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MRI as an imaging modality in evaluation of spinal pathologies causing Compressive Myelopathy

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ABSTRACT: Quadriplegia and impairment are most commonly caused by spinal cord compression. Many spinal cord illnesses can be reversed if detected and treated early on, making them one of the most serious neurologic crises. MRI is used to differentiate between compressive and non-compressive causes of myelopathy. The goals of this study are to reliably locate a spinal tumour as Extradural / Intradural location, also to evaluate the spinal cord, intervertebral discs and ligament integrity following acute spinal trauma. MRI was performed on patients with a probable clinical history of compressive myelopathy in VMKV medical college, Salem. Purposive sampling was used to choose the patients for the study and descriptive analysis was used to evaluate the data. Spinal trauma (43.3 %) and spinal infection / TB (23.3 %) were the most common causes of spinal cord compression. Extradural compressive lesions accounted for 25 of the 30 cases, while Intradural – Extramedullary lesions accounted for 5. There were 13 cases of spinal damage, 7 cases of infective spondylitis with epidural component, one epidural abscess, and 5 metastases among the twenty-five extradural compressive pathology. 4 out of 5 intradural tumours were appropriately detected. So, MRI is the gold standard for evaluating soft tissue injuries in the spine, including spinal cord edema/contusion, intervertebral discs, and ligaments. Although MRI is most sensitive tool for detecting, characterising, and grading spinal infections, biopsy and culture are still required for a definitive diagnosis. So, at the conclusion, I can say that MRI is non-invasive, radiation free which is highly definitive, sensitive, and accurate modality for evaluating compressive myelopathy.

Keywords: Spine, compressive myelopathy, spinal trauma, extradural compression, intradural neoplasms, MRI.

INTRODUCTION

The phrase compressive myelopathy refers to spinal cord getting compressed mostly by two causes, those are either problem within the cord or from outside compression of the cord. Most common causes can be traumatic fracture either by dislocation, retroplusion or just fracture of the involved vertebrae, disc bulges and herniation / sequestrations, spinal tumors involving the both medullary region or epidural area, paravertebral abscess and hemorrhage involving the epidural space (Sabhikhi *et al.*, 2021).

Quadriplegia and impairment are most commonly caused by spinal cord injuries. When it comes to diagnosing traumatic spinal lesions, plain radiographs have a limited sensitivity. As a result, trauma victims who have plain films that are negative for spine injury but have a high clinical suspicion of injury or are positive for spinal injury should have their spine evaluated with magnetic resonance imaging (MRI). MRI is the gold standard for evaluating the difference between the hemorrhage and abscess involving at the common overlapping regions which is important in the management of the cause and also helps in involvement of IV discs (intervertebral discs), finding the subtle soft tissue injuries around the spine, particularly which involving the spinal cord, and the injury to the ligaments at the spinal levels (Ashoka *et al.*, 2003).

Extradural, intradural extramedullary, and intramedullary are the most common classifications for spinal tumours. For two reasons, this classification is a bit of an oversimplification. For starters, a single lesion might exist in two compartments at the same time. A neurofibroma, for example, could be dumb bell-shaped and extend into both the extradural and intradural extramedullary regions in some cases. Second, two lesions with identical pathophysiology may arise in different compartments in different instances. Neurofibroma, for instance, can develop in any of the three compartments, including the intramedullary region. Nonetheless, because it is traditional and aids in the classification of spinal tumours, this classification scheme is valuable (Sze and Twohig 1991).

The purpose of an MRI is to differentiate between compressive and non-compressive myelopathy. The primary causes of spinal etiologies causing no compression to cord are inflammatory, neurovascular causes and the viral etiology goes under intrinsic causes after once the causes of compression have been ruled out (Vyas *et al.,* 2017).

Objectives of the study

1. To differentiate various types of compressive myelopathy.
2. MR characterization of compressive lesions in the spinal cord.
3. To distinguish the lesions into extradural and intradural compartments based on their location.

