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Research Article

ROLE OF MRI IN THE EVALUATION OF COMPRESSIVE MYELOPATHY

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ABSTRACT

The purpose of the study is to establish the role of magnetic resonance imaging (MRI) in the evaluation of various causes of compressive myelopathy, characterization of compressive lesions and to classify the lesions based on location into extradural / intradural compartments.

Seventy patients who were clinically suspected to have compressive myelopathy were subjected for MRI. In this study, extradural compression due to degenerative changes (54.3%) was found to be the most common cause of compressive myelopathy, followed by infectious spondylitis (14.3%), post traumatic compressive myelopathy (12.8%), primary neoplasms & metastases (12.8%) and other causes (5.8%).

There were 6 cases of intradural extramedullary pathology, remainder (64 cases) of the cases showed extradural location of pathology. MRI detected cord changes in 97% of cases with cord compression and also assessed the integrity of spinal cord, intervertebral discs and ligament after acute spinal trauma. MRI is very definitive, sensitive, accurate, though costly but very specific, non-invasive, radiation free modality for evaluation of compressive myelopathy.

INTRODUCTION

Compressive myelopathy is the term used to describe spinal cord compression of multiple etiologies. Compression may be due to degenerative changes of disc (herniation), vertebral body (posterior osteophytes), Luschka joints, facet joints, ligamentum flavum or post traumatic compression by fracture / displaced vertebra, epidural hemorrhage or abscess (infectious spondylodiscitis) or extradural/intradural (extramedullary) neoplasm or vascular malformations or developmental cranio-vertebral junction abnormalities.

Spinal cord diseases often have devastating consequences, ranging from quadriplegia and paraplegia to severe sensory deficits. Many of these diseases are potentially reversible if recognized and treated at an early stage, thus they are among the most critical neurologic emergencies. Therefore it is important to recognize the significance of magnetic resonance imaging when approaching a multifactorial disease, such as compressive myelopathy, where prognosis depends on an early and accurate diagnosis.

Objectives

1. To evaluate various causes of compressive myelopathy.
2. MR characterization of spinal cord compressive lesions.
3. To classify the lesions based on location into extradural / intradural compartments.

MATERIALS AND METHODS

This is an observational study conducted in the Department of Radiodiagnosis, Mahatma Gandhi Medical College & Research institute, Pondicherry, for duration of two years. Seventy patients with clinical suspicion of compressive myelopathy were subjected to MRI examination using 1.5 Tesla MRI 8 channel PHILIPS MRI machine. Turbo spin echo sequences T_1WI & T2WI (axial & sagittal), STIR (coronal & sagittal), Gradient sequence T2 FFE (axial), myelosequence (sagittal & coronal) and whole spine T2WI sagittal. If contrast is required, T1W fat saturated precontrast images (axial & sagittal) and T1W fat saturated post contrast (axial, sagittal & coronal) images were acquired in addition to routine sequences.

RESULTS

Majority of patients with degenerative, infectious & post-traumatic myelopathy and with primary neoplasms are young adults/ middle age group (31-50 years). While patients with metastases belonged to older age group (>50 years) and others which included congenital hind brain and developmental cranio-vertebral junction abnormalities belonged to pediatric & young adult age group.

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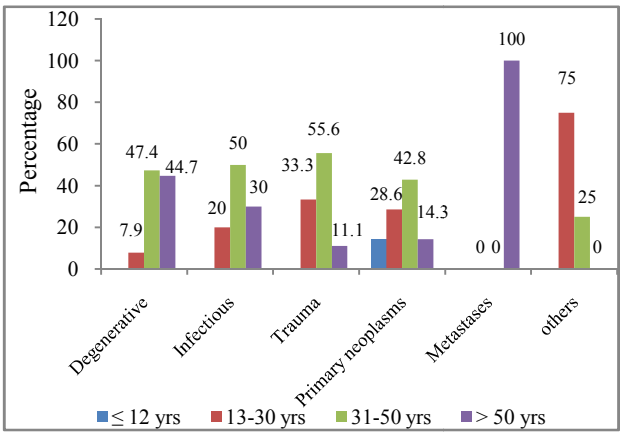


