# The Role of MRI in the Diagnostic Approach to Spinal Cord Compression

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**Abstract:** ***Introduction**: Magnetic resonance imaging (MRI) of the spine is a powerful tool for the evaluation, assessment of severity, and follow-up of diseases of the spine. Spinal cord diseases often have devastating consequences. **Aim**: To identify various aetiologies associated with spinal cord compression. To locate the site of lesion (intramedullary / intradural - extramedullary / extradural). To illustrate the characteristic MRI signs in those various pathologies. To describe the important aspects of MRI techniques in the assessment of spinal cord compression. **Methods of collection of data**: our study is a descriptive study carried out on 50 patients visiting the OPD / IPD referred to MRI scan to the Department of Radio diagnosis, Rangaraya medical college, Kakinada in stipulated period from December 2020 t0 November 2021. **Result**: study conducted on 50 patients of spinal cord compression; traumatic myelopathy is seen in 21 patients (42%), infectious cause in 12 patients (24%), metastases in 9 patients (18%) and primary neoplasms in 8 cases (16%). In our study trauma is the most common cause of spinal cord compression. **Conclusion**: Magnetic resonance imaging is an excellent modality for imaging pathologic processes involving the spine. It permits high-resolution imaging of not only the osseous structures but also the soft-tissue structures in multiple orthogonal planes through the use of varying pulse sequences that allow for characterization of the different tissues in and around the spine.***

**Keywords:** MRI imaging of spine, Spinal cord compression, Spinal pathologies

## 1.Introduction

Magnetic resonance imaging (MRI) of the spine is a powerful tool for the evaluation, assessment of severity, and follow-up of diseases of the spine[1]. Spinal cord diseases often have devastating consequences.

The nature and extent of which is related to:

- The level that is compressed-high or low cervical, high and low thoracic, lumbosacral.
- The direction from which the compression originates; from outside or from within the spinal cord, posterior, lateral or anterior.
- The speed with which the compression is accomplished.

Spinal cord involvement was seen in many of these patients[3]. Spine MRI has important attributes that make it valuable in assessing spinal disease. MRI allows direct visualization of the spinal cord, nerve roots, and discs. MRI provides better soft tissue contrast and the ability to directly image in the sagittal and coronal planes. It is also the only modality for evaluating the internal structure of the cord. Compared with other modalities, MRI does not use ionizing radiation. MRI allows to differentiate spinal cord haemorrhage and oedema which may have a prognostic value [4].

The causes of compressive paraplegia can be classified on neuroimaging (MRI) as being either extradural or subdural in site. Subdural includes those arising from either within the spinal cord (intramedullary) or those arising outside the cord (extramedullary). Acute cord compression is a medical emergency and needs rapid evaluation and intervention in order to prevent permanent disability. The history and neurological examination localise the level of weakness, and help to determine the likely cause of the paraplegia. MRI is extremely sensitive and has 90% accuracy in the diagnosis of acute vertebral osteomyelitis [5, 6]. With the advent of MRI which is a very sensitive modality for spinal lesions, the yield for positive diagnosis has greatly increased which was not possible in the pre MRI era3. Today, MR is considered the procedure of choice for the work-up of all spinal tumours[7]. Many spinal cord diseases are reversible if recognized and treated at an early stage. The role of MRI is to distinguish compressive from non-compressive myelopathy.

The concept of spinal cord injury without radiological abnormality is known by the acronym SCIWORA. New imaging techniques such as diffusion-weighted MR imaging (DWI), may provide important information complimentary to conventional MRI to allow a better prognostic evaluation of recovery from SCIWORA[8].

The spine is the second-most-common location for metastatic disease to the CNS in patients with malignancies, after the brain9. Myeloma, lung carcinoma, breast carcinoma, prostate carcinoma, and lymphoma are often metastasize to vertebral bodies10. MR is extremely sensitive to the detection of metastasis in the vertebral bodies or extradural space[9].

## 2.Aims and Objectives of the Study

- To identify various aetiologies associated with spinal cord compression.
- To locate the site of lesion (intramedullary / intradural – extramedullary / extradural).
- To illustrate the characteristic MRI signs (if any) in those

various pathologies.
- To describe the important aspects of MRI techniques in the assessment of spinal cord compression

## 3.Materials and Methods

### 3.1 Methods of collection of data:

Our study is a descriptive study carried out on 50 patients visiting the OPD / IPD referred to MRI scan to the Department of Radio diagnosis, Rangarasya medical college, Kakinada in stipulated period from December 2020 to November 2021.

### 3.2 Case selection

The patients who are clinically suspected as a case with spinal cord compression was investigated with MRI. The study group included a sample size of 50 patients selected by a purposive sampling, the data will be analysed by a descriptive reanalysis, a complete clinical history of the patient was taken with particular reference to the motor and sensory symptoms.

**Inclusion criteria:**
Inclusion criteria were patients of all age groups irrespective of the sex, and only diagnosed cases of cord compression were included. (A proforma was designed for the study. Diagnosis was based on history, clinical examination and MR indings.)

**Exclusion criteria:**
1) Cases of non-compressive myelopathy.
2) Degenerative disc herniation.

### 3.3 Patient preparation:

The procedure was briefly explained to the patient and consent was taken, detailed story for contraindication of MRI was specifically taken, They were provided with light music to minimize the noise within the MRI room.

### 3.4 Equipment

1.5 T General Electrical Medical system. Standard surface coils and body coils were used for cervical, thoracic and lumbar spine for acquisition of images.

### 3.5 Sequences

Conventional spin echo sequences T1WI, T2WI, FLAIR Sag, STIR sag, T1WI, T2WI axial and GRE axial, and post contrast T1WI axial, sag and coronal.

| Sequences | TR | TE | Flip angle |
|---|---|---|---|
| SE T1 | 500 | 23 | 70° |
| FSE T1 | 440 | 14 | 90° |
| T2 | 3000 | 120 | 90° |
| GRE T2* | 612-1000 | 27 | 30° |
| FLAIR | 8500 | 120 | 90° |
| STIR | 4400 | 20 | 90° |

FOV: Sagittal: 30cm
Axial: l8cm
Matrix size: 256x 256
Slice thickness: 4, 5mmx 5mm
Contrast: Gd-DTPA at a dose of 0. lmmol / I kg body wt.

