Section: Radio Diagnosis

Original Research Article

MAGNETIC RESONANCE IMAGING EVALUATION OF COMPRESSIVE MYELOPATHY

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ABSTRACT

Background: The objective is to evaluate the various causes of Compressive Myelopathy and to classify the spinal cord compressive lesions based on location into extradural/intradural compartments.

Materials and Methods: It is a single institutional prospective study in Govt. General hospital, Kurnool. The informed consent from the patients have been obtained. All patients with suspected compressive myelopahy were identified and included in the study.

Results: In our study, the most common cause for compressive myelopathy in our study was extradural compression from trauma (56%), followed by compression secondary to infective spondylitis (25%) and secondary neoplasms/metastasis (4%). Primary intradural tumors {both extramedullary as well as intramedullary tumors} are the most intradural causes of compressive myelopathy. In the case of spine injury, the common site of involvement was the thoracic spine, followed by the cervical spine. Primary neoplasms like neurofibroma and meningioma were more common than secondary neoplasms/metastasis in our study.

Conclusion: MR imaging depicts the spinal cord directly, assesses its contour and internal signal intensity characteristics reliably and noninvasively. We can evaluate associated cord edema or contusion and the integrity & early changes in intervertebral discs and ligaments. These can be crucial in the long term prognosis of the patient. This makes MRI an essential modality in assessing soft tissues of the spine and spinal cord.

Keywords: Compressive Myelopathy, extra dural, intradural, Mri, spinal tumours.

INTRODUCTION

Compressive myelopathy is a term used to describe spinal cord compression either from outside or within the cord itself. Spinal cord compression is commonly due to a herniated disc, post traumatic compression by fracture / displaced vertebra, epidural hemorrhage/abscess, or epidural/Intradural (Intramedullary and Extramedullary) neoplasm.

Spinal cord injury is the primary cause of quadriplegia and disability. Plain radiographs have low sensitivity for identifying traumatic spinal lesions. MR must be taken to evaluate the spine more definitively in patients with trauma with negative radiographic findings but with a high clinical suspicion of fracture or positive for spinal injury.

In spinal trauma, MRI demonstrates fractured/subluxated vertebral bodies relationship to the cord and highlights significant stenosis. MRI identifies the signal abnormalities within the cord, helping to localize and define the severity of trauma.

Spinal tumors are usually categorized as extradural, intradural extramedullary, or intramedullary tumours. Spinal tumors are usually categorized as extradural, intradural extramedullary, or intramedullary in location. This classification represents somewhat of overgeneralization for two reasons. First, a given lesion may be present simultaneously in two compartments. For example, in case of Neurofibroma it can be dumbbell-shaped and extend into the extradural and intradural extramedullary spaces. Second, in different cases, two lesions with identical

pathology may be seen in different compartments. For example, Neurofibroma may happen in any of the three compartments, including the intramedullary space. Nevertheless, this classification scheme is useful because it is traditional and helps to characterize spinal tumors. In extradural space, primary bone tumors can occur. For few exceptions, such as hemangioma, most of the primary bone tumors are unusual. Secondary tumors/metastases are more frequently in the extradural space. In the intradural extramedullary space, primary tumors, such as meningioma and neurofibroma, are more common. Secondary tumors or leptomeningeal metastases formerly were considered quite rare. However, this entity is now seen with increasing frequency.

Imaging Techniques: Philips 1.5 Tesla Mri machine is used. Standard surface coils and body coils were used for the cervical, thoracic, and lumbar spine. Pre-contrast scanning was done using T1W, T2W axial, STIR sagittal. Omniscan (gadodiamide) or magnevist (dimeglumine gadopentetate) were used as contrast agents in a dose of 0.1mmol /kg body weight in cases of neoplasms and infections. Post-contrast T1w sagittal, axial, and coronal images were obtained. STIR and gradient sequences were also routinely obtained.

