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Original Research Article

Role of MRI in Evaluation of Compressive Myelopathy

Ankur Kumar Phukan[1]*, Bijit Kumar Duara[2], Siddhartha Sarma Biswas[3], Chittaranjan Sarma[4]

[1]Department of Radiology, Tinsukia Medical College & Hospital, Tinsukia, Assam,

[2] Department of Radiology Gauhati Medical College & Hospital, Guwahati, Assam.

[3] Department of Radiology Assam Medical College & Hospital, Dibrugarh, Assam.

[4] Department of Radiology Nalbari Medical College & Hospital, Nalbari, Assam.

*Correspondence : Dr. Ankur Kumar Phukan (ankurphukan1987@gmail.com)

ABSTRACT

Background: Compressive myelopathy is a critical condition that can result from various etiologies, including trauma, infection, neoplasms, and degenerative changes. MRI is considered the gold standard for assessing spinal cord compression, owing to its excellent soft tissue contrast and ability to produce multiplanar images.
Objective: This study aims to evaluate the role of MRI in diagnosing and characterizing compressive myelopathy, with a focus on differentiating between extradural and intradural lesions.

Methods: A cross-sectional study was conducted on 50 patients with suspected compressive myelopathy referred to the Department of Radiodiagnosis, Gauhati Medical College & Hospital, Guwahati, Assam. MRI scans were performed using a 1.5 Tesla Siemens Avanto machine. The lesions were categorized based on location (extradural vs. intradural) and etiology (trauma, infection, neoplasms, etc.).

Results: The most common causes of compressive myelopathy was found to be infections (30%) and trauma (40%). Extradural lesions accounted for 84% of cases, while intradural lesions were less common (16%). MRI accurately identified cord compression, vertebral body destruction, and epidural soft tissue components in all cases. Trauma patients showed cord edema/contusion in 100% of cases, while infection cases demonstrated vertebral body destruction and pre/paravertebral collections in all cases. Neoplasms were predominantly intradural, with neurofibromas and meningiomas being the most common.

Conclusion: MRI is an indispensable tool for the evaluation of compressive myelopathy, providing detailed information on the location, extent, and nature of spinal cord compression.

Keywords: Compressive myelopathy, MRI, spinal cord compression, extradural, intradural, trauma, infection, neoplasms.

INTRODUCTION

Compressive myelopathy refers to spinal cord compression caused by external or internal factors, leading to damage or dysfunction of the spinal cord, meninges, or perimeningeal spaces. Causes include degenerative changes (e.g., disc herniation, osteophytes), trauma (e.g., fractures, epidural hemorrhage), infections (e.g., abscesses), neoplasms (extradural/intradural), vascular malformations, or craniovertebral junction abnormalities[1]. Plain radiographs are insensitive for detecting spinal trauma, making MRI the gold standard for evaluating spinal soft tissue injuries, cord lesions, and occult trauma. MRI delineates the relationship between fractured/subluxated vertebrae and the cord, identifies signal abnormalities, and assesses stenosis[2]. Spinal tumors are classified as extradural, intradural extramedullary, or intramedullary based on their anatomical location [3,4,5]. While this classification is useful, lesions like neurofibromas can span multiple compartments, and identical pathologies may occur in different locations[6]. Intradural extramedullary tumors, such as meningiomas and neurofibromas, are common, while leptomeningeal metastases are increasingly recognized due to improved diagnostic techniques and longer patient survival[7]. Early diagnosis of spinal cord diseases is critical, as many are reversible. MRI plays a pivotal role in distinguishing compressive from non-compressive myelopathy, with non-compressive causes including vascular, inflammatory, and infectious etiologies[8]. MRI is also the preferred modality for evaluating spinal tumors, offering unparalleled detail in assessing tumor involvement of the spinal column, canal, and cord[9].

MATERIAL AND METHODS

This cross-sectional study was conducted over 12 months (September 2016 to August 2017) at the Department of Radiodiagnosis, Gauhati Medical College & Hospital. Ethical clearance was obtained from the institutional review board. Using purposive sampling, a total of 50 patients exhibiting clinical signs of compressive myelopathy with detailed motor and sensory symptom histories were enrolled. MRI scans were conducted using a 1.5 Tesla Siemens Avanto machine. Standard sequences included T1-weighted, T2-weighted, STIR, and post-contrast images. Lesions were categorized based on location (extradural vs. intradural) and etiology (trauma, infection, neoplasms, etc.). Statistical analysis was performed using SPSS 17.