Figure 1 Age distribution in various diagnoses

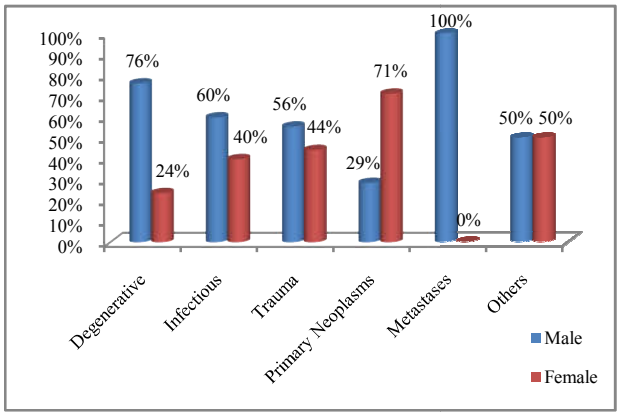


Figure 2 Gender / sex distribution in various diagnoses

Majority of the cases of compressive myelopathy with degenerative changes of spine, infectious spondylitis, trauma and metastases occurred in male population while primary neoplasms are more common in female population.

Table 1 Causes of compressive myelopathy

MR diagnosis	Number of patients (n=70)	%
Degenerative causes	38	54.3
Infectious Spondylitis	10	14.3
Trauma	9	12.8
Tumours / Metastases	9	12.8
Congenital Hindbrain & Developmental CVJ abnormalities	4	5.8
Total	70	100.0

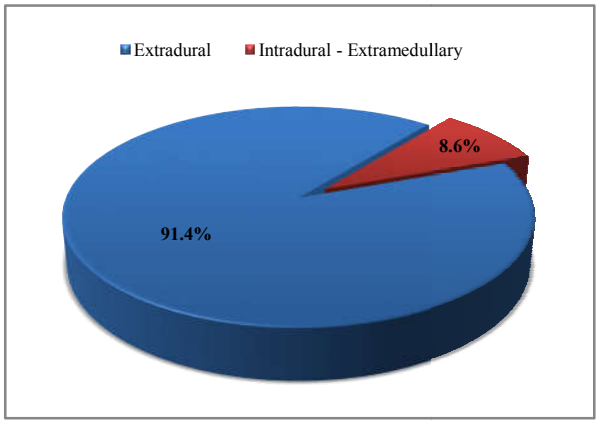


Figure 3 Location of the pathology

Most common cause for compressive myelopathy in our study was compression due to degenerative changes (54.3%) followed by spinal infection (14.3%). Extradural compressive lesions (91.4%) are the most common causes for compressive myelopathy in the current study.

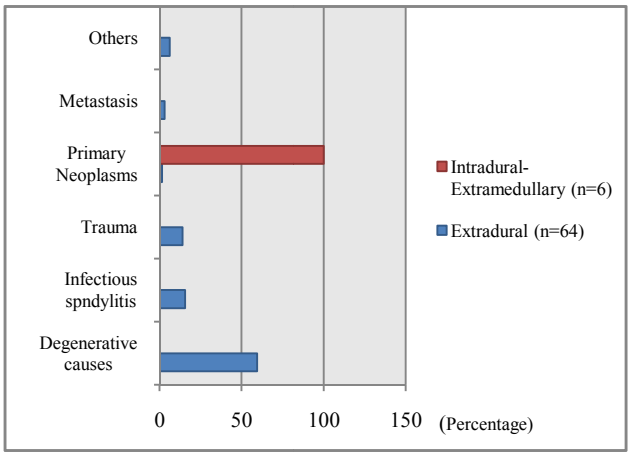


Figure 4 Compartmental division of various etiologies

Degenerative causes, infectious spondylitis and trauma are common causes for extradural compression while primary neoplasms are more common in intradural extramedullary compartment in our study.

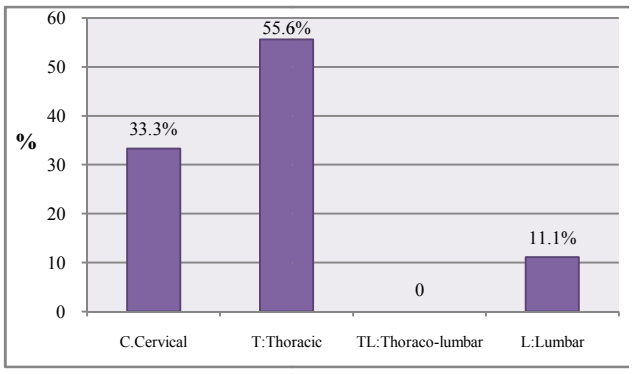


Figure 5 Level of spine injury

In spinal injury, the most common site involved is thoracic followed by cervical region.