Aims and Objectives of the Study

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

MATERIAL AND METHODS

Study Design: Prospective study.
Study Center: Department of Radio-Diagnosis and Imaging, Kurnool medical college, kurnool
Study Duration: Nov 2021 to Nov 2023(24-month)
Sample Size: 100

Inclusion Criteria

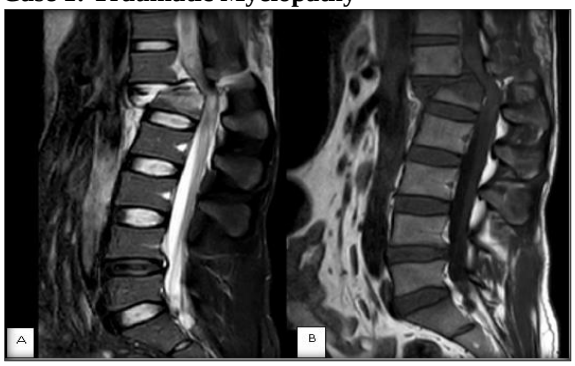
- All age groups
- Both sexes
- All cases of compressive myelopathy

Exclusion Criteria

- Cases of non – compressive myelopathy
- Degenerative disc herniation
- Contraindication for MRI.

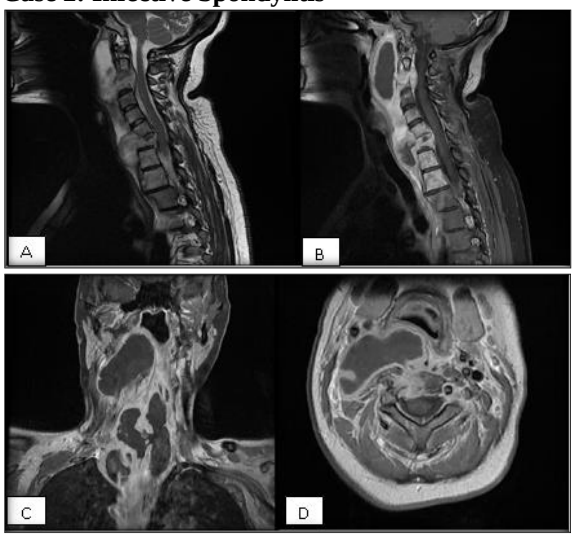
RESULTS

Case 1: Traumatic Myelopathy



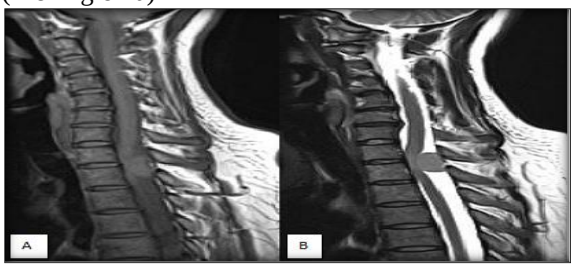
(A)Sagittal T1W, (B) Sagittal T2 Images show the evidence of fracture displacement of the L1 vertebral body posteriorly, causing spinal cord compression; there is also disruption of posterior longitudinal ligament and fracture of the posterior neural arch. There is also an increased T2 signal in the spinal cord

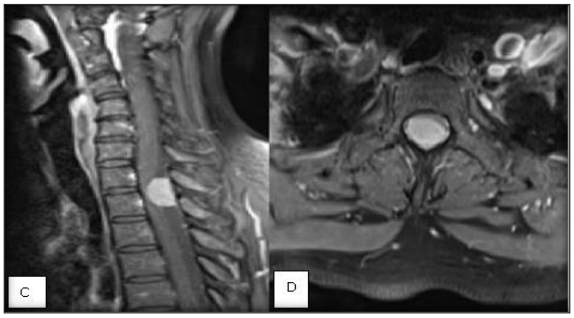
Case 2: Infective Spondylitis



(A) T2 Sagittal Images show the destruction of C2, C6, and C7 vertebral bodies with extensive marrow edema. (B)Sagittal contrast-enhanced T1 (C)Coronal contrast (D)Axial contrast images show multiple loculated smooth rim enhancing pre and paravertebral collections noted extending into the posterior mediastinum. There is a small epidural component at C2-3 & C6-7 level, causing compression over the spinal cord; no underlying cord edema changes were noted.

