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ORIGINAL ARTICLE

Role of Magnetic Resonance Imaging in the Evaluation of Compressive Myelopathy in Rohilkhand Region, India

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ABSTRACT

Background and objective: Spinal cord compression is the most important cause of neuropathy and disability. Many spinal cord diseases are reversible if recognized early. They are definitely among the most critical of neurologic emergencies. Plain radiographs have a low sensitivity for identifying traumatic/neoplastic spinal lesions. The role of magnetic resonance imaging (MRI) is to distinguish the compressive from noncompressive causes of myelopathy, localize the spinal tumors as being extradural/intradural, and assess the integrity of spinal cord, intervertebral disks, and ligaments after acute spinal trauma.

Mateirals and methods: It is a descriptive study with 90 cases carried out in the Department of Radiodiagnosis and Imaging at Rohilkhand Medical College & Hospital, Bareilly, Uttar Pradesh, India. The patients with a suspected clinical history of compressive myelopathy were subjected to MRI scanning. Acquired images were evaluated based on severity of cord compression, location in the extradural/intradural, level of lesion (cervical, thoracic, and lumbar), signal intensities of the neoplasms, vertebral fracture with epidural hematoma, ligamentous injury, and cord edema/contusion. The patients were chosen for the study by a process of purposive sampling, and data were analyzed by descriptive analysis.

Results: In our study of 90 cases of compressive myelopathy we found various different causes for compression. Among these are trauma (39), infectious causes (21), Metastasis (15), primary neoplasm (meningioma (06) + neurofibroma (09).

Conclusion: The MRI is the definitive modality in assessing soft tissues of the spine and spinal cord abnormalities. In our study, with the help of MRI, we could successfully characterize the spinal cord after trauma, identify spinal tumors based on extradural/intradural locations, and assess the integrity of spinal cord, intervertebral disks, and ligaments. Thus, in the end, we can conclude that in cases of RTA and other causes, which lead to compressive myelopathy, MRI is the definitive and accurate answer to the clinical question.

Keywords: Compressive myelopathy, Extradural compression, Intradural neoplasms, Magnetic resonance imaging, Spine, Spinal trauma.

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INTRODUCTION

Compressive myelopathy is the term used to describe the spinal cord compression either from outside or within the cord itself. Compression may be due to herniated disk, posttraumatic compression by fracture/displaced vertebra, epidural hemorrhage/abscess, or epidural/intradural (intramedullary and extramedullary) neoplasm (Table 1). Spinal cord injury is the major cause of quadriplegia and disability. Plain radiographs have a low sensitivity for identifying traumatic spinal lesions. Therefore, trauma

Table 1: Causes of compressive myelopathy

Spinal neoplasm	
a. Extradural neoplasms:	b. Intradural/extramedullary neoplasm, cysts and tumor like masses
i. Benign tumors and cysts and tumor-like masses	i. Schwannoma ii. Neurofibroma
1. Neurofibroma	iii. Meningioma
2. Osteochondroma	iv. Ganglioneuroma
3. Vertebral body tumors	v. Paraganglioma
• Hemangioma	vi. Dermoid/epidermoid
• Osteoclastoma	vii. Arachnoid cyst
• Osteoblastoma	viii. Lipoma
• Giant cell tumor	ix. Metastases
	x. Ependymoma
4. Aneurysmal bone cysts	c. Intramedullary tumors, cysts, and tumor-like masses
5. Epidural lipomatosis	i. Ependymoma
6. Angiolipoma	ii. Astrocytoma
7. Synovial cysts	iii. Hemangioblastoma
8. Arachnoid cysts	iv. Glioblastoma
	v. Metastases
	vi. Hydrosyringomyelia
	vii. Developmental tumors
ii. Malignant tumors	Spinal cord tumors and tumor-like masses:
1. Metastases 2. Lymphoma 3. Myeloma 4. Sarcoma 5. Chordoma	• Extradural lesions (lesions of osseous spine, epidural space, and paraspinous soft tissues) • Intradural extramedullary lesions (lesions that are inside the dura but outside the spinal cord) • Intramedullary lesions (spinal cord tumors and cysts).

