusion criteria: Patients who are hemodynamically unstable, with metallic implants, pacemakers.*
***Results:*** *Age of patients ranged from 11-80 years with mean age 45 years. Cervical spine is most commonly involved and RTA being most common cause of spinal injury. Cord compression, haemorrhage are most common presentation in MRI. MRI is less sensitive in detecting posterior element fractures as compared to vertebral bodies fracture, it also over-estimates ligament injuries and shows highest sensitivity for intervertebral disc injury. In our study, we have seen one case of pseudomeningocele formation with brachial plexus injury and two cases of vertebral artery thrombosis.*
***Conclusion:*** *Magnetic Resonance Imaging is the only tool available for depicting the changes within the cord, ligaments and paraspinal soft tissues which helps in the management of the patients and in predicting the prognosis of recovery.*
***Key Words:*** *RTA, MRI, Spine injuries*

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## I. Introduction

Patients with Spine injuries are commonly seen in trauma and can be fatal, particularly if not identified in a short time. Most spinal injuries are due to Road Traffic Accidents (RTA) and sports injuries. Injuries in this region may produce neurologic defects, sometimes severe and fatal. CT plays an essential role in rapid assessment of trauma patients.[1] Multi detector 3D reconstructed CT are preferred. Spine CT has very good sensitivity, specificity and good diagnostic accuracy in picking up spinal fractures but is inadequate in detecting purely ligamentous or cord injury.[2] CT evaluation is more complicated in patients with severe degenerative disease. Traumatic and Non traumatic disc herniation appear identical on MRI. Both can cause cord compression leading to central cord syndrome. Traumatic disc herniation are best evaluated with MRI due to excellent contrast between disc, vertebral body and CSF on pulse sequences.[3]

Many advantages of MRI such as high contrast resolution, absence of bony artifacts, multiplanar capability and choice of various pulse sequences make possible to diagnose spinal trauma more accurately.[4] More adequate information about neural and extra-neural injuries requiring surgical interventions can be obtained. In cases of spinal cord injuries, most MRI findings correlate with the degree of neurological deficit and also indicate prognosis.[5]

MRI is an excellent diagnostic modality for evaluation of spinal trauma as the MRI findings correlated well with surgical findings and also with degree of weakness and prognosis. The purpose of this study was to evaluate this correlation. [6]

## II. Aims And Objectives

1)To study the role of magnetic resonance imaging in spinal trauma
2) Surgical correlation of MRI findings in spinal trauma.

## III. Materials And Methods

We prospectively evaluated 85 patients with a history of spinal injury and who had undergone MR imaging of the spine from January 2018 to July 2019 were included in the study after informed consent.
**Study Location:** RIMS, Ranchi.
**Study period:** January 2018 to July 2019
**Inclusion criteria:** All patients with traumatic spinal injuries were included in the study. **Exclusion criteria:** Patients who are hemodynamically unstable, with metallic implants, pacemakers.

In all the patients' mode of injury, findings on neurological examination and neurological status at the time of admission (American Spinal Injury Association –ASIA score) were noted.

MRI was performed on a 1.5 Tesla MRI machine without contrast administration (contrast administration was not a part of standard protocol). The pulse sequences included T1WI, T2WI using spin echo and gradient echo techniques and Short Tau Inversion Recovery sequences. Axial and sagittal T2WI, sagittal T1WI, Sagittal and coronal STIR images were obtained. Images were obtained with a slice thickness of 4mm and a matrix size of 512 x 512. On MRI, signal changes in vertebral bodies, ligaments, intervertebral discs, spinal cord and soft tissues were noted:

- In patients who were operated, the preoperative findings were noted.
- The neurological status of the patient at the time of discharge was noted.
- MR imaging findings were compared with surgical findings and prognosis of the patient based on ASIA score at the time of admission and discharge.

Statistical Analysis: Statistical Analysis was by using One way ANOVA and Student t test. P value is 0.004 is considered statistically important.