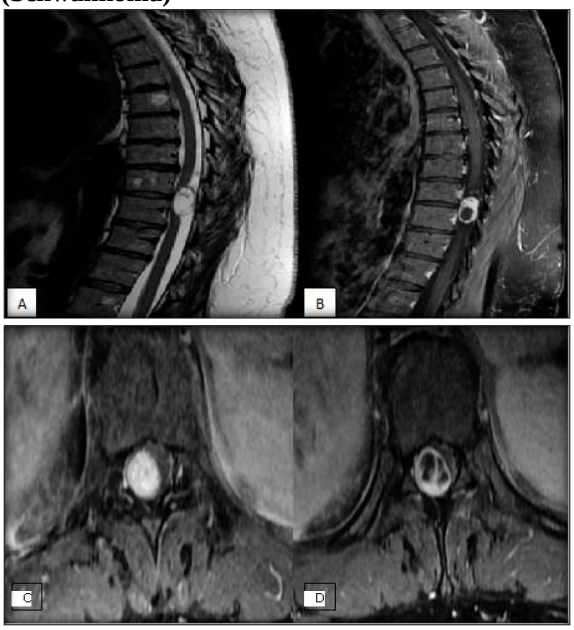
Case 3: Intradural Extramedullary Lesion (Meningioma)





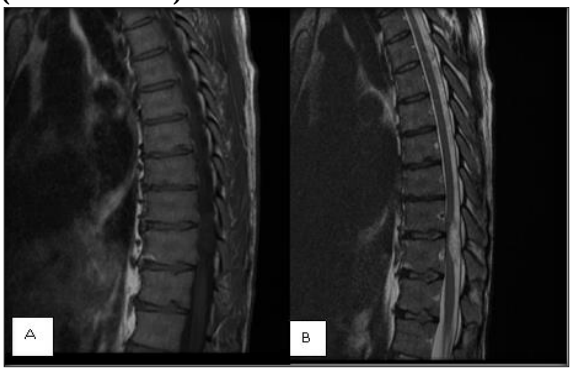
(A)(B) Sagittal T1 and T2 (C) Sagittal contrast (D)Axial Contrast shows a homogeneous enhancing well-circumscribed intra-dural, extramedullary mass with a broad dural base, dural tail, and in the vertebral canal at the level of C7-T1 is demonstrated, causing spinal cord compression.

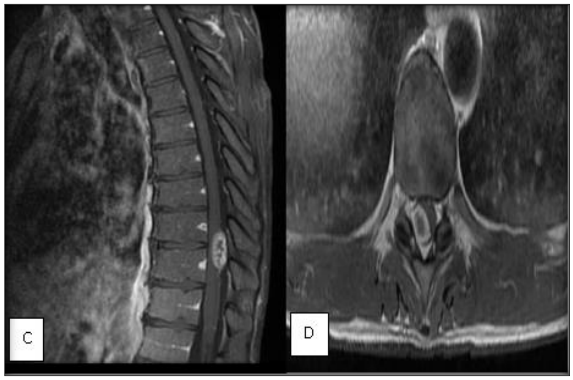
Case 4: Intradural Extramedullary Lesion (Schwannoma)



(A) Sagittal T2 showing A well-defined intradural extramedullary lesion heterogenous high T2 signal, (B) Sagittal and (C) (D) Axial section contrast study heterogeneously enhancing lesion noted at the lower dorsal spine level causing compression over the spinal cord.

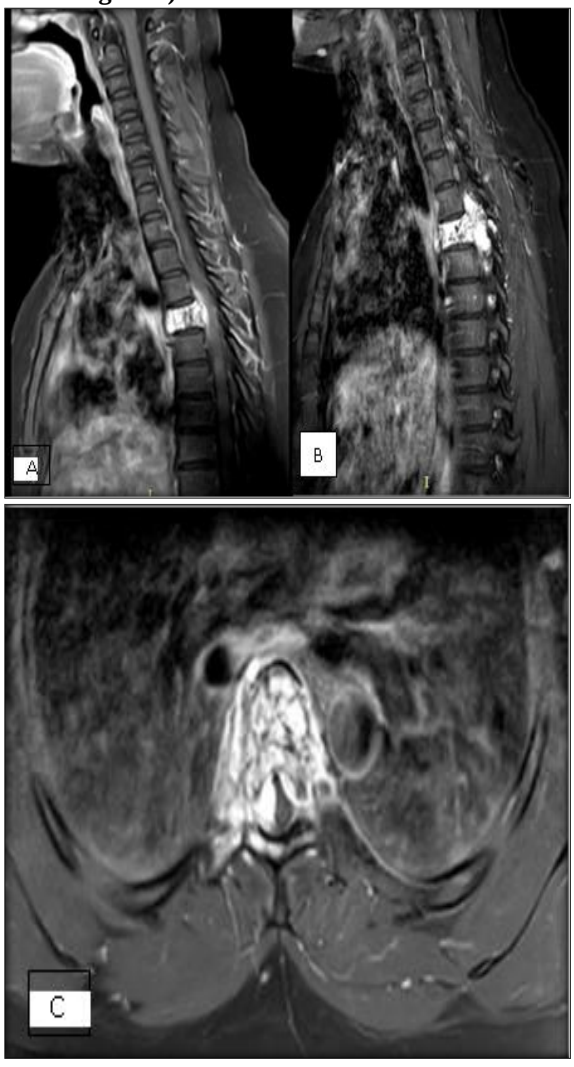
Case 5: Intradural Extramedullary Lesion (Neurofibroma)