MATERIAL AND METHODS

Data collection: For a 15-month period, descriptive study was conducted on 30 patients who were sent to the Department of Radiodiagnosis, Vinyaka missions kirupananda variyar (VMKV) medical college for an MRI scan.

Case selection: MRI was used to assess patients who are clinically suspected of having compressive myelopathy. A total of 30 patients were included in the study group, chosen using a purposive sampling method. A descriptive analysis was used to examine the data.

The patient's complete clinical history was collected, with special attention paid to the patient's motor and sensory problems and procedure was briefly explained to the patient and the consent was taken.

Inclusion criteria: All age groups, Both sexes, All cases of compressive myelopathy.

Exclusion criteria: Cases of non – compressive myelopathy, degenerative disc herniation, patients allergic to gadolinium IV contrast and claustrophobic patients.

Equipment: SEIMENS 1.5 TESLA MRI Superconducting magnet. Standard surface coils and body coils, were used for cervical, thoracic and Lumbar spine for acquisition of images.

Sequences: Precontrast scanning was done using T_1WI, T_2Wl, FLAIR sagittal, STIR sagittal, T_1WI, T_2WI axial with slice thickness 4.5mm x 5mm. In case of neoplasms, post contrast sagittal, axial and coronal T1W images were obtained. FLAIR and STIR MRI sequences were collected on a regular basis.

A. Data analysis

STATA version 12 was used for analysing this descriptive statistical data. Results of continuous measurements are presented on mean +/- standard deviation (min –max) and results on categorical measurements are presented in number (%). Significance is assessed at 5% level of significance.

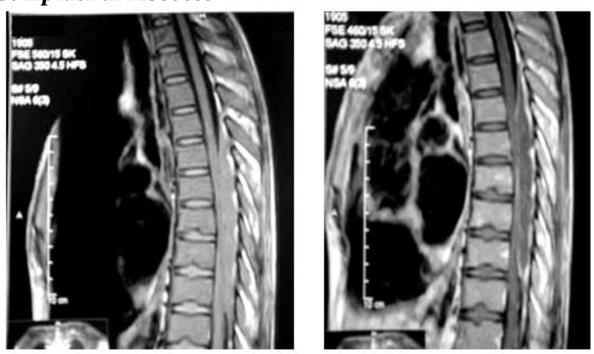
Continuous numerical data was presented using descriptive statistics (mean [SD] and median [range] in tables. Distribution of categories for patient characteristics and MRI findings was presented as frequency distributions including number with characteristic and corresponding percentage. These distributions were presented in form of graphs, pie charts and frequency tables.