## IV. Results

Eighty five patients who presented to our hospital with the history of spinal trauma and underwent MRI of the spine in a time period from January 2018 to July 2019 were included in study. Of the 85 patients, 65 were males and 20 were female patients. The below table shows the gender and spinal distribution of the injury.

| S . N o | G e n d e r | C e r v i c a l | D o r s a l | L u m b a r | T o t a l |
|---|---|---|---|---|---|
| 1 | M a l e | 3 6 | 1 4 | 1 5 | 65 (76.4%) |
| 2 | F e m a l e | 9 | 6 | 5 | 20 (23.52%) |
| 3 | T o t a l | 4 5 | 2 0 | 2 0 | 8 5 |

**Table 1: Gender Distribution**

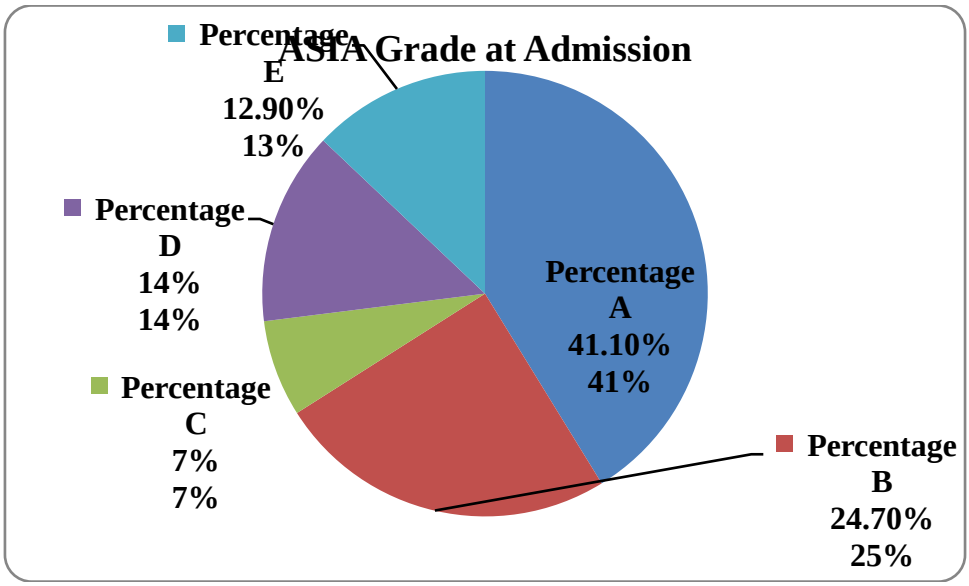


**Figure 1: ASIA Grade at Admission**

| S. No | Region | No of cases |
|---|---|---|
| 1 | Cervical | 45 (52.9%) |
| 2 | Dorsal | 20 (23.5) |
| 3 | Lumbar | 20 (23.5) |

**Table 2: Region Distribution**

The various modes of injury were road traffic accidents (RTA), fall from a height, fall of a heavy object on the spine, assault. In the male patients, commonest mode of injury to the cervical and dorsal spine was RTA; and to the lumbar spine was fall from a height. Among the female patients, RTA was the commonest mode of injury to the cervical spine; and fall from a height in case of dorsal and lumbar spine.

The neurological status of the patients at the time of admission and discharge was graded according to the ASIA classification. The commonest grade at presentation was A in the cervical and dorsal regions and E in the lumbar region.

| | | |
|---|---|---|
| **Hyper-flexion sprain** | 5 | |
| **Flexion compression fracture** | 3 | |
| **Flexion tear-drop fracture** | 1 | |
| **Bilateral facet dislocation** | 1 | 5 |
| **Unilateral facet dislocation** | 6 | |
| **Burst fracture** | 1 | |
| **Posterior element fractures** | 5 | |

**Table 3: Skeletal Injuries In Cervical Spine**

| | |
|---|---|
| **Wedge compression fracture** | 7 |
| **Burst fracture** | **6** |
| **Posterior element fractures** | **2** |
| **Subluxations/dislocations** | **4** |

**Table 4: Skeletal Injuries In Dorsal Spine**

| | | |
|---|---|---|
| Wedge compression fracture | 1 | 1 |
| **Burst fracture** | **7** | |
| Posterior element fractures | **3** | |