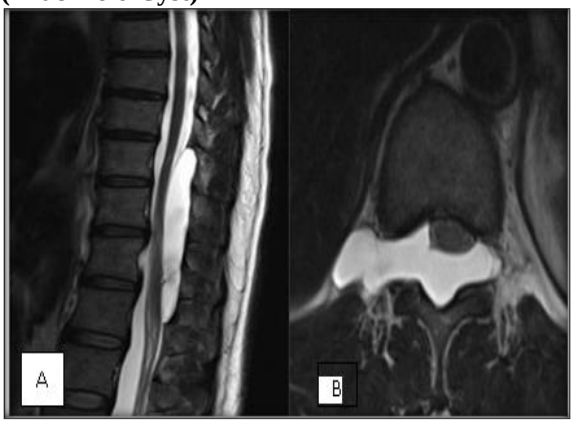
(A) Sagittal T1 (B) Sagittal T2 (C) Sagittal (D) Axial contrast study showing an oval intradural extramedullary mass causes displacement and severe compression of the cord, with subtle T2 hyperintensity in the adjacent cord. The mass shows T2 hyperintense and T1 hypointense, with vivid enhancement but an irregular central region of non- enhancement

Case 6: Extramedullary Lesion (Vertebral Haemangioma)



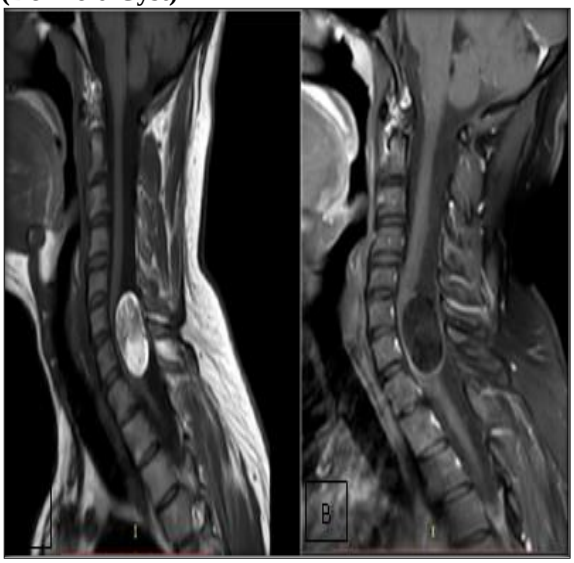
(A)(B) Sagittal (C)Axial STIR images study shows an expansile hyperintense lesion noted in the T5 vertebra with extension into the spinal canal, causing spinal canal stenosis and compression over the spinal cord.

Case 7: Intradural Extramedullary Lesion (Arachnoid Cyst)



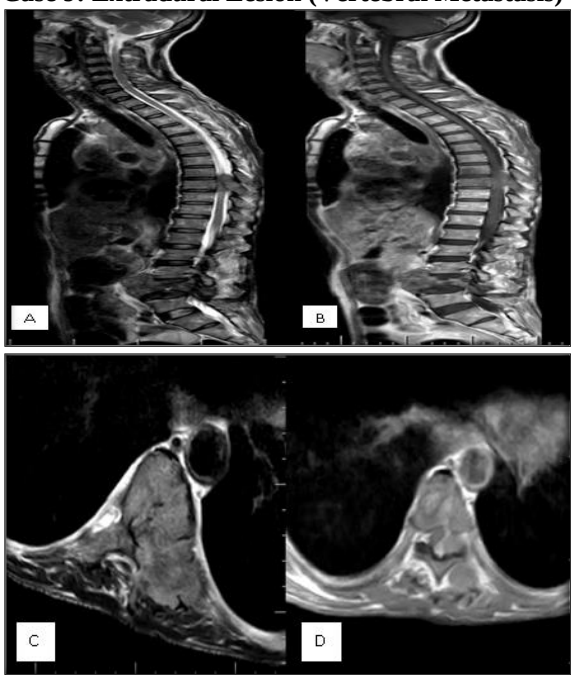
(A)Sagittal T2 (B) Axial T2 Images showing, Welldefined CSF signal intensity noted extradural compartment causing compression over the cord at the thoracic vertebra level with extension and widening of bilateral neural foramina.