RESULTS

Age and Gender Distribution: The majority of patients were aged 31-50 years (56%), with a male predominance (62%).

Etiology: Trauma was the most common cause (40%), followed by infection (30%), primary neoplasms (14%), and metastases (10%).

Location: Extradural lesions were more common (84%) than intradural lesions (16%).

Trauma: All trauma patients showed cord compression, with 75% having ligamentous injuries and 45% having epidural hematomas.

Infection: All infection cases showed vertebral body destruction and pre/paravertebral collections, with 86.6% having epidural soft tissue components.

Neoplasms: Primary neoplasms were predominantly intradural, with neurofibromas and meningiomas being the most common. Metastases were all extradural, with 100% showing multiple lesions.

Other Causes: Rare causes included ossified posterior longitudinal ligament (2%), arachnoid cyst (2%), and spinal tuberculoma (2%)

Table 1: Age wise distribution of different patients

Age in years	Total number of patients (N=50)
12-30 yrs	8(16%)
31-50 yrs	28(56%)
>50 yrs	14(28%)

Maximum number of cases in our study comes under the age group of 31-50 yrs**.**

Table 2: Locations of the pathologies:

Compartment	Number of patients	%
Extradural	42	84
Intradural extramedullary	8	16
Total	50	100

DISCUSSION

In this study of 50 cases of compressive myelopathy, trauma (43.3%) and infection (30%) were the most common causes, followed by tumors (24%), spinal tuberculoma (2%), arachnoid cysts (2%) and ossified posterior longitudinal ligament (OPLL) (2%). MRI was the primary diagnostic tool, providing detailed insights into the etiology, location, and severity of spinal cord compression.

Trauma (20 cases)

Most injuries resulted from road traffic accidents (80%) and falls (20%). Similar findings were found by studies conducted by Kulkarni et al[10] and Stien et al[11]. In our study, thoracic spine injuries predominated (55%), with cervical (30%) and lumbar (15%) injuries being less common. This distribution is consistent with the results of Kerslake et al[12], who similarly identified the thoracic spine as the most vulnerable to trauma. In all patients, MRI revealed spinal cord compression, appearing hypointense on T1WI and hyperintense on T2WI/STIR, suggestive of edema/contusion. Prognosis was more favorable for edema than hemorrhage, with signal intensity serving as a prognostic marker—patients with edema often achieved complete or partial recovery, consistent with prior studies by Hackney et al[13] and Flanders et al[14].

Infectious Causes (15 cases)

Thoracic spine involvement was predominant (46.6%), with vertebral body destruction in 100 % and epidural abscesses in 86.6% of all cases. The epidural component causing cord compression appeared hypointense on T1-weighted imaging (T1WI) and heterogeneously hyperintense on T2WI and STIR sequences. These imaging findings align with the study by Galhotra et al[15], which reported spondylodiscitis with epidural extension in 86% of cases and vertebral body destruction in 71.8%. Additionally, our observations corroborate the findings of Roos et al[16] and Moorthy et al[17], who identified the thoracolumbar junction as the most frequently affected site—a pattern consistent with our study results. In our study, 10 cases (66.6%) demonstrated spinal cord changes, aligning with Jain, A.K. et al[18] regarding description of these changes potentially indicating cord edema, myelomalacia, atrophy, or syringomyelia.

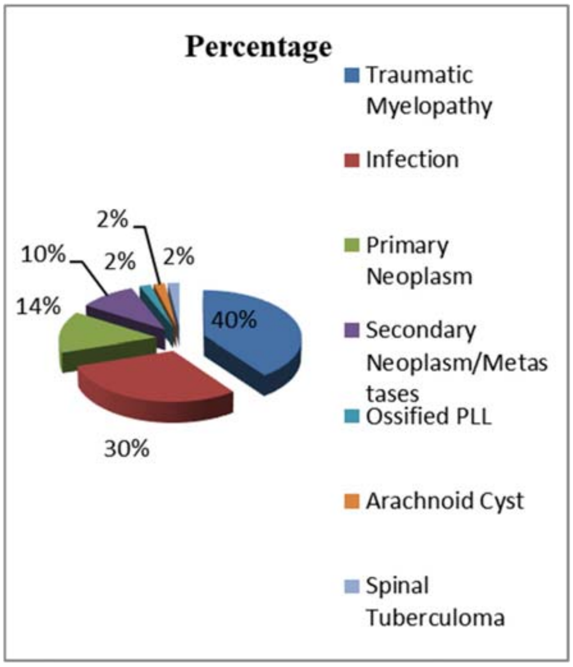

Figure 1: Causes of Compressive Myelopathy

Tumors (12 cases)