victims with plain films negative for spine injury, but with a high clinical suspicion of injury or positive for spinal injury should undergo MRI for a more definitive evaluation of the spine. The MRI is the definitive modality in assessing spinal soft tissue injuries, especially in the evaluation of spinal cord, intervertebral disks, and ligaments. It also allows to differentiate spinal cord hemorrhage and edema, which may have a prognostic value. In case of spinal trauma, MRI demonstrates the relationship of fractured/subluxed vertebral bodies to the cord and highlights a significant stenosis. The signal abnormalities within the cord can be identified, helping to localize and define the degree of trauma. In case of suspected cord compression due to neoplasm, MRI serves as an excellent test for imaging tumor involving spinal column, canal, and cord. Today, MRI is considered the procedure of choice for the workup of all spinal tumors.

The role of MRI is to distinguish compressive myelopathy from noncompressive myelopathy. Once compressive lesions have been excluded, noncompressive causes of myelopathy that are intrinsic to the cord are considered, viz. primarily vascular, inflammatory, and infectious causes.

OBJECTIVES

- To evaluate the various causes of compressive myelopathy
- The MR characterization of spinal cord compressive lesions
- To classify the lesions based on location in the extradural/intradural compartments

MATERIALS AND METHODS

The data for the study intended are to be collected from patients referred for MRI scan to the Department of Radiodiagnosis, Rohilkhand Medical College & Hospital, Bareilly, Uttar Pradesh, India.

Data Collection

The intended study is a descriptive study carried out on 90 patients visiting the outpatient/inpatient departments referred for an MRI scan to the Department of Radiodiagnosis, Rohilkhand Medical College & Hospital, Bareilly, Uttar Pradesh, India, for a period from January 2017 to July 2017 duration.

Case Selection

The patients who are clinically suspected as a case of compressive myelopathy will be investigated with MRI. The study group will include a sample size of 90 patients selected by a purposive sampling. The data will be analyzed by a descriptive analysis. A complete clinical history of the patient was taken with particular reference to the motor and sensory symptoms.

Patient Preparation

The procedure will be briefly explained to the patient and consent will be taken. Detailed history for contraindications of MRI will be specifically taken.

Inclusion Criteria

- Age group 12 to 70 years of both the sexes
- All provisional cases of compressive myelopathy with clinical history

Exclusion Criteria

- Degenerative disk herniation

Patient Preparation

The procedure was briefly explained to the patient and consent was taken. Detailed history for contraindication of MRI was specifically taken.

Equipment

APERTO LUCENT .4 TESLA OPEN MAGNET:HITACHI. Standard surface coils and body coils were used for cervical, thoracic, and lumbar spine for acquisition of images.

Sequences

Conventional spin echo sequences T1-weighted imaging (T1WI), T2-weighted imaging (T2WI), short tau inversion recovery (STIR) sag, STIR coronal and postcontrast T1, WI axial, Sag, and coronal.

OBSERVATIONS

The most common cause (Table 2) for compressive myelopathy in our study was spinal infection (43.3%) followed by spinal trauma (23.3%).

Extradural compressive lesions (83.3%) are the most common cause for compressive myelopathy

Spinal injuries and infection are the common causes for extradural compression, while primary neoplasms are more common in intradural compartments in our study (Table 3).

Table 2: Causes of compressive myelopathy

MR diagnosis	*Number of patients (n = 90)*	*Percent*
Traumatic myelopathy	39	43.3
Infective/Tuberculosis	21	23.3
Primary neoplasm	15	16.7
Secondary neoplasm/metastasis	15	16.7
Total	90	100

Table 3: Location of the pathology

Compartment	*Number of patients*	*Percent*
Extradural	75	83.3
Intradural–extramedullary	15	16.7
Total	90	100

The majority of patients of spinal injury (38.5%) and primary neoplasm (60%) are young adults/middle age group (20–49 years). The majority of patients of spinal infection (42.9) and secondary neoplasm (80%) are the older age group (>50 years).