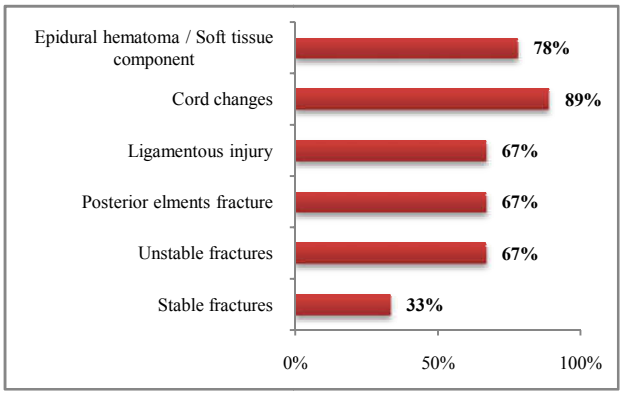


Figure 6 Characterization of spinal injuries by MRI

MRI depicts not only the spinal cord changes but also the relationship of subluxed / dislocated vertebral bodies to the cord, posterior elements fracture, ligamentous disruption, soft

tissue injuries. All these have prognostic implication and can be used to classify injury into stable / unstable.

Table 2 Primary neoplasms and their compartmental distribution

Primary neoplasms (n=7)	No. of patients
Intradural-Extramedullay Compartment	6
Extradural compartment	1
Intradural-Extramedullary primary neoplasms	
Ependymoma	2
Meningioma	3
NF- II	1
Total	6

Primary neoplasms (85.7%) were common in the intradural extramedullary compartment in this study.

Table 3 Location of the Intradural Extramedullary neoplasms

Diagnosis	Cervical	Thoracic	Lumbar	Thoraco-Lumbar
Ependymoma	2	0	0	0
Meningioma	0	3	0	0
NF – II	0	0	0	1

Meningiomas were more common in thoracic region and Ependymomas in the cervical region in our study.

DISCUSSION

The ability of MRI to show the spine and spinal cord with greater sensitivity and specificity than myelography and CT is well established for trauma, neoplastic, congenital and degenerative disorders. MRI has become the modality of choice to image spine and spinal cord pathologies because of its ability to depict cross-sectional anatomy in multiple planes without ionizing radiation, exquisite soft tissue delineation and non-invasiveness.

In our study comprising of 70 cases of compressive myelopathy, we found various different causes of compression. Among them 38 cases were of degenerative compressive myelopathy (33 patients had cervical spondylosis), 10 cases were of infectious spondylitis, 9 cases were post traumatic compressive myelopathy, 9 cases comprising of primary neoplasms & metastases and the remaining 4 cases comprised congenital hindbrain and developmental cranio-vertebral junction abnormalities. These findings were similar to the study conducted by Sreeramulu D *et al*[4] in the year 2015 which showed Cervical spondylosis (64%) as the most common cause of compressive myelopathy followed by Caries spine (16%).

In the present study, out of 38 cases of degenerative compressive myelopathy, 33 patients had cervical spondylosis, among them 32 cases showed cord changes i.e., intramedullary high signal intensity on T2 weighted images. The study conducted by Takahashi *et al*[2] showed that the intramedullary high signal intensity (T2W) in cervical spondylosis to be an indicator of poor prognosis, as this change reflected myelomalacia or cord gliosis secondary to longstanding compression of the spinal cord.

Another study conducted by Hui Chen *et al*[3] in the year 2016 concluded that the surgical outcomes were poorer in the patients with both T2 intramedullary signal changes, especially when the signal changes were multisegmental and had a well-defined border and T1 intramedullary signal changes compared with those without intramedullary signal changes. Preoperative magnetic resonance imaging including T1 and T2 imaging can thus be used to predict postoperative recovery in cervical spondylosis myelopathy patients.