**Technique:**
Patients were examined with MRI scan in the supine position with proper positioning and immobilization of the body, Standard surface coils were used for aquisition of images, Pre contrast scanning was done using TlWI, T2Wl, FLAIR Sagittal, STIR sagittal, TlWI, T2 WI axial with slice thickness 4.5mm x 5mm.

Omni scan (Gadoldamide) or Magnevist (dimeglumine gadopentetate) were used as contrast advents in dose of 0. l mmol / kg body weight in case of neoplasm's and infections. For spinal trauma contrast was not done. Post contrast TlWI sag, axial and coronal images were obtained.

Whenever required, thinner sections were obtained in the region interest.

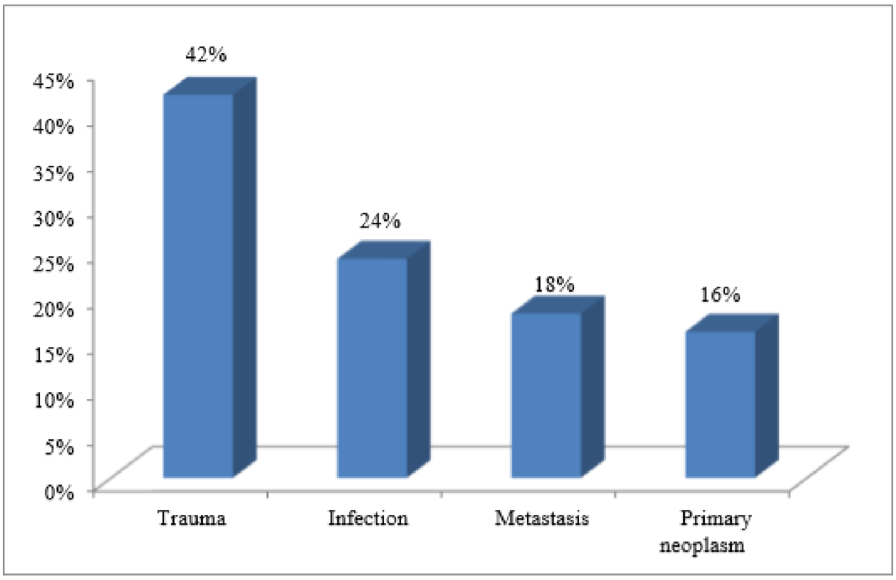
A special MRI sequences like FLAIR and STIR were routinely obtained, The MRI images were analyzed based on location (cervical, thoracic, lumbar), segment of the spinal cord involvement and severity of injury. In cases of trauma, site and level of injury vertebral fracture, ligamentous injury, presence / absence of hematoma to classify into spinal subdural / extramural hematoma were noted.

Neoplasm's were classified based on appearance into benign/ malignant, based on location into extramural, intramural-extramedullary and intramedullary lesions. Follow up: Whenever possible patients were followed up for histopathological diagnosis in cases of neoplasm and outcome in cases of spinal trauma.

## 4.Observation & Results

**Table 1:** Causes of Spinal cord compression

| Aetiology | No. of patients (n=50) | % |
|---|---|---|
| Trauma | 21 | 42% |
| Infection | 12 | 24% |
| Metastasis | 9 | 18% |
| Primary Neoplasm | 8 | 16% |

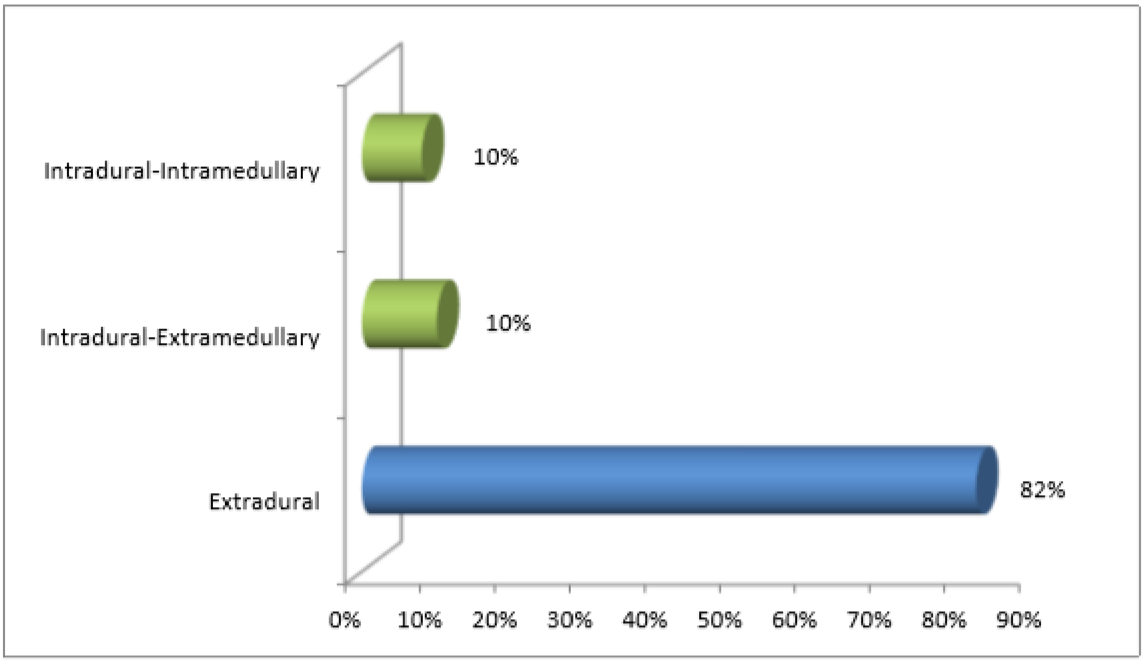



**Graph 1:** Causes of Spinal cord compression

Spinal trauma is the most common cause of spinal cord compression (42%) followed by infectious etiology.