Most of the spinal injuries (84.6%) (Figs 1 and 2) occur in the male population, while spinal infection/tuberculosis (57.1%) (Fig. 3), primary neoplasm (60%), (Figs 4 and 5)and secondary/metastasis (Fig. 6) (60%) are more common in female population (Table 4).

Most of the spinal injury, infection, and secondary neoplasm involve extradural compartment, while most of

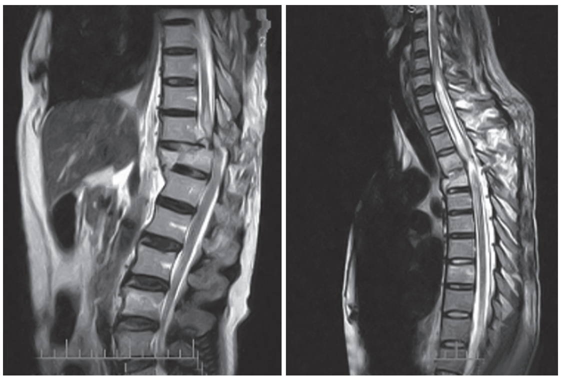


Fig. 1: Dislocation causing extensive cord edema; cord compression

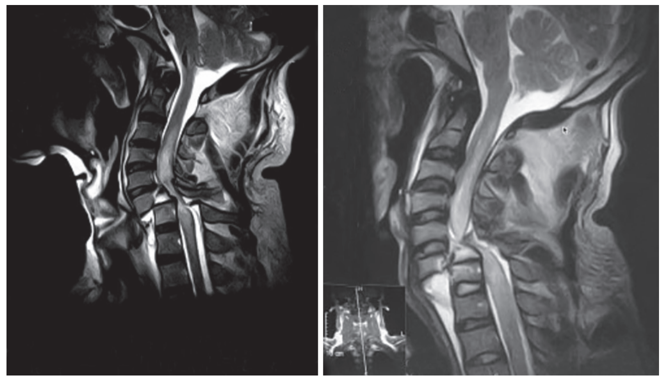
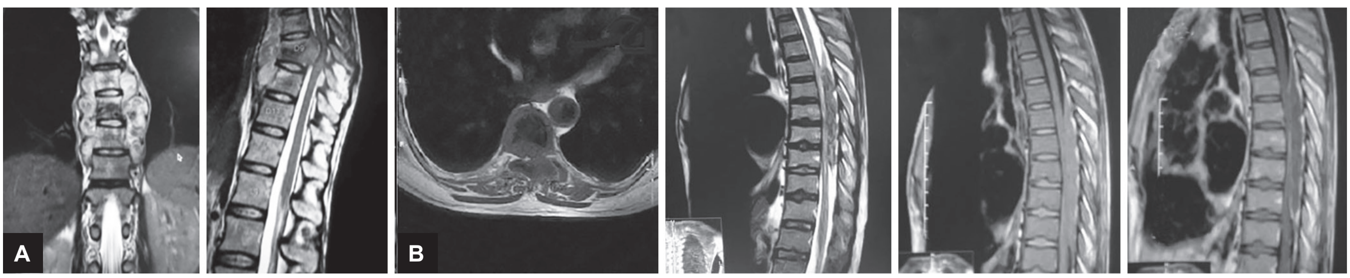


Fig. 2: Pre and para vertebral collection with all and pll disruption; severe cord compression with edema