In our study, out of 10 cases of infectious spondylitis, 8 cases were tuberculous spondylitis and 2 were pyogenic spondylitis. In cases of TB Spondylitis, MRI showed vertebral body destruction with pre and para vertebral collection, and rim enhancement around the intra-osseous and paraspinal soft tissue abscesses. In cases of TB spondylitis, the cortical definition of affected vertebrae was invariably lost in contradistinction to pyogenic spondylitis. In 8 cases, the lesions were noted in thoracic region and in two cases the lesions were in lumbar region. These findings were in concordance with studies conducted by Roos DEA *et al*[8] and Galhotra RD *et al*[14].

Posterior elements involvement was seen in both cases of pyogenic spondylitis but was seen in only one case of tuberculous spondylitis in our study. These findings are comparable to the study conducted by Na-Young Jung *et al*[37] which concluded that posterior elements involvement is very common in pyogenic spondylitis but rare in tuberculous spondylitis.

In our study, the level of spinal injuries among the 9 cases of spinal trauma were thoracic (55.6%), cervical (33.3%) and lumbar (11.1%).These findings are similar to the study conducted by Kerslake *et al*[25]. Spinal cord compression was observed in all the 9 cases of spinal injury. The causes of spinal cord compression included vertebral body fracture with retropulsed fracture fragments and epidural hematoma in 6 cases and subluxation of vertebral body in 2 patients. In our study, 8 out of 9 traumatic myelopathy patients showed focal hypointensity on T1W and hyperintensity on T2W images and STIR images at the level of cord compression, suggestive of cord edema/contusion. These signal changes are consistent with studies done previously by Hackney *et al*[6]. The cord signal intensity has the prognostic implication where patient with cord edema recovered completely or partially and patient haemorrhage in cord had poor prognosis. This has also been shown by studies done by Hackney *et al*[6], Flanders *et al*[37] and Kulkarni *et al*[11].

MRI depicted not only the spinal cord changes in our patients but also the relationship of subluxed/dislocated vertebral bodies to that of cord, posterior elements fracture (6 patients), ligamentous disruption (6 patients) and epidural haematoma (7 patients).The advantage of MRI in demonstrating all these characteristics in spinal injury is shown by many studies done by Yamashita *et al*[24], Kulkarni *et al*[11], etc.

In our study of 70 cases, there were 2 (2.9%) cases of metastases causing compressive myelopathy. Among them one case was due to skeletal metastases from prostatic cancer and the other case was metastases from unknown primary. The metastatic spinal lesions were intraspinal extradural masses that extended from an abnormal part of the vertebra, causing cord compression in both cases of metastases. This is in concordance with the study conducted by Lien *et al*[18] in which 90% of cases of metastases showed extradural masses extended from an abnormal part of a vertebra. We had one case of prostatic cancer with spinal metastases causing cord

compression where patient presented with back pain but no focal neurological deficit. According to the study conducted by Venkitaraman R *et al*[52], a significant proportion of patients with metastatic prostatic cancer may harbour overt or occult spinal cord compression in the absence of focal neurological deficit. MRI of the spine is useful for the early diagnosis of spinal cord compression in such cases as it is major determinant influencing treatment outcome.

In the current study, both the cases of metastases showed more than one lesion. This is in comparison to the study done by Lien *et al*[18] in which 78% of cases of metastases had more than one lesion which include vertebral masses in addition to those compressing the cord.

In our study, the level of lesions in both cases of metastases is in the thoracic region. This is in comparison to the study done by Livingston *et al*[1] where site of epidural tumor in thoracic spine was 68%.

Out of 7 cases of primary neoplasms, we had 6 cases of intradural extramedullary neoplasms. These values are comparable to the study conducted by Cormick PC *et al*[17], which concluded that 2/3rd of intradural tumors are extramedullary.

In our study, among the 6 cases of intradural extramedullary primary neoplasms, there were 3 cases of meningioma, 2 cases of ependymoma and a single case of NF II where the lesions could not be differentiated between schwannoma and meningioma.