B. Observations noted

1. Sclerotic metastases – prostatic carcinoma

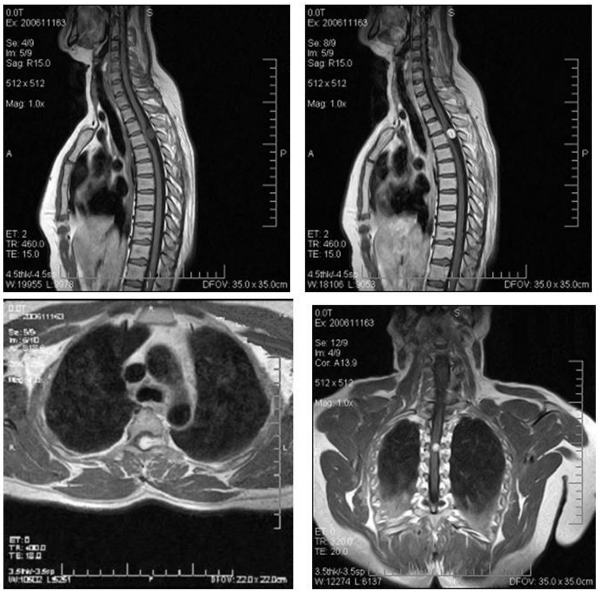
2. Traumatic myelopathy

3. Epidural Abscess

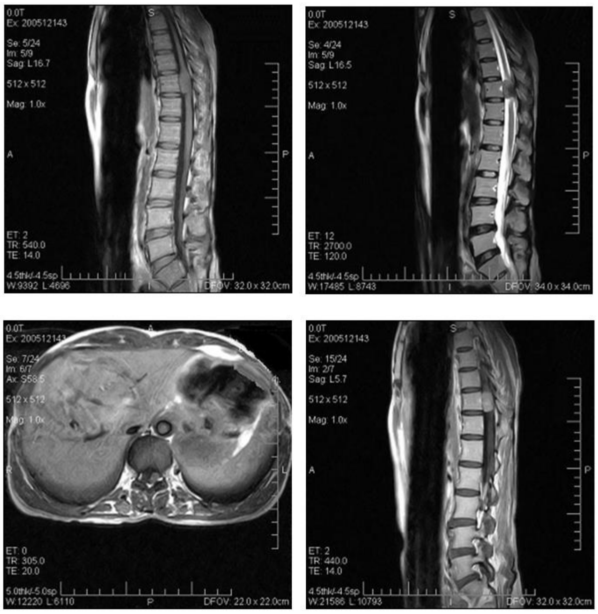


4. Tuberculosis of spine with cold abscess

5. Neurofibroma extending into neural foramen



6. Meningioma



RESULTS AND DISCUSSION

In our analysis, spinal trauma (43.3%) and spinal infection (23.3%) were the two most frequent causes of compressive myelopathy.

The majority of cases of compressive myelopathy are caused by extradural compressive lesions (83.3%).

While spinal infections or TB (tuberculosis) (57.1%), primary neoplasms (60%) and secondaries / metastasis (60%) are mostly seen in females, males are more likely to suffer from spinal injury (84.6%) than females.

The majority of primary neoplasms involve the intradural compartment, whereas the majority of spinal injuries, infections, and secondary tumours involve mostly extradural compartment.

Thoracic, then cervical, are the most often injured regions of the spine in case of trauma.

Prognostic value exists for pattern of signal intensity variations. When compared to cord bleeding, which has a protracted course, cases connected with edema or contusion have a better result.

In addition to showing changes in the spinal cord, MRI also shows how subluxed or dislocated vertebral bodies relate to the cord, as well as posterior elements fractures, disruption of ligaments, and soft tissue injuries that can all have an impact on prognosis and be classified as stable or unstable injuries.

Thoracic region spine is the mostly involved site for spinal metastases.

A key indicator of a metastatic disease is the multiplicity of the lesions.

In the intradural compartment, primary tumours are more frequent (100%) than metastases.

While neuro fibromas are mostly seen in the thoracic and the cervical regions, meningiomas are more common in the thoracic region.

The data given in Graphs 1 and 2 revealed:

Graph 1: the most common cause of extradural compression is trauma and infection, where as primary tumors were more common in intradural compartment.

Graph 2: prognostic value exits for pattern of signal intensity variation. When compared to cord haemorrhage with has poor outcome, patients with edema and contusion has better results.

As per the data given in Table 1 to 3 revealed:

Table 1: Young adults and middle-aged people (20 – 40 yrs age group) make up the majority of spinal injury patients (38.5%) & primary neoplasm patients (60%). While the majority of those who suffer from spinal infections (42.9%) and secondary neoplasms (80%) are older people (>50 years).

Table 2: The most frequent causes of extradural compression in our investigation were spinal traumas and infections, whereas primary neoplasms were more prevalent in the intradural compartment.

Table 3: The detection of extradural lesions like metastases, epidural abscesses, and infective spondylitis with epidural soft tissue component is made possible by the high sensitivity and specificity of MRI. Additionally also sensitive to identifying the intra-dural primary tumors, however occasionally it might be challenging to distinguish between meningioma and neurofibroma.