**Table 5: Skeletal Injuries In Lumbar Spine**

| Type | Cervical | | Dorsal | | Lumbar | Total |
|---|---|---|---|---|---|---|
| **SCIWORA** | 9 | | - | | - | 9 (7.8%) |
| **EDEMA** | 1 | 2 | 1 | | - | 13 (11.3%) |
| **HEMORRHAGE** | 2 | 5 | 1 | 3 | 3 | 41 (35.6%) |
| **TRANSECTION** | 3 | | 2 | | - | 5 (4.3%) |
| **COMPRESSION** | 2 | 4 | 1 | 4 | 7 | 45 (39.1%) |
| **SYRINX** | 1 | | 1 | | | 2 (1.73%) |

**Table 6: Cord injuries**

| Type of cord injury | No of cases |
|---|---|
| **Cord Edema** | 6 (66.6%) |
| **Cord Haemorrhage** | 3 (33.3%) |

**Table 7: SCIWORA**

| Age Group (years) | No of cases |
|---|---|
| 10 - 20 | 2 |
| 21 - 30 | 2 |
| 31 - 40 | 1 |
| 41 - 50 | 3 |
| 51 - 60 | 1 |

**Table 8: SCIWORA – AGE DISTRIBUTION**

| Type of cord injury | ASIA | | | | |
|---|---|---|---|---|---|
| | A | B | C | D | E |
| Edema | - | 5 | - | 1 | - |
| Haemorrhage | 2 | - | 1 | - | - |

**Table 9: Sciwora - Asia Grade at Admission**

| Mode of Injury | No of cases |
|---|---|
| RTA | 8 |
| Fall from a height | 3 |
| Assault | 2 |

**Table 10: Cord Edema – Mode Of Injury**

| ASIA grade at admission | No of cases |
|---|---|
| A | 4 |
| B | 7 |
| C | - |
| D | 2 |
| E | - |

**Table 11: Cord Edema – Asia Grade at Admission**

| Mode of Injury | No of cases | | | Total |
|---|---|---|---|---|
| | Cervical | Dorsal | Lumbar | |
| RTA | 16 | 8 | 2 | 4 |
| Fall from a height | 5 | 5 | 3 | 13 |
| Fall of a heavy weight | 2 | - | - | 2 |
| Assault | 2 | - | - | 2 |
| | 25 | 13 | 3 | 41 |

**Table 12: Mode of Injury – Cord Haemorrhage**

| ASIA Grade | No of cases |
|---|---|
| A | 2 |
| B | 4 |
| C | 21 |
| D | 19 |
| E | 6 |

**Table 13: Asia Grade at the time of Discharge**

**CORD COMPRESSION:** Compression of the cord to a varying degree by bone, herniated disc or epidural haematoma was noted in 45 cases. This was the commonest cord injury in our study. In most of the cases, it was associated with cord haemorrhage and poor neurological scores at admission.
**CORD TRANSECTION:** Transection was noted in 5 cases – 3 in the cervical and 2 in the dorsal region.
**LIGAMENTOUS INJURIES:** In our study, ligament injuries were commonly noted in cervical spine. Of the ligaments involved, posterior ligaments (Interspinous, Supraspinous, Ligamentum flavum) were commonly involved than Anterior and Posterior longitudinal ligaments. (ALL & PLL).
**CORRELATION OF MR IMAGING FINDINGS WITH SURGICAL FINDINGS:** Approach to spine surgery can be anterior, posterior or combined. The operative approach determined the structures visualized during surgery. For the anterior approach, the anterior longitudinal ligament, vertebral body, disc, posterior longitudinal ligament are adequately visualized. For the posterior approach, posterior osseous elements, ligamentum flavum, interspinous ligaments were adequately visualized. Depending upon the approach, surgical information was available for either the anterior or posterior structures. In our hospital, anterior approach was commonly used for cervical spine and posterior approach was commonly used for dorsolumbar spine. But the approach varies depending on the predominant spinal column injured. Of the 56 cases operated, 20 through anterior approach and 36 through posterior approach. In anterior approach, vertebral body fractures or subluxations were noted in 17 patients; ALL injury in 11 patients; PLL in 13patients; disc injury in 5 patients; cord haemorrhage in 12 patients. In posterior approach, injury to Ligamentum flavum was noted in 8 patients; Interspinous ligament injury was noted in 9 cases; posterior element osseous injury was noted in 11 patients; facet joint dislocation was noted in 7 patients.