**Table 2:** Location of Pathology

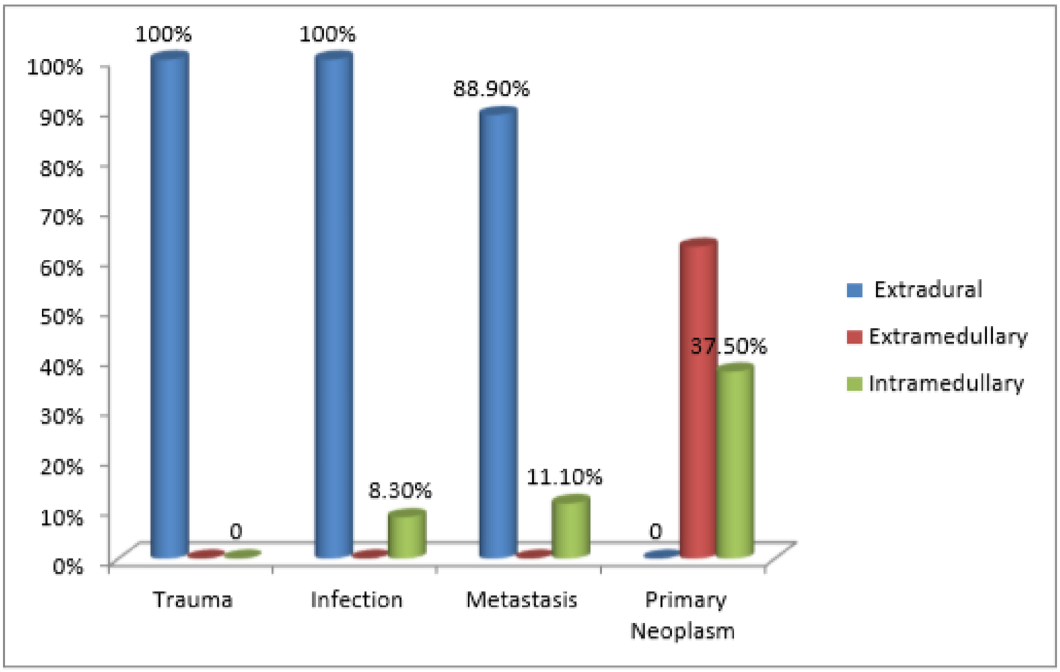
| Compartment | No. of patients | % |
|---|---|---|
| Extradural | 41 | 82% |
| Intradural-Extramedullary | 05 | 10% |
| Intradural- Intramedularry | 05 | 10% |




**Graph 2:** Location of Pathology Lesions of extradural compartment is the most common cause of spinal cord compression in our study.

**Table 3:** Pathology According to Various Compartments

| Aetiology | no of cases ( n = 50 ) | Extradural | Intradural-Extramedullary | Intradural-Intramedullary |
|---|---|---|---|---|
| Trauma | 21 | 21 | - | - |
| Infection | 12 | 12 | - | - |
| etastasis | 9 | 8 | - | 1 |
| Primary Neoplasm | 8 | - | 5 | 3 |




**Graph 3:** Pathology According to Various Compartments

Spinal trauma, infections and metastasis predominantly involves extradural compartment while primary neoplasms involves intradural compartment in our study.

**Table 4:** Age Distribution in Various Diagnoses

| Aetiology | 12-30 yrs | 30-50 yrs | >50 yrs |
|---|---|---|---|
| Trauma ( n = 21 ) | (n = 9 ) 42.85% | ( n = 7 ) 33.33% | ( n = 5 ) 23.82% |
| Infection ( n = 12 ) | ( n= 3) 25% | ( n = 4 ) 33.33% | ( n = 5 ) 41.67% |
| Metastasis ( n = 9 ) | - | ( n = 2 ) 22.22% | ( n = 7 ) 77.78% |
| Primary neoplasm ( n = 8 ) | - | ( n = 5 ) 62.5% | ( n = 3 ) 37.5% |



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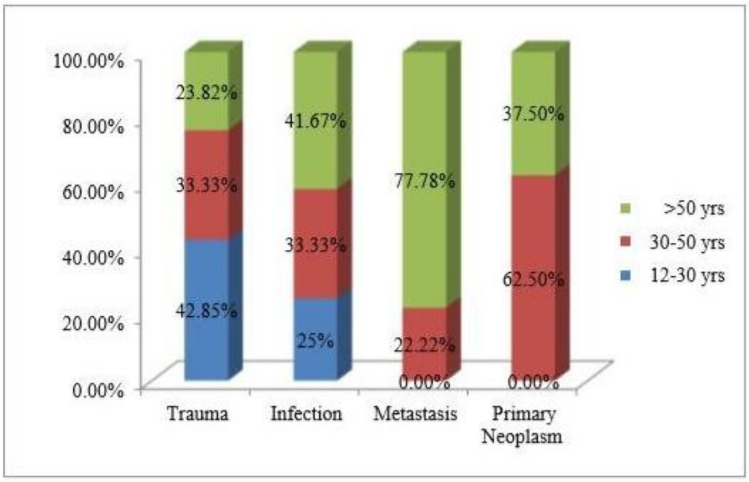
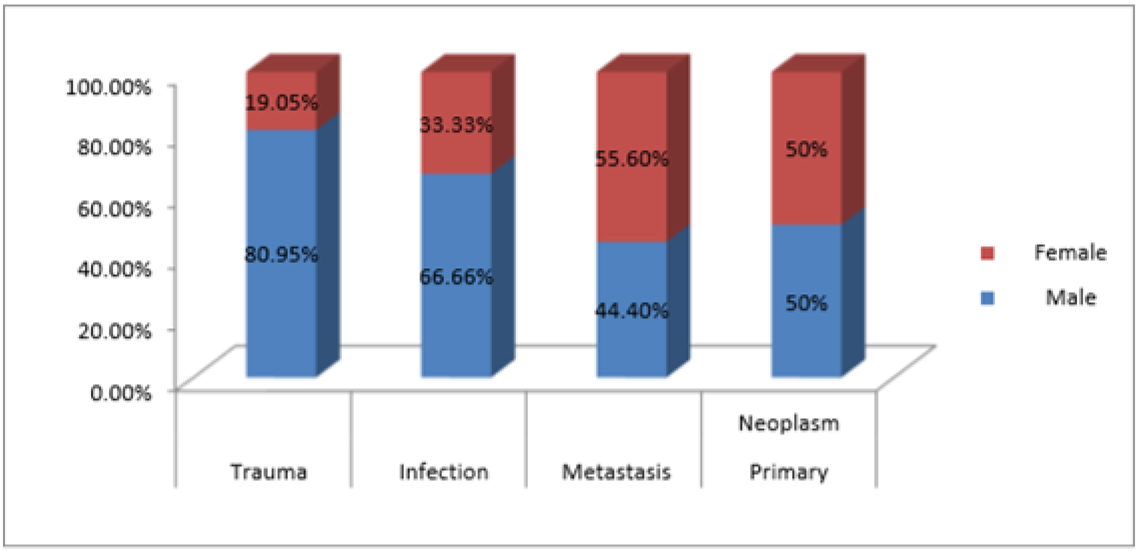



**Graph 4:** Age Distribution in Various Diagnoses P value – 0.010 (< 0.05) chi square test.

There is a significant difference between different age groups based on etiology since P < 0.05.