Figs 3A and B: (A) Tuberculosis of spine with cold abscess; (B) epidural abscess

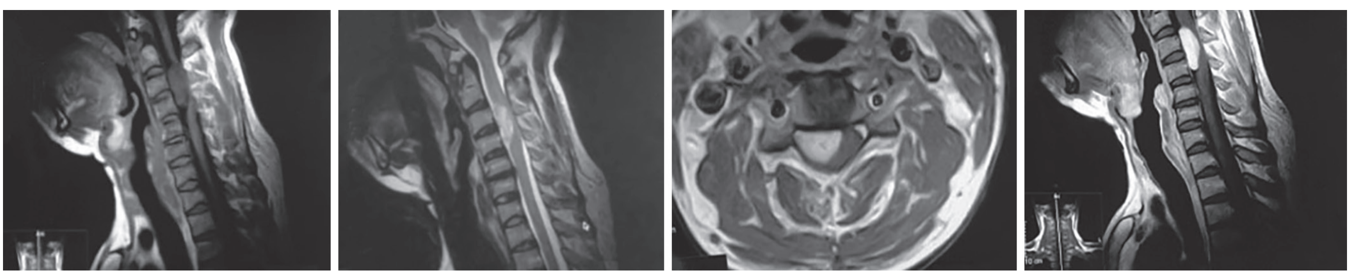


Fig. 4: Intradural extramedullary neurofibroma

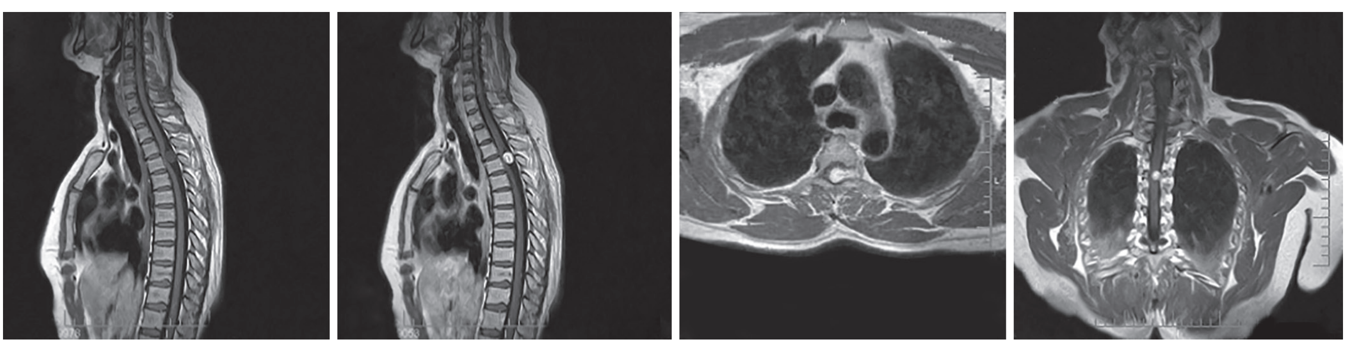


Fig. 5: Intradural extramedullary neurofibroma with extension into neural foramina

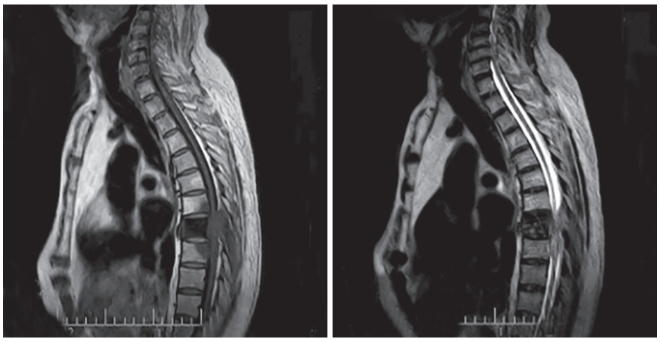


Fig. 6: Sclerotic metastasis—carcinoma prostate

the primary neoplasms involve the intradural compartment (Table 5).

In spine injury, the common site involved is the thoracic followed by cervical region (Table 6).

The patterns of signal intensity changes have prognostic value. Cases associated with edema/contusion have favorable outcomes as compared with cord hemorrhage, which has protracted course.