The primary intradural extramedullary tumors in our series consisted of neurofibromas (4 cases) and meningiomas (3 cases), with all 7 cases demonstrating spinal cord compression. The neurofibromas (nerve sheath tumors) exhibited iso- to hypointense signal on T1-weighted imaging and hyperintense signal on T2-weighted imaging, along with intense heterogeneous enhancement following contrast administration. Notably, two cases demonstrated extension into the neural foramina. This was in concurrence with the study Dorsi et al[19], Matsumoto et al[20], Li MH et al[21], McCormick PC et al[22] and Rothwell CI et al[23] where they reported that nerve sheath tumours may have an epidural extension through intervertebral foramen with a ‘dumbbell’ shape.

Metastatic tumors were identified in five cases, with 80% occurring in the thoracic region. The most frequent primary malignancies included lung, breast, and lymphoma. All cases (100%) presented with multiple lesions. These findings align with Lien et al.'s study[24], which reported multiple lesions (including vertebral metastases and cord-compressing lesions) in 78% of cases. Our results further correlate with Smoker WRK et al's observations[25] that lesion multiplicity strongly suggests metastatic etiology. Our imaging protocol for

Table 3 Age, Gender and Compartment with Causes of Compressive Myelopathy.

Variables	MRI diagnosis							P value
	Trauma (N=20)	Infection (N=15)	Primary Neoplasm (N=7)	Secondary Neoplasm/ Metastases (N=5)	Ossified PLL (N=1)	Arachnoid cyst (N=1)	Spinal Tuberculoma (N=1)	
Age in years								
• 12-30	1(5%)	3(20%)	2(28.5%)	0	0	1(100%)	1(100%)	<0.001
• 31-50	17(85%)	7(46.6%)	3(42.8%)	0	1(100%)	0	0	
• >50	2(10%)	5(33.3%)	2(28.5%)	5(100%)	0	0	0	
Gender								
• Male	16(80%)	10(66.6%)	2(28.5%)	1(20%)	1(100%)	0	1(100%)	<0.04
• Female	4(20%)	5(33.3%)	5(71.4%)	4(80%)	0	1(100%)	0	
Compartment								
• Extradural	20(100%)	15(100%)	0	5(100%)	1(100%)	1(100%)	0	<0.0001
• Intradural	0	0	7(100%)	0	0	0	1(100%)	

spinal metastases included T1WI, T2WI, STIR, DWI, In-Phase (IP) and Out-of-Phase (OOP) sequences, along with post-contrast imaging. T1WI effectively identified bone marrow metastases, while STIR demonstrated superior sensitivity for detecting additional marrow lesions. All five cases exhibited significant signal intensity drop on OOP sequences (Signal Intensity Ratio > 0.8), indicative of metastatic vertebral collapse - findings consistent with studies by Ragab et al[26], Erly et al[27], and Parizel et al[28].

Intravenous Gd-DTPA administration in all cases revealed mild homogeneous-to-heterogeneous enhancement. While post-contrast MRI remains valuable for intradural pathology, our observations confirm its limited utility in improving detection of extradural spinal metastases. Notably, all cases demonstrated diffusion restriction, correlating with findings reported by Zhou et al[29], Balliu et al[30], and Parizel et al[28].

Rare Causes

One case each of arachnoid cyst, OPLL, and spinal tuberculoma were identified causing compressive myelopathy. Previous studies by Kochan et al[31], Choi et al[32], and Bisson et al[33] indicate that extradural spinal arachnoid cysts are uncommon findings and a rare cause of compressive myelopathy.

Figure 2: Traumatic myleopathy. T1WI Sagittal showing traumatic retrolisthesis with cord compression and T2WI Sagittal showing cord swelling with cord edema.

Figure 3 : STIR image showing stretching of PLL with PLC sprain and paraspinal muscle strain GRE image showing blooming artefact.