| S.No | Structure | No of cases Injured | | |
|---|---|---|---|---|
| | | MRI | Surgery | |
| 1 | Skeletal/ vertebral body | 1 | 7 | 1 7 |
| 2 | ALL | 1 | 6 | 1 1 |
| 3 | PLL | 1 | 3 | 1 3 |
| 4 | Cord haemorrhage | 1 | 2 | 1 2 |
| 5 | Disc | 6 | | 5 |
| 6 | Ligamentum flavum | 7 | | 8 |
| 7 | Posterior elements | 8 | | 1 1 |
| 8 | Interspinous ligament | 1 | 1 | 9 |
| 9 | Facet joints | 2 | 1 | 2 1 |

**Table 14: MRI WITH SURGICAL CORRELATION**

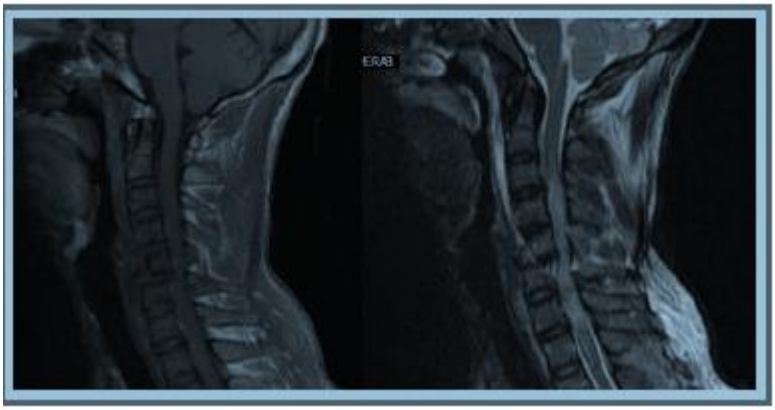

**Figure 2: Mid sagittal T1W & T2W images-tear-drop fracture of C5 vertebral body with cord compression by retropulsed C5 & cord haemorrhage (C2-C7), disrupted all, ligamentum flavum, interspinous ligament.**

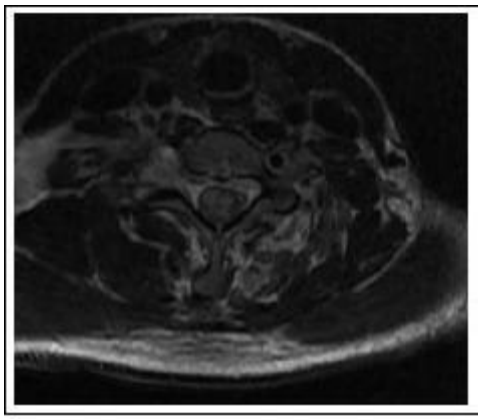

**Figure 3: Axial T2WI-cord haemorrhage with flow void in vertebral artery**

**Figure 4: Midsagittal T2WI – dislocation of C5 over C6 with cord transection and haemorrhage, disruption of ligaments**

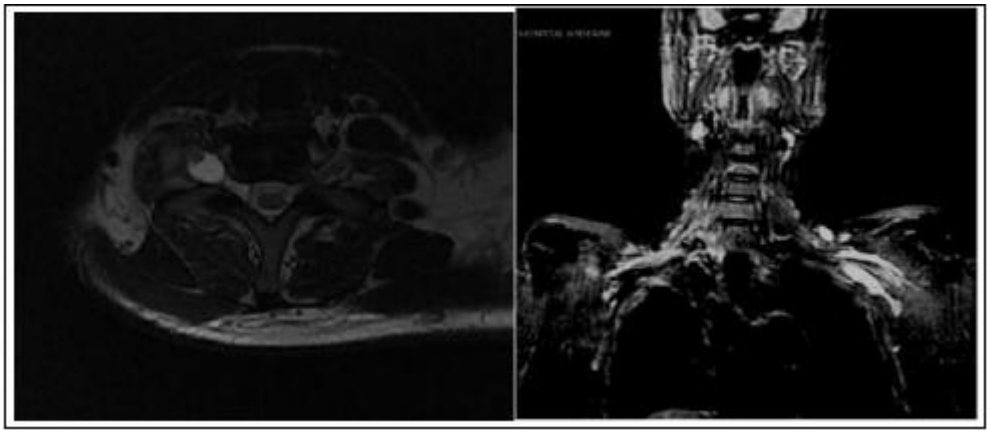

**Figure 5: Axial T2WI – nerve root avulsion with pseudomeningocele, coronal STIR- hyperintensity along the divisions of brachial plexus on left side- edema**