The 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, which all have prognostic implications and can be used to classify injury into stable/unstable (Tables 7 and 8).

Primary neoplasms (100%) are more common in intradural compartment than metastases.

Meningiomas are more common in thoracic region, whereas neurofibromas are common in thoracic and cervical regions (Tables 9 to 12).

The MRI is very sensitive as well as specific in detecting extradural lesions, such as metastases, epidural abscess, and infective spondylitis with epidural soft tissue component. It is also sensitive in detecting intradural primary neoplasms, but differentiating

Table 4: Age, gender, and compartmental distribution in various diagnoses

	MR diagnosis				
Variables	*Traumatic (n = 39)*	*Infection (n = 21)*	*Primary neoplasm (n = 15)*	*Secondary neoplasm/ metastasis (n = 15)*	*p-value*
Age in years					
• 12–30	12 (30.8%)	6 (28.6%)	0	0	0.462
• 31–50	15 (38.5%)	6 (28.6%)	9 (60%)	3 (20%)	
• >50	12 (30.8%)	9 (42.9%)	6 (40%)	12 (80%)	
Gender					
• Male	33 (84.6%)	9 (42.9%)	6 (40%)	6 (40%)	0.110
• Female	6 (15.4%)	12 (57.1%)	9 (60%)	9 (60%)	
Compartment					
• Extradural	39 (100%)	21 (100%)	0	15 (100%)	<0.001%
• Intradural	0	0	15 (100%)	0	

Table 5: Causes according to compartment

Causes	*Number of patients (n = 90)*	*Extradural (n = 85)*	*Intradural–extramedullary (n = 5)*
Spinal injury	39 (43.3%)	39 (52.2%)	0
Infective tuberculosis	21 (23.3%)	21 (28.0%)	0
Primary neoplasm	15 (16.7%)	0 (0%)	15 (100%)
Secondary neoplasm	15 (16.7%)	15 (20.0%)	0

Table 6: Level of spinal injury

Level of lesion	*Number of patients (n = 39)*	*Percent*
C: Cervical	18	46.2
T: Thoracic	21	53.8
• LT: Lower thoracic	18	46.2
• UT: Upper thoracic	3	7.7
TL: Thoracolumbar	0	0.0
L: Lumbar	0	0.0

Table 7: Characterization of spinal injuries by MRI

MRI findings	*Number of patients (n = 39)*	*Percent*
Stable fracture	18	46.2
Unstable fracture	21	53.8
Posterior element fracture	21	53.8
Ligamentous injury	21	53.8
Cord changes	36	92.3
Epidural hematoma	18	46.2
Pre- and paravertebral collection	18	46.2

Table 8: Characterization of nontraumatic spinal compression by MRI

Magnetic resonance imaging	*Number of patients (n = 51)*	*Percent*
Stable fracture	3	5.9
Unstable fracture	3	5.9
Posterior elements fracture	18	35.6
Ligamentous injury	9	17.6
Cord changes	9	17.6
Epidural hematoma	36	70.6
Pre- and paravertebral collection	12	23.5

Table 9: Site of metastases

Levels of lesions in secondary neoplasm/mets	*Number of patients (n = 15)*	*Percent*
Cervical	3	20
Thoracic	12	80
• Upper	6	40
• Lower	6	40
Thoracolumbar	0	0
Lumbar	0	0

Table 10: Multiplicity of lesions in metastasis

Multiplicity	*Number of patients (n = 15)*	*Percent*
Negative	6	40
Positive	9	60

Table 11: Intradural extramedullary lesions

Primary neoplasm	*Number of patients (n = 15)*
Neurofibroma	6
Meningioma	9

Table 12: Location of the intradural extramedullary neoplasms

Diagnosis	*Cervical*	*Thoracic*	*Lumbar*
Meningioma	0	6	3
Neurofibroma	3	3	0

Table 13: Summary of all the causes of the compressive lesions

MR diagnosis	*MR*	*Histopathological examination*	*% correlation*
Traumatic myelopathy	39	0	–
Infection	21	18	85.7
Metastases	15	15	100
Neurofibroma	9	3	33.3
Meningioma	6	3	50

meningioma from neurofibroma sometimes may be difficult (Table 13).