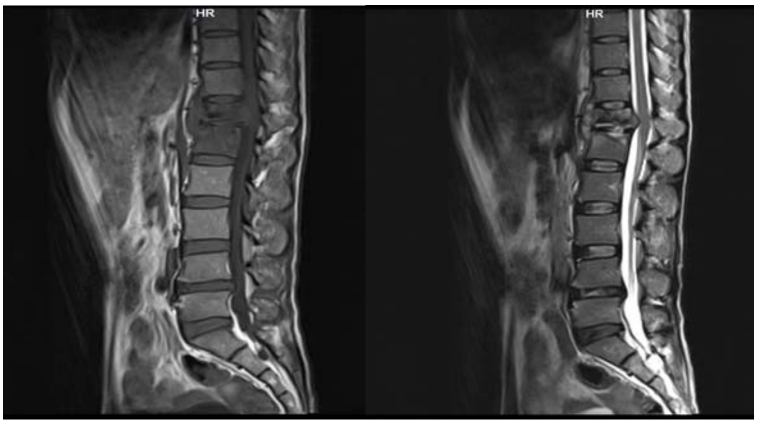

Figure 4 : T1WI and T2WI Sagittal images of Tuberculosis of the spine with pre vertebral collection and epidural soft tissue component and end plate irregularity involving D12 and L1 vertebra.

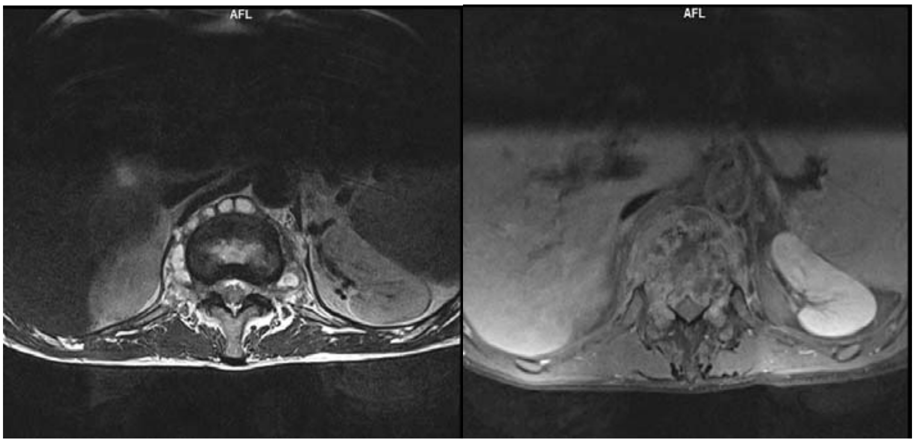

Figure 5 : T2WI Axial image showing multi loculated pre and paravertebral collection extending to bilateral psoas muscle along with epidural collection. T1WI Axial Post Contrast showing heterogeneous rim enhancement of the pre and paravertebral and epidural collection.

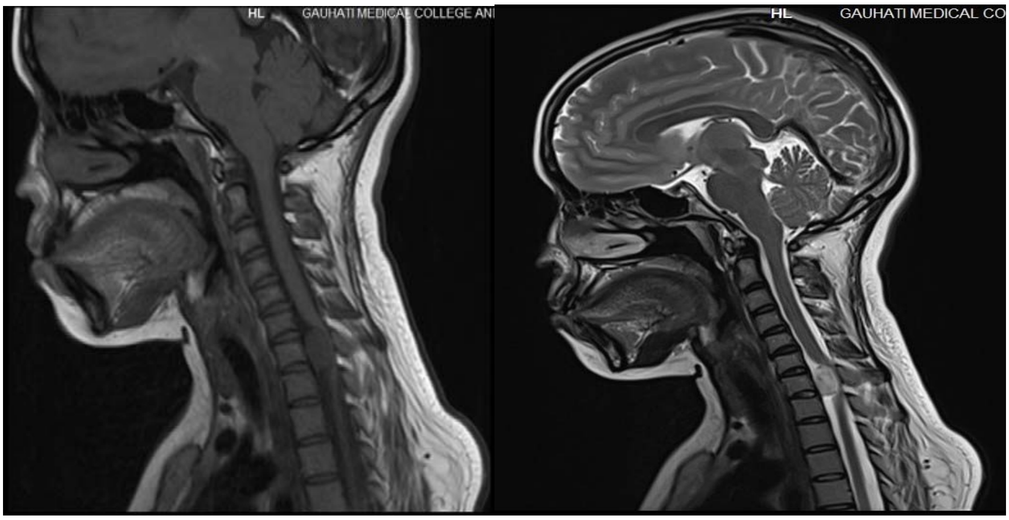

Figure 6 : Peripheral nerve sheath tumour (neurofibroma).
T1WI and T2WI Sagittal images showing a hyperintense lesion cord compression by the lesion.