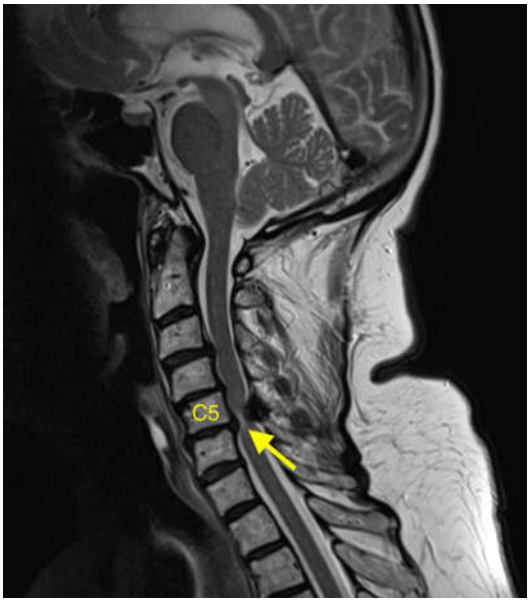
Several studies conducted by Matsumoto S *et al*[30], Gezen F *et al*[42] and Souweidane MM *et al*[34] showed signal characteristic of meningioma as iso intense to the cord on T1W and T2W images with intense homogeneous enhancement on post contrast. In our study, all the three cases of meningioma showed iso intensity on T1W images, iso-hyperintensity on T2W images and intense homogeneous enhancement on post contrast.

In our study, all 3 cases of meningioma were seen in women aged between their fourth and fifth decades and in the thoracic region. This is in concordance with the study conducted by Souweidane MM *et al*[34], which stated that women, usually between their fourth and fifth decades, account for approximately 80% of patients with spinal meningiomas with lesion located in the thoracic region in majority of the cases.

We had one case of os odontoideum with atlanto-axial instability causing cervical canal narrowing with cord compression and altered signal intensity (T2W) of cord at this level. These findings were comparable to the study conducted by Watanabe M *et al*[13] which has concluded that in patients comprising of os odontoideum with atlanto-axial instability, patient is likely to have cord compression with clinical symptoms.

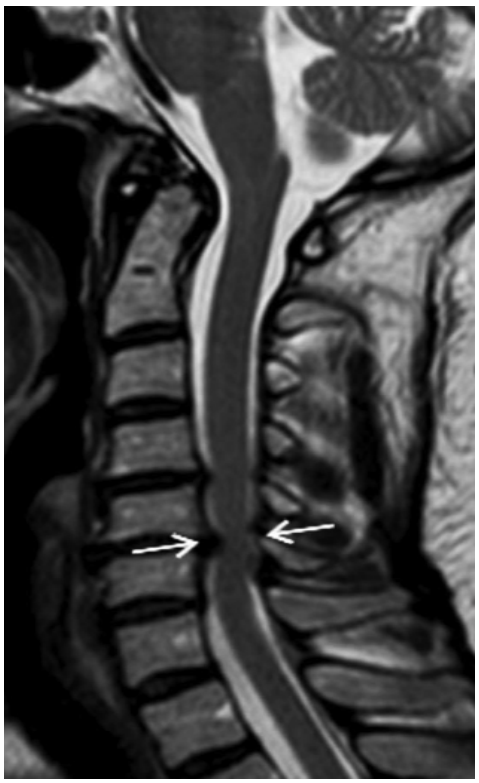
Illustrative cases

Case 1: A case of degenerative disc disease at multiple levels with cord compression. At C5-6 level, disc protrusion in the anterior aspect and thickened ligament flavum in the posterior aspect of the spinal canal are causing cord compression with focal T2 signal hyperintensity suggestive of myelomalacic changes.



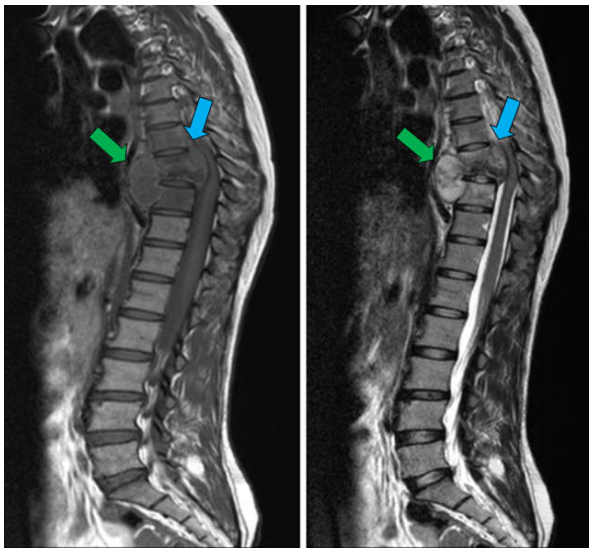
Case 1 T2 Sagittal view demonstrating degenerative compressive myelopathy

Case 2: A case of degenerative compressive myelopathy at C4-5 & C5-6 levels with no significant T2 altered signal intensity at the level of cord compression.