**Table 5:** Gender distribution in various diagnoses

| Gender | Trauma (n = 21) | Infection (n = 12) | Metastasis (n = 9) | Primary Neoplasm (n = 8) |
|---|---|---|---|---|
| Male | 80.95% (n = 17) | 66.66% (n = 8) | 44.4% (n = 4) | 50% (n = 4) |
| Female | 19.05% (n = 4) | 33.33% (n = 4) | 55.6% (n = 5) | 50% (n = 4) |

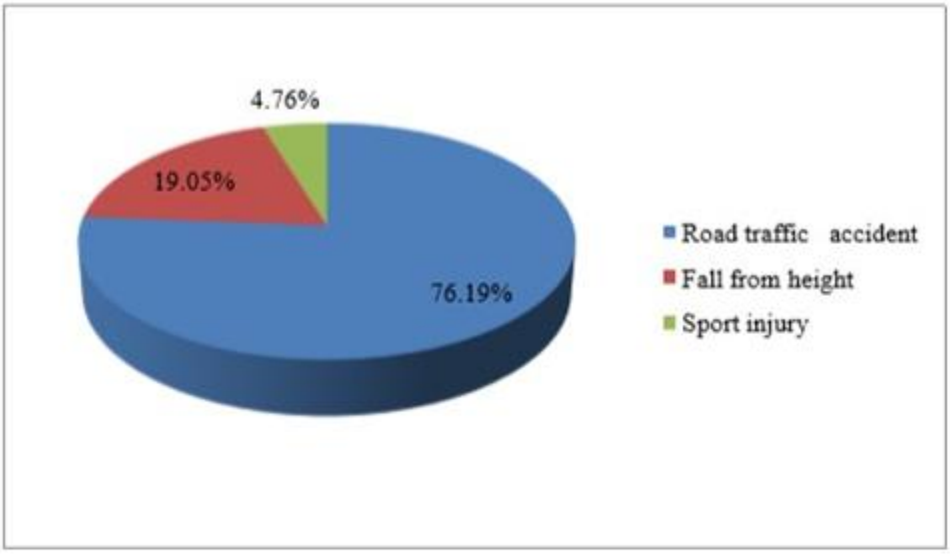



**Graph 5:** Gender distribution in various diagnoses P value-0.182 (> 0.05) chi square test

However when compared with gender, there was no significant difference in the occurrence of various events as described in the table.

**Table 6:** Mode of Spinal Injury

| Cause | No of cases (n = 21) | % |
|---|---|---|
| Road traffic accident | 16 | 76.19% |
| Fall from height | 4 | 19.05% |
| Sport injury | 1 | 4.76% |

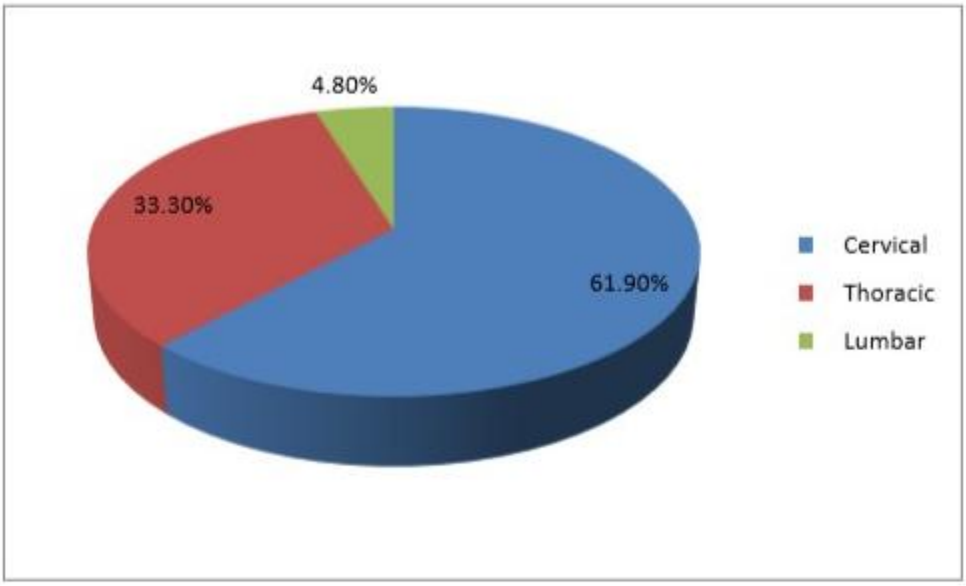



**Graph 6:** Mode of Spinal Injury

The most common mode of spinal cord injury in our study is road traffic accident followed by fall from height.