DISCUSSION

The ability of MRI to show the spine and spinal cord with greater sensitivity and specificity than myelography and computed tomography is well established for trauma, neoplastic, congenital, and degenerative disorders. The MRI is the only currently available technique that provides direct visualization of the spinal cord. This 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 noninvasiveness.

In our study of 90 cases of compressive myelopathy, we found various different causes for compression. Among these are trauma (39), infectious causes (21), primary neoplasms (15), and secondary neoplasm (15).

Out of 90 cases of compressive myelopathy, we had 39 (43.3%) cases of spinal trauma. Among 39 patients, the mode of injury was fall from height (70%) and road traffic accidents (RTAs; 30%). In a study conducted by Kulkarni et al,[1] the most common mode of injury to the spinal cord was fall from a height and the least cause was the RTA.

A similar finding of the mode of injury has been observed in our study conducted. This is in comparison with the study conducted by Yamashita et al.[2]

In our study, the levels of injuries among the 39 patients were thoracic (53.8%), cervical (46%), and lumbar (15.4%). This is comparable with the study conducted by Kerslake et al.[3]

The spinal cord abnormalities demonstrated by MRI were cord compression and abnormal signal intensities within the spinal cord. Spinal cord compression was observed in all the 39 cases of spinal injury. The causes of spinal cord compression included subluxation of vertebral body in 21 patients and epidural hematoma in 18 patients.

Abnormal signal intensities from the spinal cord were observed in 36 of 39 patients and 1 patient had no cord changes. Totally, 36 patients showed hypointensity on T1WI and hyperintensity on T2WI and fluid attenuation inversion recovery (FLAIR) images suggestive of cord edema/contusion. These signal changes are inconsistent with studies done previously by Hackney et al.[4]

The cord signal intensity has the prognostic implication where patient with cord edema recovered completely/partially. This has also been shown by studies done by Hackney et al[4] and Friedman and Flanders.[5]

Of the 21 cervical injury patients, 15 patients expired during the period of hospitalization. This may be attributed to severity of cord compression and multisegment involvement of the cord changes.

The MRI depicted not only the spinal cord changes in our patients, but also the relationship of subluxed/dislocated vertebral bodies to the cord (36 patients), posterior elements fracture (21 patients), ligamentous disruption (21 patient), soft tissues injuries (18 patients), and epidural hematomas (18 patients).

The advantage of MRI in demonstrating all these changes is shown by many studies done by Yamashita et al,[2] Kulkarni et al,[1] etc.

In our study of 90 cases, 15 (16.7%) are of metastatic disease of the spine as a cause of compressive myelopathy. Intraspinal extradural masses that caused cord compression extended from an abnormal part of the vertebra in all the 15 patients. This is substantiated by a study conducted by Lien et al[6] in which 90% showed extradural masses extended from an abnormal part of a vertebra. Out of 15 patients, 9 (60%) showed more than one lesion.

This is in comparison with the study done by Lien et al,[6] in which 78% had more the one lesion, which include vertebral metastases in addition to those compressing the cord.

In our study, the most common site of involvement was the thoracic spine (80%). This is in comparison with the study done by Livingston and Perrin[7] where site of epidural tumor in thoracic spine was 68%.

The three most common primary tumors with metastases to the spine and extradural space were lung carcinoma (15%), breast carcinoma (14%), and lymphoma (11%). In our study, we had three patients with primary carcinoma bronchus, three patient had breast carcinoma, three lymphoma, three carcinoma prostate, and three patients with unknown primary. We used T1WI, T2WI, and STIR sequences and postcontrast to image spinal metastases. The T1WI was useful in the detection of bone marrow metastases and STIR helped in picking up more marrow lesions.