For trauma, neoplastic, congenital, and degenerative disorders, MRI's ability to display the spine and spinal cord with greater sensitivity and specificity than myelography and CT is well established. The only technique that allows direct visualisation of the spinal cord is magnetic resonance imaging (MRI). Because of its variable application to portray cross-sectional anatomy in many planes and to equire soft tissue components, its non-invasiveness nature and without ionising radiation unlike CT, MRI has become the modality of choice for imaging spine and spinal cord diseases.

We discovered a variety of compression reasons in our research of 30 cases of compressive myelopathy. Traumatic myelopathy (13 cases), infectious cases (7 cases), primary tumors / neoplasms (5 cases), and secondary tumors / neoplasms (5 cases) are among them. The most prevalent mechanism of spinal cord injury is a car accident, while the least common cause is a fall. But in our study we had 13 cases (43.3 percent) occurrences of spinal trauma are noted out of 30 cases of compressive myelopathy. RTA cases (70%) and fall from height cases (30%) were the most common modes of injury among the 13 patients (Kulkarni *et al.*, 1987*)*.

In our research, we discovered a similar finding for the mode or manner of injury to spinal cord. The age of the patients in our study ranged from 12 years to 70 years of age, with a mean age of 42 years and reveals 11 males and 2 females (M: F = 11:2) (Yamashita *et al.,* 1991). Thoracic (53.8%), cervical (46%), and lumbar (15.4%) injuries were the most common among the 13 patients in our study (Kerslake *et al.,* 1991).

Cord compression and aberrant signal intensities within the spinal cord were the pathologies revealed by MR imaging. All 13 cases of spinal damage had spinal cord compression due to different reasons. The common causes seen were subluxation of the vertebral body seen in about 7 cases and epidural haemorrhage seen in about 6 cases.

12 cases out of the 13 patients, abnormal cord signal intensities were noted, while one patient had no abnormal cord signal intensities. T1 weighted images revealed hypointense signal, T2WI showed hyperintense signal, whereas FLAIR images revealed marked hyperintensity, indicating cord edema or contusion in 12 cases (Hackney *et al.,* 1986).

When patients with cord edema (8 patients) recovered totally or partially, the cord signal intensity has a predictive significance is been supported by 2 theories (Hackney *et al.,* 1986; Flanders 1997).

Five of the seven patients with cervical injuries died while they were in the hospital. This could be due to the intensity of the cord compression and the chord alterations involving multiple segments.

The association of subluxation of vertebare / displacement of the vertebral bodies to the cord is seen in among 12 patients, posterior elements fracture seen in 7 patients, ligamentous (ALL and PLL) disruption seen in 7 patients, soft tissue injuries seen in 6 patients, and epidural hematomas seen in 6 patients, were all clearly seen on MRI along with spinal cord signal changes. Studies done by (Yamashita *et al.,* 1991; Kulkarni *et al.,* 1987) also showed demonstration of all these changes by MRI.

Out of 30 patients studied, 5 cases (~16.7 %) of compressive myelopathy showed etiology of metastatic spine disease. 90% of patients had extradural masses that extended from an abnormal part of a vertebra (Lien *et al.,* 1990), we also got similar results in all the five individuals, intraspinal extradural tumours caused spinal cord compression. 3 of the 5 patients (60 %) had multiple lesions.

In contrast to our study (Lien *et al.,* 1990) found that 78 % of the patients had multiple lesions, including vertebral metastases in addition to those compressing the cord.

The thoracic spine was the most common site of involvement in our study (80 %). 68 percent of epidural tumours were found in the thoracic spine. Lung carcinoma (15%), breast carcinoma (14%), and lymphoma (11 %) were the three most prevalent original malignancies with metastases to the spine and extradural region (Livingston and Perrin 1978). We had 1 patient each with primary carcinoma bronchus, breast carcinoma, lymphoma, carcinoma prostate, and 1 unknown primary in our study. To scan spinal metastases STIR images are more effective than T1 weighted images, we also used the T1WI, T2W sequences, as well as post contrast images.