## V. Discussion

Our study of MRI evaluation of spinal trauma consisted of 85 patients presenting with history of spinal trauma and underwent MR imaging. Of the 85 patients, 56 were operated and radiological and surgical correlations are compared.

Our study of MRI evaluation of spinal trauma consisted of 85 patients presenting with history of spinal trauma and underwent MR imaging. Of the 85 patients, 56 were operated and radiological and surgical correlations are compared.[7]

Of the 85 patients, 65 were males and 20 were females accounting for 76.4% & 23.52% of the cases respectively. The greater incidence of spinal injury in males was also noted in study by Mahmood et al.

The spinal injuries are commonly caused by blunt injuries and rarely by penetrating injuries. The various modes on injury noted in our study were RTA (road traffic accident), fall from a height, fall of a heavy object over neck and assault. The commonest causes were RTA and fall from a height accounting for 51.76% and 37.64% of the cases respectively. [8]

The cervical spine was the most commonly involved (52.9%); the dorsal and lumbar spine (23.5%). D11/D12; C5/C6; L1 were the most commonly involved. The dorso-lumbar junction is more prone to injury due to the change in the curvature and centre of gravity.[9]

Bilateral facet dislocation in cervical spine and wedge compression fracture in dorsolumbar spine, are commonest patterns of skeletal injury. Posterior element fractures were noted in 10 cases. One case of Jefferson's fracture and tear drop fracture were noted. One case of osteoporotic and chance fracture are identified each. [10]

SCIWORA was noted in 9 cases accounting for 7.8%of the cases. The types of injuries noted in these patients are cord edema (66.6%) and cord hemorrhage (33.3%). Siddhartha Sharma et al noted Spinal Cord Injury Without Radiographic Abnormalities suspected cervical spine injury showing cord edema (58.3%) and haemorrhage (41.6%)in his study.

In our study, cord edema was seen in 13 cases – 12 in cervical and 1 in the dorsal region. The results were similar to study by Mahmood et al. Cord hemorrhage was noted in 41 cases.

## VI. Conclusion

MRI features of 85 patients with spinal trauma were studied and imaging findings were correlated with neurological outcome based on ASIA score and with the surgical findings in feasible cases:

1. The age group ranged from 11yrs to 80yrs with a mean age of 45 yrs with male preponderance.
2. The cervical spine was the most commonly involved (in 52.9% of the cases); RTA and fall from a height were the most common causes of spinal injury.
3. Cord compression and hemorrhage were the common presentations of cord injuries and cord edema had better prognosis compared to cord compression and hemorrhage; worse neurological outcome was seen with cord transection and hemorrhage.
4. MRI was able to detect most of the skeletal injuries though less sensitive in detecting posterior element fractures (72.7% sensitivity) as compared to vertebral body fractures.
5. We encountered 5 cases of cord transection, one case of nerve root avulsion with pseudomeningocele formation with brachial plexus injury and two cases of vertebral artery thrombosis.
6. MRI was able to detect intervertebral disc injury with 100% sensitivity.
7. Though MRI overestimated anterior longitudinal ligament injury, Interspinous ligament injury and underestimated Ligamentum Flavum injury; it has good sensitivity in depicting ligamentous injuries.
8. Our study of MRI evaluation of spinal trauma consisted of 85 patients presenting with history of spinal trauma and underwent MR imaging. Of the 85 patients, 56 were operated and surgical findings were mostly in accordance with MRI findings.

Magnetic Resonance Imaging is the only tool for identifying pathology within the cord, ligaments and para-spinal soft tissues and helps in the management and prognostic assessment of the patients.

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