The intravenous gadolinium–diethylenetriamine penta-acetic acid was used in 9 out of 15 patients, which showed mild homo- to heterogeneous enhancement. Observations have shown that postcontrast MR does not improve the detection of extradural spinal metastases even though it has great value in intradural disease.

We had 15 cases of primary intradural extramedullary neoplasms, among which 6 were neurofibroma and 9 were meningioma. All the 15 cases showed spinal cord compression. Of the 9 cases of neurofibromas, MR diagnosed 6 cases as neurofibroma.

In 3 cases, MR could not differentiate between meningioma and neurofibroma.

Neurofibromas were iso- to hypointense on T1WI and hyperintense on T2WI and showed intense enhancement on postcontrast. One case showed extension into the neural foramina. Studies done by David et al, Dorsi and Belzberg,[8] and Matsumoto et al[9] showed that on T1WI, the signal varied from hypo- to isointense to the cord and, on T2WI, they are hyperintense in signal and also may show decreased signal in the central portion consistent with necrosis. Neurofibromas showed marked enhancement, which was heterogeneous. Of the 15 intradural extramedullary neoplasms, 9 were meningiomas. On MRI, it was given as meningioma/neurofibroma as differential diagnosis. It showed isointensity on T1WI and T2WI and showed moderate homogeneous enhancement on postcontrast. Several studies by Matsumoto et al,[9] Gezen et al,[10] and Souweidane et al[11] showed signal characteristic of meningioma as isointense to the cord on T1 and T2WI with intense homogeneous enhancement on postcontrast.

In our study, 21 cases of infective spondylitis were associated with compressive myelopathy. About 18 cases were in the thoracic region and 3 in the lumbar region. The X-ray showed some abnormality in 15 cases. The MRI showed vertebral body destruction with pre- and paravertebral collection in six cases. Epidural component compressing the cord was seen in all the 21 cases which were hypointense on T1WI and hyperintense on T2WI and FLAIR images. Cord edema was associated with six cases. Study by de Roos et al[12] showed thoracolumbar junction as the most commonly affected site as in our cases. They showed rim enhancement around the intraosseous and paraspinal soft tissues abscess. In our observation, contrast study was not done due to various reasons. Though provisional diagnosis of tubercular etiology was given, ideally, contrast study should have been done to increase the specificity of MRI.

We had one case of epidural abscess compressing the spinal cord, who presented with sudden onset of weakness in both lower limbs. The MRI showed extradural soft tissue posterior to the cord extending from T4 to T9 level, causing compression on the spinal cord. It was isointense on T1WI and hypointense on T2WI, and showed peripheral minimal enhancement. The study conducted by Numaguchi et al[13] showed thoracic region as the most common site of involvement and signal intensities of the abscess as comparable with our study.

We had three cases of chronic hypertrophic pachymeningitis as a rare cause of compressive myelopathy. The X-ray was normal and MRI showed diffuse irregular, thickened leptomeninges from C7 to T5 level, which was isointense to cord on T1WI and hypointense on T2WI and FLAIR. Postcontrast showed homogeneous intense enhancement.

The unenhanced MR findings of this disease have been reported by several authors. They reported moderate to marked hypointensity on T1WI and T2WI, particularly on T2WI. Friedman et al[14] observed a pattern of intense enhancement of the lesion, which is comparable with the case in our study.

CONCLUSION

The MRI is the definitive modality in assessing soft tissues of the spine and spinal cord abnormalities. In our study, with the help of MRI, we could successfully characterize the spinal cord after trauma, identify spinal tumors based on extradural/intradural locations, and assess the integrity of spinal cord, intervertebral disks, and ligaments. Thus, in the end, we can conclude that in cases of RTA and other causes, which lead to compressive myelopathy, MRI is the definitive and accurate answer to the clinical question.

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