IV Gd-DTPA was administered, mild homogeneous enhancement to heterogeneous enhancement was seen in three of the five patients. On observation post-contrast images MRI showed high sensitivity in intradural lesions / tumors and showed less sensitive in the diagnosis of extradural metastases in spine.

There were five cases of primary intradural extramedullary neoplasms, two of which were neurofibroma and three of which were meningioma. The spinal cord was compressed in each of the five cases. MR identified two of the three instances of neurofibromas as neurofibromas. In one case, MR was unable to distinguish between meningioma and neurofibroma.

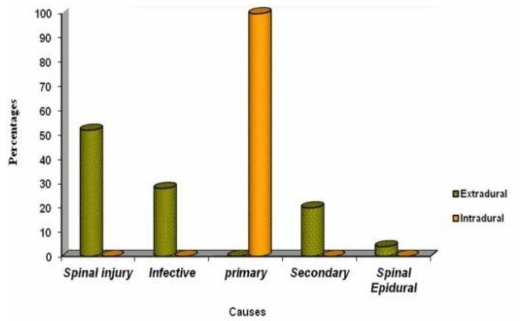
On T1WI, neurofibromas were iso- to hypointense, and on T2WI, they were hyperintense, with post-contrast enhancement. In one case, the tumour had grown into the neural foramina. Hyperintense lesions with central necrosis noted in T2 weighted images and T1 weighted images showed iso to hypointense signals, according to studies by some authors (Dorsi and Belzberg 2004; Matsumoto *et al.,* 1993). Neurofibromas revealed a substantial and diverse enhancement. Meningioma was found in three of the five intradural extramedullary neoplasms. Meningioma / neurofibroma was indicated as a differential diagnosis on MRI. On T1 and T2WI, it showed iso intensity, and on post contrast, it showed modest homogenous enhancement. In several studies done by (Matsumoto *et al.,* 1993; Souweidane and Benjamin 1994; Gezen *et al.,* 2000) found that the signal characteristic of meningioma showed intensely homogeneous enhancing lesion on post contrast images. On T1 and T2WI showed iso intense signal to the cord.

Seven patients with of infective spondylitis were also linked to compressive myelopathy in our investigation. Six of the cases occurred in the thoracic region, while one occurred in the lumbar region. In five of the cases, an X-ray revealed some abnormalities. In two cases, MRI revealed vertebral body disintegration with pre and paravertebral collection. All 7 patients had an epidural soft tissue mass / component causing compression over the cord, which was hypointense on T1weighted images but showed hyperintense signal on T2 weighted images and FLAIR imaging. Cord edoema was found in two of the cases. The most common affected site, as in our patients, was the thoraco-lumbar junction (Roos *et al.*, 1986). Rim enhancement was seen surrounding the intra-osseous and paraspinal soft tissue abscess. Contrast studies were not performed in our observations, for a number of reasons. Though a presumptive diagnosis of tuberculosis was made, a contrast study should have been performed to improve the MRI's specificity.

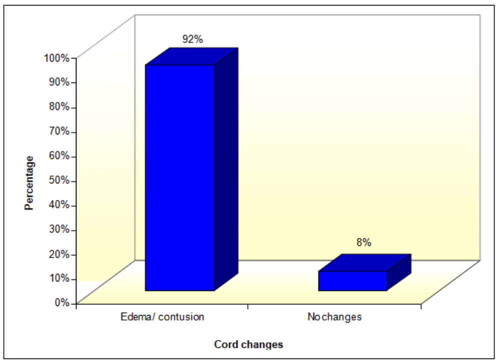
One patient came with a sudden onset of paralysis in both lower limbs due to an epidural abscess compressing the spinal cord. Extradural soft tissue posterior to the cord was seen on MRI seen from D4 to D9 vertebral level, causing compression over the corresponding segment of spinal cord. Lesion showed isointensity on T1WI and hypointense signal on T2WI with minimal peripheral enhancement on post contrast images. The thoracic spine is the most commonly involved area with abscess signal intensities (Numaguchi *et al.*, 1993) which is comparable to our study.