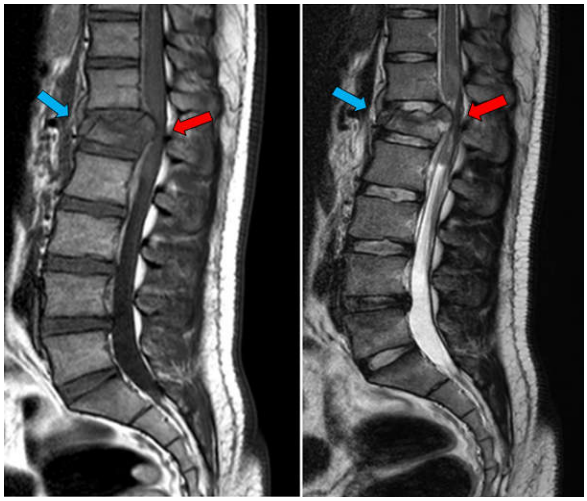
Case 2 T2 Sagittal view demonstrating degenerative compressive myelopathy

Case 3: A case of tuberculous spondylodiscitis showing contiguous involvement of T7 to T9 vertebral bodies with prevertebral abscess (green arrow), epidural abscess (blue arrow) and severe cord compression at T8 and T9 levels.

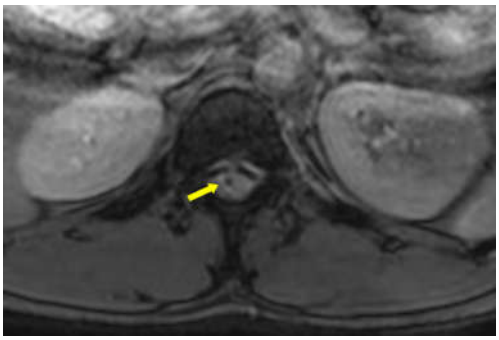


Case 3 T1 (left) & T2 (right) Sagittal view of thoracic spine demonstrating tuberculous spondylodiscitis causing cord compression

Case 4: Case of post traumatic myelopathy showing burst fracture of L1 vertebra (blue arrow) with retropulsion causing thecal & cord compression (red arrow) and focal hemorrhagic contusion of cord at this level (yellow arrow).

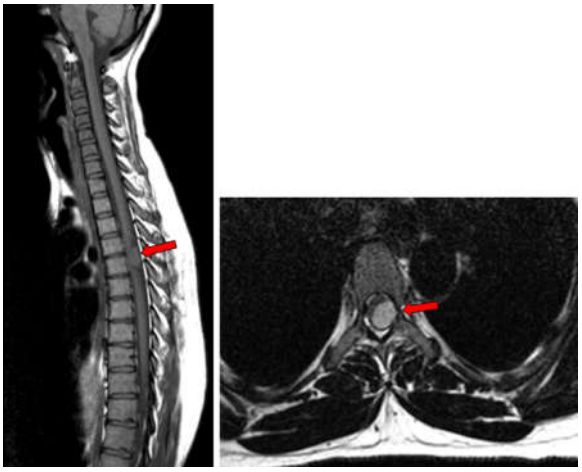


Case 4 T1 (left) & T2 (right) Sagittal view of lumbo-sacral spine demonstrating traumatic myelopathy

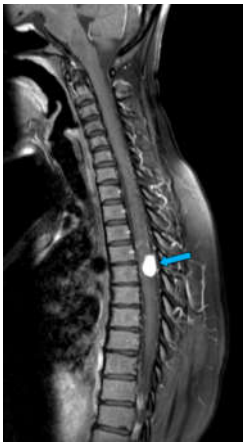


Case 4 T2 GRE Axial view demonstrating focal haemorrhage in cord at the level of compression

Case 5: A case of intradural extramedullary meningioma causing cord compression at T4-5 level (red arrow). The lesion shows homogeneous intense enhancement (blue arrow) on post contrast image.