**Table 7:** Level of Spinal Injury

| Level of injury | No of cases (n = 21) | % |
|---|---|---|
| Cervical | 13 | 61.91% |
| Thoracic | 7 | 33.33% |
| Lumbar | 1 | 4.76% |

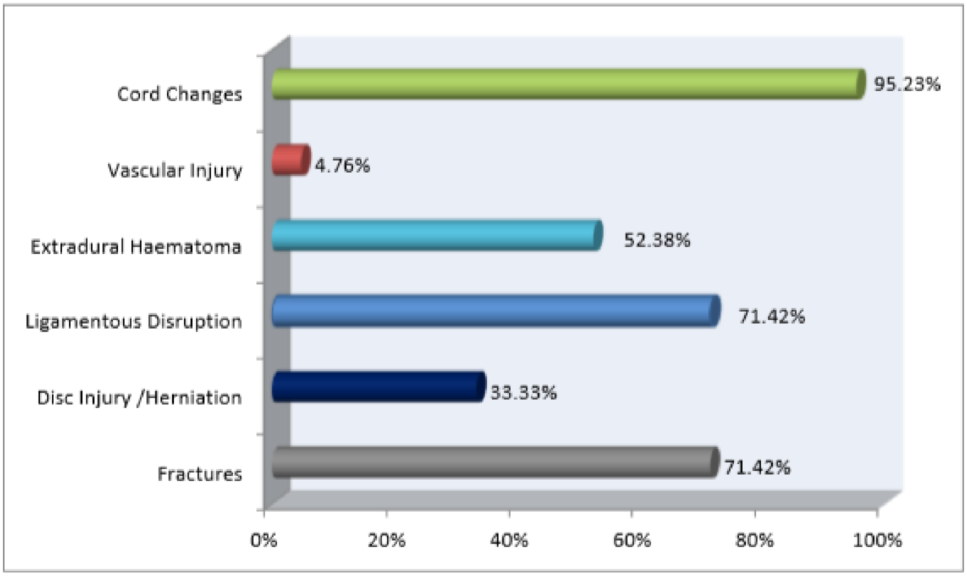



**Graph 7:** Level of Spinal Injury

In spine Injury, the common site involved is the cervical region followed by thoracic region.

**Table 8:** Characterisation of Spinal Injuries by MRI

| Type of Injury | No of cases ( n = 21 ) | % |
|---|---|---|
| Fractures | 15 | 71.42% |
| Disc Injury /Herniation | 7 | 33.33% |
| Ligamentous Disruption | 15 | 71.42% |
| Extradural Haematoma | 11 | 52.38% |
| Vascular Injury | 1 | 4.76% |
| Cord Changes | 20 | 95.23% |

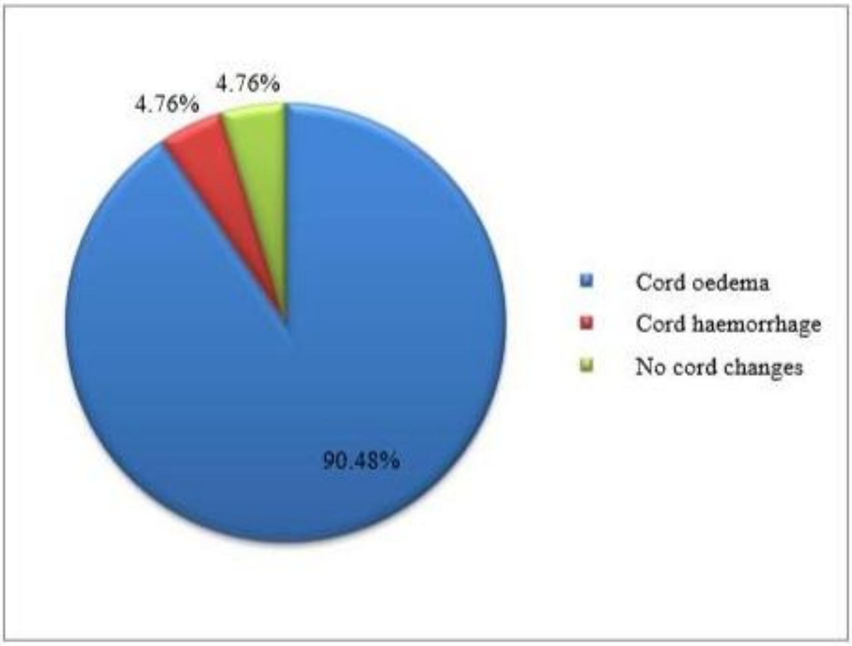



**Graph 8:** Characterisation of Spinal Injuries by MRI

MRI helps to characterise the spinal injury and thereby implicates prognosis.

**Table 9:** Characterisation of Cord Changes by MRI

| Cord Changes | No of cases | % |
|---|---|---|
| Cord oedema | 19 | 90.48% |
| Cord haemorrhage | 1 | 4.76% |
| No cord changes | 1 | 4.76% |

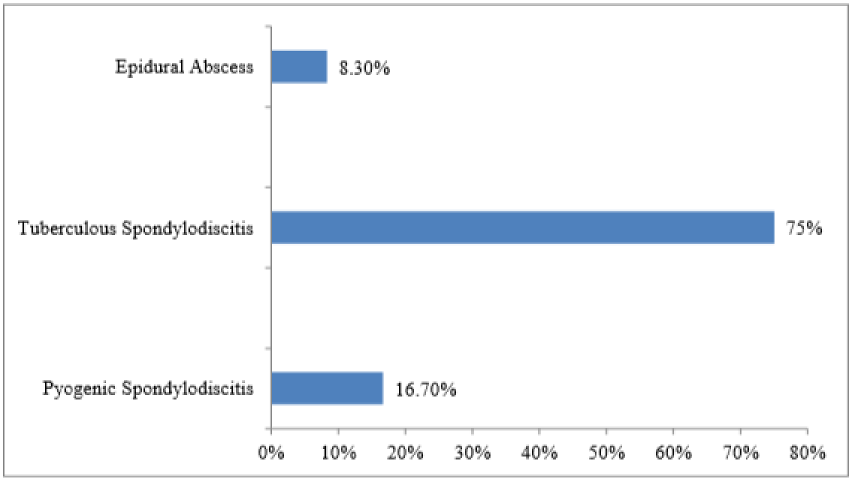



**Graph 9:** Characterisation of Cord Changes by MRI

Cord changes in spinal injury could be edema, small contusions or haemorrhage.