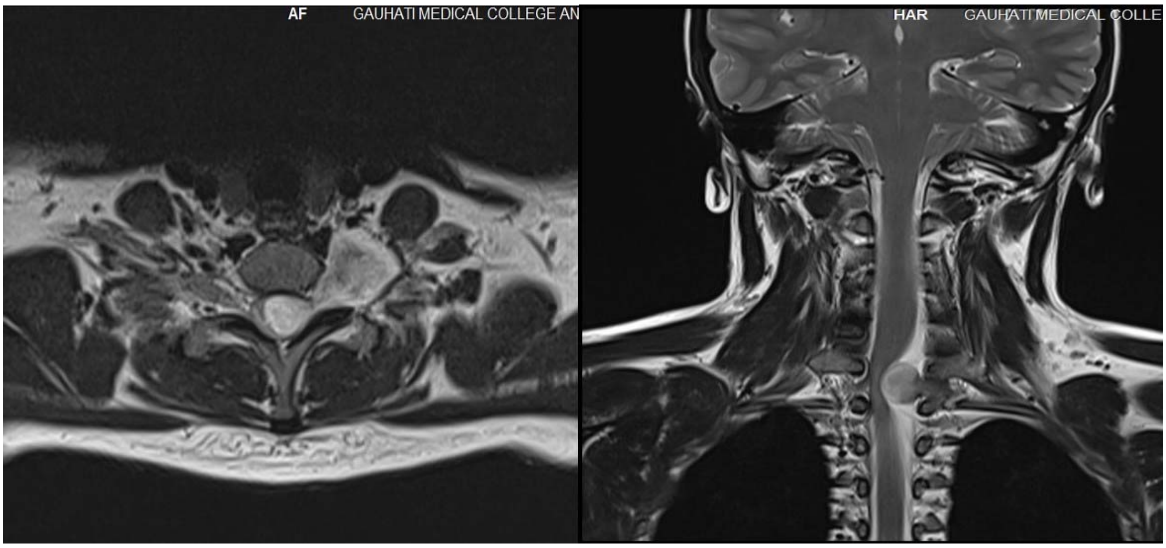

Figure 7 : Peripheral nerve sheath tumour (neurofibroma).
T2WI Axial showing dumbbell shaped. T2WI Coronal.

Figure 8 : Multiple metastases(Carcinoma Breast).
T1WI and T2WI Sagittal showing altered signal intensities in multiple dorsal vertebral bodies along with soft tissue components in dorsal epidural space.

Spinal tuberculoma as a rare cause of compressive myelopathy was also found by study done by Makkar G et al[34] where it showed indentation over the thecal sac and cord with resultant cord edema at the same level.

On applying Chi Square analysis, it is seen that there is a significant relation between Age, Gender, respective Compartments with causes of compressive myelopathy (P value <0.05).

Our findings indicate that extradural compression typically resulted from spinal injuries and infections, while intradural lesions were more often due to primary neoplasms.

CONCLUSIONS

MRI stands as the definitive, non-invasive, and radiation-free imaging modality for evaluating compressive myelopathy. It excels in assessing spinal cord abnormalities, including edema, contusion, and early changes in intervertebral discs and ligaments, which are crucial for long-term prognosis. MRI is highly sensitive and specific in detecting and characterizing spinal tumors, infections, and extradural lesions such as metastases and spondylodiscitis. Advanced techniques like Chemical Shift MRI and Apparent Diffusion Coefficient (ADC) further enhance its ability to differentiate between osteoporotic and neoplastic vertebral collapses. While MRI is invaluable for localizing and characterizing intradural lesions, definitive diagnosis often requires biopsy and culture. In this study, MRI successfully evaluated spinal tumors based on location (extradural/intradural) and assessed spinal cord integrity post-trauma. Despite its cost, MRI remains the most accurate and reliable modality for diagnosing and managing compressive myelopathy.

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