Case 8: Intradural Extramedullary Lesion (Dermoid Cyst)



(A) Sagittal T1w image showing well defined ovoid T1 hyperintense lesion in the intradural extramedullary region at the cervical level, and (B)Sagittal T1 fat suppression contrast study shows no significant enhancement.

Case 9: Extradural Lesion (Vertebral Metastasis)



(A)Sagittal T2 and (B) T1 and (C) (D) Axial T2 images showing multiple expansile lesions noted in vertebrae in multiple levels involving both anterior and posterior elements. Large epidural soft tissue noted in D9-10 level, causing severe spinal canal stenosis and compression over the spinal cord.

Table 1: Age Distribution in Various Pathologies

Variables	MR diagnosis					P-value
	TraumatIc (n=56)	Infection (n=25)	Primary Neoplas m (n=12)	Metastases (n=4)	Misc(n=3)	
12-30 Years	8(14.2%)	8(32%)	0(0%)	0(0%)	0(0%)	0.001
31-50 Years	38(67%)	12(48%)	2(16.6%)	1(25%)	1(33.3%)	
>50 Years	10(17.8%)	5(20%)	10(83.4%)	3(75%)	2(66.7%)	

Table 2: Gender Distribution in Various Pathologies

Variables	Traumatic (n=56)	Infection (n=25)	Primary Neoplasm (n=12)	metastases (n=4)	Misc (n=3)	P-value
Male	44(78.5%)	9(36%)	9(75%)	3(75%)	3(100%)	0.003
Female	12(21.5%)	16(64%)	3(25%)	1(25%)	0(0%)	

Table 3: Causes of Compressive Myelopathy

MR diagnosis	Frequency N=100	Percentage
Traumatic Myelopathy	56	56(56%)
Infection/TB	25	25(25%)

Primary neoplasm	12	12(12%)
Secondary Neoplasm /Metastases	4	4(4%)
Miscellaneous	3	3(3%)

Table 4: Location of The Pathology

Compartment	FrequencyN=100	Percentage
Extradural	87	87(87%)
Intradural	13	13(13%)
Total	100	100(100%)

Table 5: Causes According to Various Compartment

Causes	Number ofpatients (n=100)	Extradural (n=87)	Intradural(n=13)
Spinal injury	56(56%)	56(64.4%)	0(0%)
Infective/TB	25(25%)	25(28.7%)	0(0%)
Primary neoplasms	12(12%)	0(0%)	12(92.3%)
Metastasis	4(4%)	4(4.6%)	0(0%)
Miscellaneous	3(3%)	2(2.3%)	1(7.7%)

Table 6: Level of Spinal Injury

Level of lesion	Frequency N=56	Percentage
C: Cervical	16	28.6%
T: Thoracic	26	46.4%
LT: Lower Thoracic	22	39.3%
UT: UpperThoracic	4	7.1%
TL: Thoraco – Lumbar	8	14.3%
L: Lumbar	6	10.7%

Table 7: Characterisation of Spinal Injuries by MRI

MRI Findings	Frequency N=56	Percentage
Stable fractures	26	46.4%
Unstable fractures	30	53.6%
Posterior elements fracture	28	50%
Ligamentous injury	28	50%
Cord changes	53	95%
Epidural hematoma/ soft tissue component	26	46.4%
Pre and paravertebral collection	18	32.1%

Table 8: Level of Involvement in Infective Spondylitis

Level of involvement	Frequency N=25	Percentage
Cervical	3	12%
Thoracic	15	60%
Lumbar	7	28%

Table 9: Findings and Characterization of Infective Spondylitis

Findings	Frequency N=25	Percentage
Vertebral body destruction	16	64%
Pre and paravertebral collection	16	64%
Epidural component	23	92%
Cord edema changes	8	32%