**Table 10:** Type of Spinal Infection

| Aetiology | No of cases (n = 12) | % |
|---|---|---|
| Pyogenic Spondylodiscitis | 2 | 16.7% |
| Tuberculous Spondylodiscitis | 9 | 75% |
| Epidural Abscess | 1 | 8.3% |

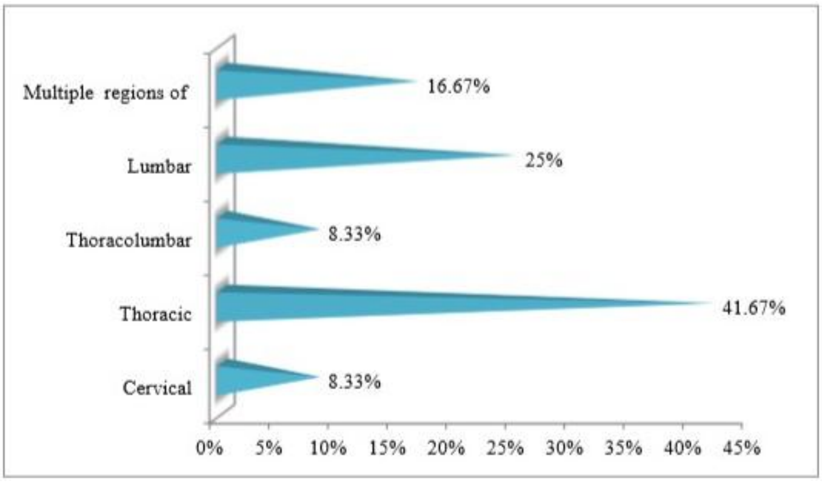



**Graph 10:** Type of Spinal Infection

Tuberculous spondylodiscitis is the most common form of spinal infection in our study

**Table 11:** Anatomic Location of Spinal Infection

| Location | No of cases (n = 12) | % |
|---|---|---|
| Cervical | 1 | 8.33% |
| Thoracic | 5 | 41.67% |
| Thoracolumbar | 1 | 8.33% |
| Lumbar | 3 | 25% |
| Multiple regions of spinal column | 2 | 16.67% |

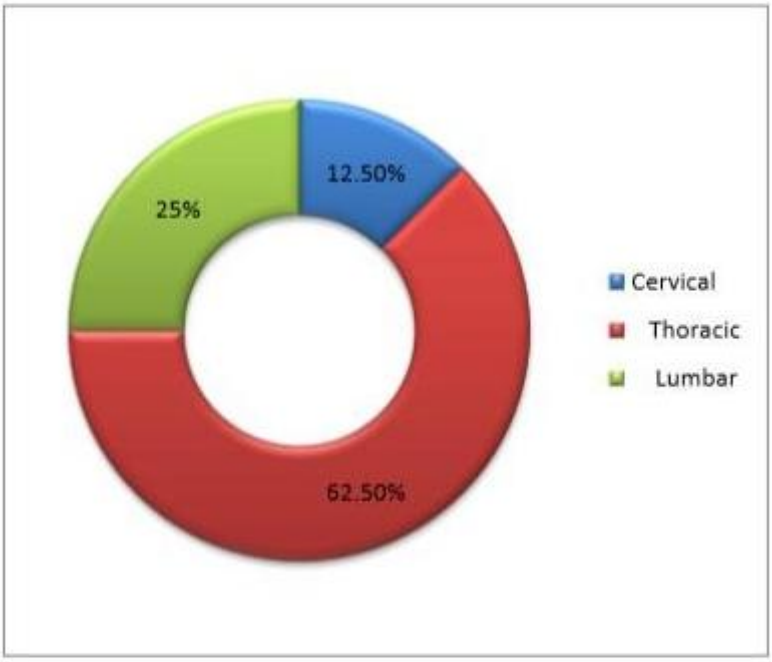



**Graph 11:** Anatomic Location of Spinal Infecion.

Thoracic spine is the most common site of involvement of spinal infections.

**Table 12:** Vertebral Level of Extradural Metastasis

| Location | No of cases ( n = 8 ) | % |
|---|---|---|
| Cervical | 1 | 12.5% |
| Thoracic | 5 | 62.5% |
| Lumbar | 2 | 25% |

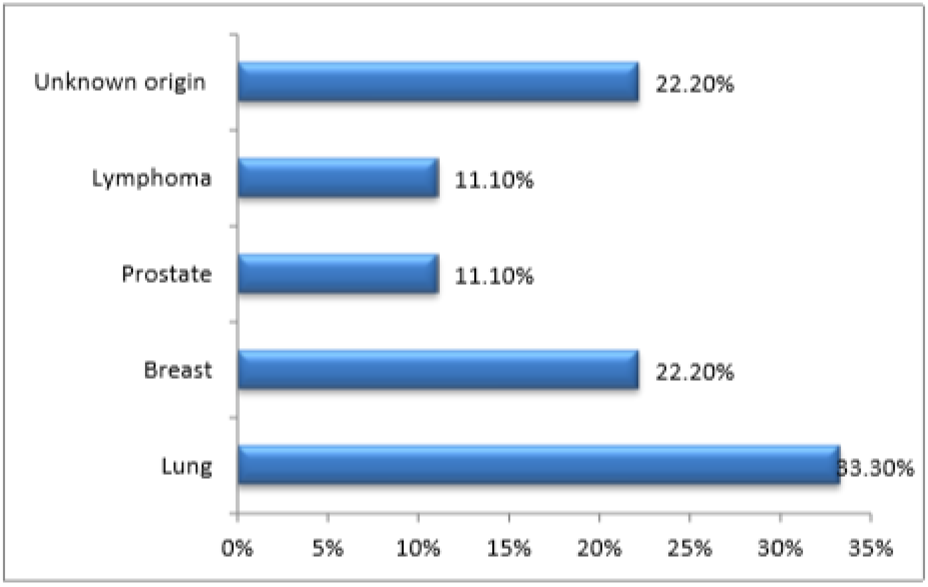



**Graph 12:** Vertebral Level of Extradural Metastasis

Thoracic spine is the most common site of involvement in metastasis in our study.

**Table 13:** Primary sources of Spinal Metastasis

| Primary Source | No of cases ( n = 9 ) | % |
|---|---|---|
| Lung | 3 | 33.3% |
| Breast | 2 | 22.2% |
| Prostate | 1 | 11.1% |
| Lymphoma | 1 | 11.1% |
| Unknown origin | 2 | 22.2% |




**Graph 13:** Primary sources of Spinal Metastasis

In our study most common primary source of metastasis was lung carcinoma.

## 5. Discussion

In our study conducted on 50 patients of spinal cord compression; traumatic myelopathy is seen in 21 patients (42%), infectious cause in 12 patients (24%), metastases in 9 patients (18%) and primary neoplasms in 8 cases (16%). In our study trauma is the most common cause of spinal cord compression.