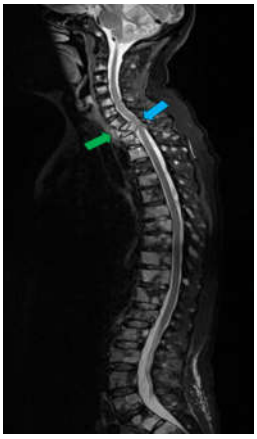


Case 5 T1 Sagittal (left) & T2 Axial (right) view showing meningioma causing cord compression at T4-5 level



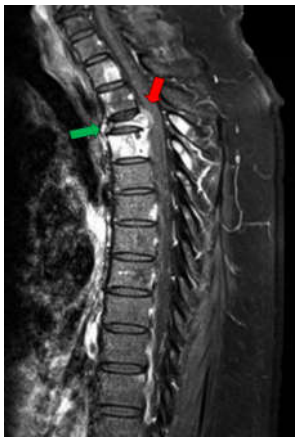
Case 5 T1 Fat Sat Contrast Sagittal view demonstrating intense homogeneous enhancement of the lesion

Case 6: A case of multiple metastases of spine with pathological fracture of T1 vertebra (green arrow) causing cord compression (blue arrow).



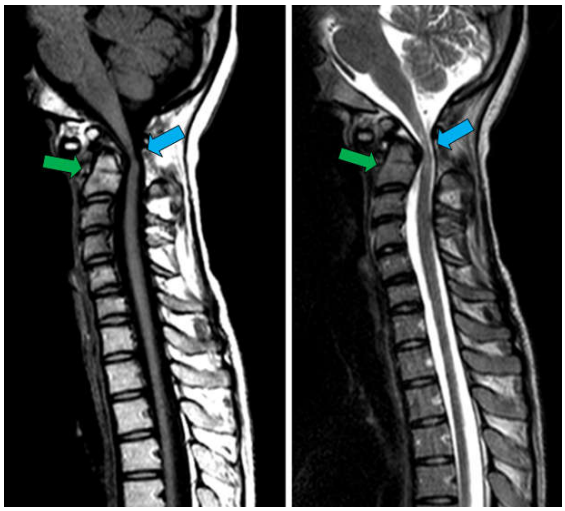
Case 6 STIR Sagittal view demonstrating multiple metastases with cord compression at T1 level

Case 7: A case of prostate cancer with spinal metastases involving T1, T3 & T4 vertebrae with pathological fracture of T3 (green arrow) forming epidural soft tissue component causing cord compression (red arrow) at this level. On post contrast, there is contrast enhancement of T1, T3 & T4 vertebrae, spinous processes and the epidural soft tissue component.



Case 7 Post contrast STIR Sagittal view demonstrating compressive myelopathy due to metastases at T3 level

Case 8: A case of os odontoideum with posterior subluxation of the axis (green arrow) with significant cervical cord compression (blue arrow) and focal myelomalacic changes.



Case 8 T1 (left) & T2 (right) Sagittal view of cervical spine demonstrating developmental CVJ abnormality causing cord compression

LIMITATIONS OF OUR STUDY

1. Surgical correlation and histopathological correlation for all cases could not be done.
2. Follow up was performed only for four months and could not be achieved for all the patients.
3. Limited sample size and duration of study.

SUGGESTIONS FOR FURTHER STUDY

1. To increase the sample size and duration of study so that the follow up may be achieved for maximum number of cases. This helps in estimating the prognostic value and the surgical outcome.
2. To do histopathological correlation. This helps to avoid equivocal diagnosis.

CONCLUSION

MRI is the definitive modality in assessing spinal soft tissue injuries, especially in the evaluation of spinal cord edema / contusion, intervertebral discs, and ligaments. MRI is very sensitive and considered the procedure of choice for the work up of all spinal tumors. MRI is the most sensitive modality to detect, characterize and grade spinal infection. However, the final diagnosis still relies on biopsy and culture. Till date, MRI is the best modality to directly image the spinal cord. In our study with the help of MRI, we could successfully characterize the spinal tumor based on location into extradural / intradural and assess the integrity of spinal cord, intervertebral discs and ligament after acute spinal trauma. So in the end, we conclude that MRI is very definitive, sensitive, accurate, though costly but very specific, non invasive, radiation free modality for evaluation of compressive myelopathy.

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