Table 10: Intradural Lesions

Intradural lesions	FrequencyN=25	Percentage
Neurofibroma	4	26.67%
Meningioma	3	20%
Schwannoma	2	13.33%
Myxopapillary ependymoma	3	20%
Dermoid cyst	1	6.67%
Vertebral haemangioma(aggressive)	1	6.67%
Arachnoid cyst	1	6.67%
Total	15	100%

Table 11: Location of The Intradural Neoplasms

Diagnosis	Cervical	Thoracic	Lumbar	Total
Meningioma	1	2	0	3
Neurofibroma	1	2	1	4
Schwannoma	0	2	0	2
Myxopapillaryependymoma	0	0	3	3
Vertebral Heamangioma (aggressive)	0	1	0	1
Dermoid cyst	1	0	0	1
Arachnoid cyst	0	1	0	1

Table 12: Site of Metastases

Levels of lesions in Secondary neoplasm/metastases	Frequency N=4	Percentage
Cervical	1	25.0%
Thoracic	2	50.0%
Upper	1	50.0%
Lower	1	50.0%
Thoraco-lumbar (T12-L1)	0	0.0%
Lumbar	1	25%

Table 13: Multiplicity of Lesions in Metastasis

Multiplicity	Frequency N=4	Percentage
Negative	1	25%
Positive	3	75%

Table 14: Summary of All the Causes of the Compressive Lesions

MR diagnosis	MRI	HPE	% correlation
Traumatic Myelopathy	56	-	-
Infection/TB	25	22	88%
Metastases	4	4	100%
Neurofibroma	4	3	75%
Meningioma	3	1	33.33%
Schwanoma	2	1	50%
Dermoid cyst	1	-	-
Arachnoid cyst	1	1	100%
Vertebral heamangioma	1	-	-

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, & degenerative disorders. 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 non – invasiveness.

In our study of 100 cases of compressive myelopathy, we found various causes for compression. Among these are trauma (56), infectious causes (25), primary neoplasms (12), and secondary neoplasm (04). Out of 100 cases of compressive myelopathy, we had 56 (56%) spinal trauma cases. Among 56 patients, the mode of injury was RTA (70%) and fall from height (30%).

In a study conducted by Kulkarni et al.1, the most common mode of injury to the spinal cord was a vehicular accident, and the least cause was the fall. A similar finding of the mode of injury is found in our study. The age of the patients in our study ranges from 12-70 years, a mean of 40 years. This is in comparison to the study conducted by Yamashita et al2. In our study, 68 were males, and 32 were females (M: F = 2.1: 1).

Location of Pathology

In our present study, extradural lesions are the most common cause of compressive myelopathy in 87 patients (87%), followed by intradural lesions in 13 patients. This is in agreement with the study by Aparna Dodia et al.[3]

Traumatic Myelopathy

In our study, the level of injuries among the 56 patients were thoracic (46.4%), cervical (28.6%), thoracolumbar (14.3%), and lumbar (10.7%). This is comparable to the study conducted by Kerslake et al.[4] The spinal cord abnormalities demonstrated by MR imaging were cord compression and abnormal signal intensities within the spinal cord. Spinal cord compression was observed in all the 56 cases of spinal injury. The causes of spinal cord compression included subluxation of the vertebral body in 48 patients and epidural hematoma in 8 patients. Abnormal signal intensities from the spinal cord were observed in 53 of 56 patients, and three patients had no cord changes.

Fifty-three patients showed hypointensity on T1WI and hyperintensity on T2WI, and STIR images suggest the cord edema/contusion. These signal changes are consistent with studies done previously by Hackney et al.[5]

The cord signal intensity has the prognostic implication where a patient with cord edema/contusion recovered only partially. This has also been shown by studies done by Hackney et al.[5] and Flanders et al.[6]

MRI depicted not only the spinal cord changes in our patients but also the relationship of subluxated / dislocated vertebral bodies to the cord (50 patients), posterior elements fracture (28 patients), ligamentous disruption (28 patient), soft tissues injuries (18 patients) and epidural hematomas (26 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.

Infective Spondylitis

In our study, 25 cases of infective spondylitis were associated with compressive myelopathy. Cord compression was noted in the thoracic region in fifteen patients, in the lumbar region in seven patients, and three patients in the cervical region.