Location of pathology confined to extradural compartment is seen in 41 patients (82%) and intradural-extramedullary compartment is seen in 5 patients and within the intramedullary compartment included 5 patients. Extradural compressive lesions (82%) are the most common cause for spinal cord compression. In the extradural compartment of 41 patients; 21 patients are with spinal injury; 12 patients are with infectious aetiology and 8 patients are of metastatic disease.

Intradural compartment is predominantly involved by primary neoplasms with 5 patients of intradural extramedullary lesions, 3 patients of intradural intramedullary lesions. One case of metastasis involving the intradural intramedullary region is noted. One case of tuberculous spondylodiscitis has both extradural component and intramedullary ring enhancing lesion likely granuloma.

Spinal trauma is a major health problem in both the developed and the developing countries. It causes an enormous economic burden because a large number of affected patients are relatively young. In the present study, majority of the affected patients belonged to the age group of 12-30 years (42.85%). The majority of the affected patients were males (80.95%) with male to female ratio of (4.25: 1) which is similar to findings in other studies35-37. The relative predominance of young male patients is due to increased mobility, work related injuries and road traffic accidents.

The most common cause of spinal trauma in present study was road traffic accidents (76.19%) followed by fall from height (19.05%) while (4.76%) of injuries were due to sport related activities. India is a developing country with increasing vehicular traffic and poorly maintained roads, especially in rural areas. Most people are not fully aware of traffic rules, roads are not well maintained and traffic regulation is often poor. These factors account for large number of motor vehicle accidents. In elderly, even minor falls can result in significant spinal trauma due to underlying osteoporotic and degenerative spine disease.

In our study most common site of injury was the cervical spine (61.91%), followed by thoracic (33.33%), and lumbar (4.76%). Cervical spine injury is most common due to excessive mobility and lack of supporting structures. Thoracic spine injury is less common as the stability is provided by thoracic cage.

Out of 12 patients of spinal cord compression with infectious etiology, 9 cases of tuberculous spondylodiscitis, 2 cases of pyogenic spondyodiscitis and one case ofepidural abscess were recorded. This is explained with tuberculous infection prevalence in India.5 cases (41.67%) were noted in thoracic region followed by lumbar 3 cases (25%).

## 6. Conclusion

Magnetic resonance imaging is an excellent modality for imaging pathologic processes involving the spine. MRI allows direct visualization of the spinal cord, nerve roots, and discs. MRI provides better soft tissue contrast and the ability to directly image in the sagittal and coronal planes. It is also the only modality for evaluating the internal structure of the cord. Compared with other modalities, MRI does not use ionizing radiation. This is particularly advantageous in the lumbar area where gonadal exposure may occur, and in the cervical spine to avoid radiation to the thyroid.

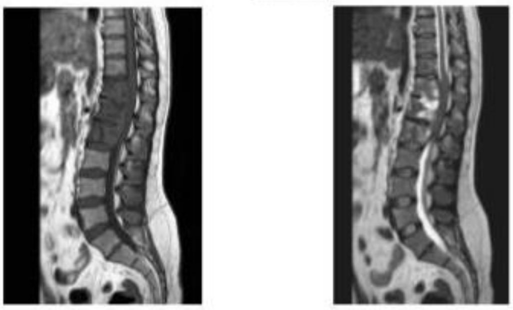
Radiological investigation is of paramount importance in the diagnosis and management of patients with spinal trauma.

MR imaging is the method of choice for assessing spinal cord lesions, igamentous injury, and vertebral bone marrow oedema. Advanced MR techniques hold promise in distinguishing benign versus malignant fractures.

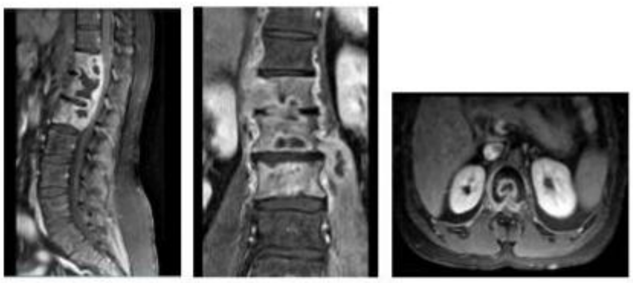
Using MR imaging patterns to recognize the disease may help to characterise infectious spondylitis and to differentiate it from other conditions. The specificity of MR imaging depends on the signal characteristics and anatomic distribution of the infection and the patient's clinical history.

Spinal tumors can cause significant morbidity and can be associated with mortality as well. MRI is helpful to classify the tumours into different compartments and narrow down the differential diagnosis. MRI is the essential procedure of choice for the work up of all spinal tumors and plays an integral role in evaluation and improving anatomic delineation and early diagnosis of spinal tumors and also plays an important role in follow-up and to monitor response to treatment. The final diagnosis for suspicious primary neoplastic lesions still relies on biopsy and histopathological examination.

CASE: 1



T1 SAG T2 SAG

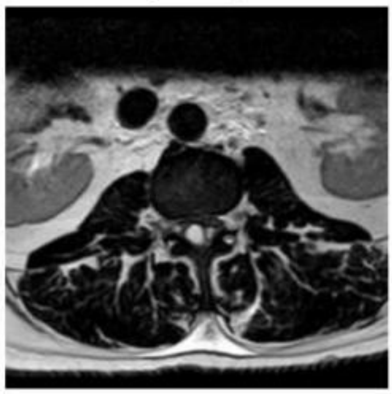


POST CONTRAST SAG POST CONTRAST CORONAL POST CONTRAST AXIAL

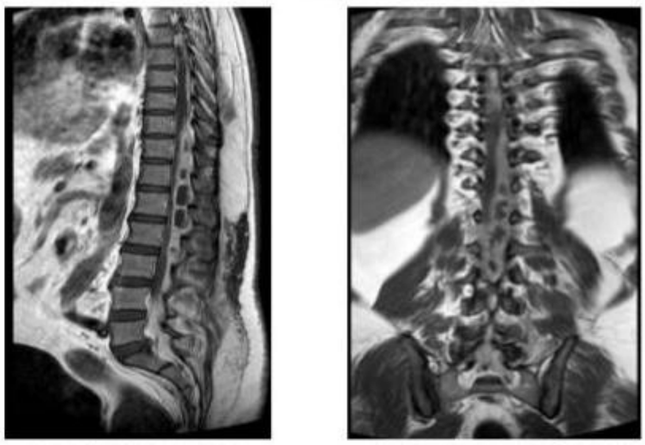
Features suggestive of spondylodiscitis predominantly affecting the posterior and lateral aspects of D12, L1, and L2 vertebrae with paravertebral collections (L > R), with extension into left psoas muscle & compressing the thecal sac, likely Koch's.