As an uncommon cause of compressive myelopathy, we had one instance of persistent hypertrophic pachymeningitis. The X-ray was normal, and the MRI revealed diffuse irregular, thickened leptomeninges from C7 to T5 that were isointense to the cord on T1WI but hypointense on T2WI and FLAIR. After the contrast, there was a uniformly intense enhancement.

Several authors have reported on the disease's unenhanced MR findings. On T1 and T2 WI, they observed mild to substantial hypointensity, particularly on T2WI. A pattern of significant enhancement of the lesion was reported (Friedman *et al.*, 1992), which is similar to the scenario in our study.



Graph 1: Causes according to various compartments.



Graph 2: Cord changes in spinal injuries.

Table 1: Gender, age & compartmental distribution in different causes.

Variables		MR diagnosis			P value
	Traumatic (n=13)	Infection (n=7)	Primary Neoplasm (n=5)	Secondary /Neoplasm metastases (n=5)	
Age in years					
12-30	4(30.8%)	2(28.6%)	0(0%)	0(0%)	
31-50	5(38.5%)	2(28.6%)	3(60%)	1(20%)	
>50	4(30.8%)	3(42.9%)	2(40%)	4(80%)	0.462
Gender					
Male	11(84.6%)	3(42.9%)	2(40%)	2(40%)	
Female	2(15.4%)	4(57.1%)	3(60%)	3(60%)	0.110
Compartment					
Extradural	13(100%)	7(100%)	0(0%)	5(100%)	<0.001**
Intradural	0(0%)	0(0%)	5(100%)	0(0%)	

Table 2: Causes due to different areas of involvement.

Causes	Number of patients (n=30)	Extradural (n=25)	Intradural – Extramedullary (n=5)
Spinal injury	13(43.3%)	13(52.0%)	0
Infective/TB	7(23.3%)	7(28.0%)	0
Primary neoplasms	5(16.7%)	0(0%)	5(100.0%)
Secondary neoplasms/ metastasis	5(16.7%)	5(20.0%)	0
Spinal Epidural Abscess	1(3.3%)	1(4%)	0(0%)

Table 3: Summary of all the causes of the compressive myelopathy.

MR diagnosis	MR	HPE	% correlation
Myelopathy (Traumatic)	13	-	-
Infection/TB	7	6	85.7
Metastases	5	5	100.0
Neurofibroma	3	1	33.3
Meningioma	2	1	50.0

CONCLUSIONS

MRI is the gold standard for detecting abnormalities in the soft tissues of the spine and the spinal cord with good anatomical delineation. It is the most effective and the most sensitive method for determining cord edema in initial compression stages and cord contusions, also good to visualize the intervertebral discs, neural foramen and ligaments (mainly ALL & PLL) integrity. MRI is a highly sensitive imaging technique that is often used to detect and characterise spinal lesions and also infections. Biopsy and histological investigation are still used to make the final diagnosis. MRI is the only imaging technique that can directly view the spinal cord without any invasive procedure.

In my research, we were able to classify the spinal masses / tumors depending on anatomical location into extradural or intradural compartment and analyse the full length of spinal cord at all the levels, IV discs and disc spaces, also the integrity of ligaments following acute spinal trauma using MRI. So, at the conclusion, I can say that MRI is a highly precise, sensitive, accurate and non-invasive modality for evaluating compressive myelopathy without using radiation.

FUTURE SCOPE

MRI as used in the present study could aid in diagnosing and delineating the spinal lesions more accurately according to the location it is involving and aid in prompt management and intervention.

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Conflict of interest. None.

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