The X-ray showed some abnormality in 16 cases. MRI showed vertebral body destruction with pre and paravertebral collection in 16 cases. Epidural component compressing the cord was seen in 23 cases: hypointense on T1WI, hyperintense on T2WI, and FLAIR images. Cord edema was associated with 8 cases.

A study by Roos Dea et al,[7] showed thoracolumbar junction as the most commonly affected site. In our study, the thoracic spine was the most common site of involvement. They showed rim enhancement around the intraosseous and paraspinal soft tissue abscess. In our observation, out of the 25 patients with infective spondylitis, 18 patients were diagnosed with TB spondylitis due to multilevel involvement, skip lesions, extensive paraspinal collection with thin peripheral rim enhancement. Those patients with single vertebral body involvement and irregular thick peripheral enhancement were diagnosed with pyogenic spondylodiscitis cases (7 patients).

Neoplasms

Intradural Neoplasms

We had 12 cases of primary intradural neoplasms, among which nine were extramedullary, and three were intramedullary. 4 were Neurofibromas, 3 were meningiomas, 3 were Myxopapillary ependymomas (intramedullary), and 2 were schwannoma. All 12 cases showed spinal cord compression.

Intradural extramedullary neoplasms

Of the 9 Intradural extramedullary neoplasms, 4 were neurofibromas. They were iso- to- hypointense on T1WI and hyperintense on T2WI and showed intense enhancement on post-contrast. One case showed an extension into the neural foramina. On HPE correlation, three were proved as neurofibromas, and one case was diagnosed as schwannoma.

Studies were done by Dorsi et al,[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 nine intradural extramedullary neoplasms, 3 were meningiomas. On HPE, only one among three patients was diagnosed as meningioma, and the remaining two were diagnosed as neurofibroma and schwannoma. These showed isointense on T1 & T2WI and showed moderate homogeneous enhancement on post-contrast. A dural tail was noted in one patient.

Several studies by Matsumoto et al9, and Souweidane et al,[10] showed signal characteristics of meningioma as isointense to the cord on T1, T2WI with intense homogenous enhancement on post-contrast. We had two cases of schwannoma, one case was confirmed on HPE, and the other one was diagnosed as Neurofibroma.

Three cases of myxopapillary ependymoma were located exclusively in the conus medullaris and cauda equina region. HPE correlation was not done in these cases. They represent 13% of all spinal ependymomas and are the most common tumors of the cauda equina region.

The lesion was intramedullary on MRI imaging. Expansile and isointense on T1, slightly hyperintense signal on T2, and avid enhancement in the post-contrast study. This agrees with the study by Andoh H et al,[11] demonstrating myxopapillary ependymomas, an intramedullary tumor expanding the cauda equina.

Miscellaneous Lesions Causing Compressive Myelopathy

Aggressive vertebral haemangioma: We had one case of vertebral haemangioma compressing the spinal cord who presented with sudden onset of weakness in both lower limbs. On MRI, the lesion was T1 hypointense, T2 hyperintense lesion noted in thoracic vertebra extending posteriorly and causing compression over the spinal cord.

We had one case of a dermoid cyst. In our study, Magnetic resonance imaging of the spine revealed a well-defined intradural extramedullary mass lesion showing fat signal noted at C6 to C7 level, causing compression over the spinal cord.

Arachnoid cyst:

We reported one case of a spinal intradural arachnoid cyst, causing compressive myelopathy in the thoracic level

Secondary neoplasm/ metastasis: In our study of 100 cases, 4 (4%) are the spine's metastatic disease as a cause of compressive myelopathy. Out of 4 patients, 3 (60%) showed more than one lesion. In our study, the commonest site of involvement was the thoracic spine (80%).

Limitations of The Study

1. The results cannot be generalized to thewhole population of compressive myelopathy.

2. Surgical correlation and histopathological correlation for all cases could not be done.

CONCLUSION

MR imaging depicts the spinal cord directly, assesses its contour and internal signal intensity characteristics reliably and noninvasively. We can evaluate associated cord edema or contusion and the integrity & early changes in intervertebral discs and ligaments. These can be crucial in the long term prognosis of the patient. It makes MRI an essential modality in assessing soft tissues of the spine and spinal cord abnormalities. MRI is a very sensitive imaging modality to detect, characterize, determine the extent of various Spinal tumors and infections. The final diagnosis still relies on biopsy and histopathological examination.

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