T2 SAG POST CONTRAST SAG POST CONTRAST CORONAL

Bony ankylosis of D3-D4-D5 vertebrae causing kyphotic deformity. Spinal cord shows myelomalacia changes extending from D1/D2 to D9/D10 disc level. Heterogenous oval shaped ring enhancement seen within the cord at D5-D6 level-likely active granuloma. Extensive fibrosis and architecture distortion in left lung. Featues suggestive of Koch's.



T2 AXIAL



POST CONTRAST SAG POST CONTRAST CORONAL



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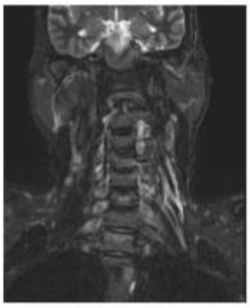
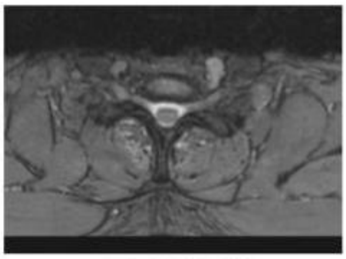
Peripherally enhancing septated longitudinally oriented extradural collection from D10 to L5 vertebrae-likely extradural abscess.

T2 SAG



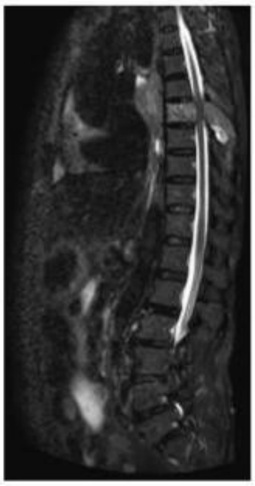
T2 CORONAL



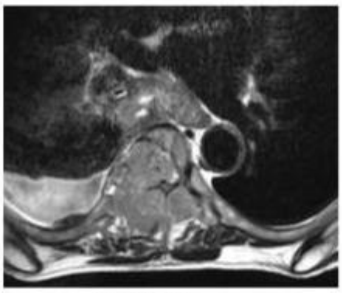
GRADIENT AXIAL

Case of spinal trauma with anterolisthesis of C6 vertebrae over C7 causing disruption of anterior and posterior longitudinal ligaments, compressing the thecal sac. . Suspected left vertebral artery (loss of flow void of left vertebral artery).

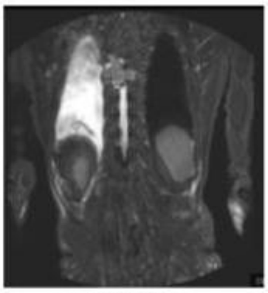
T1 SAG



STIR SAG

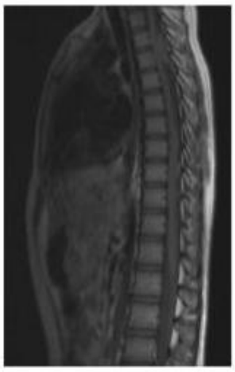


STIR AXIAL



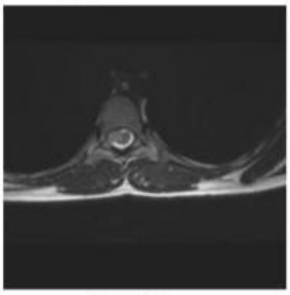
STIR CORONAL

Case of right infrahilar mass with metastasis in D7 vertebral body, pedicles, and post elements with extension into D6 spinous process, causing cord compression and edema. Associated right pleural effusion noted.

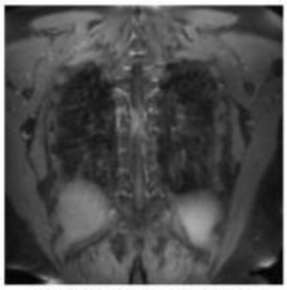


T1 SAG

T2 SAG

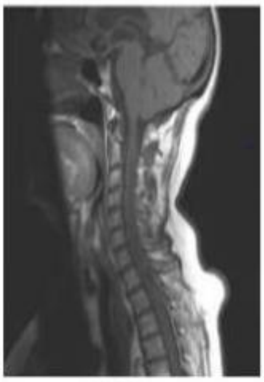


T2 AXIAL

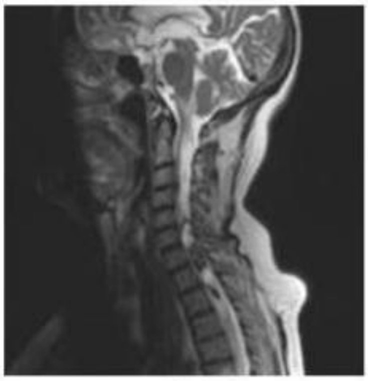


POST CONTRAST CORONAL

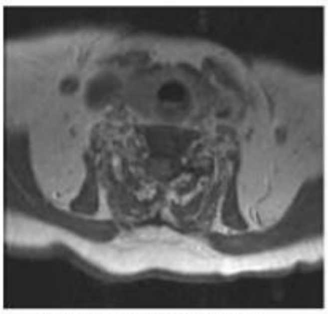
Case of intradural extramedullary mass lesion pushing the spinal cord to opposite side in the thoracic region, showing isointense signal on T1W1, T2W2 images with homogenous contrast enhancement and demonstrating 'dural tail' classic of meningioma.



T1 SAG



T2 SAG



POST CONTRAST AXIAL

POST CONTRAST SAG

Case of intramedullary lesion lesion that expands the spinal cord from the C5-C6 to D1 level demonstrating hypointense signal on T1 and hyperintense signal on T2 with cystic areas and edema proximal and distal to the lesion. Gadolinium enhanced axial MR image shows the eccentrically located intramedullary lesion likely astrocytoma.

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