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A Descriptive Cross-Sectional Study of Role of Magnetic Resonance Imaging in the Evaluation of Intraspinal Lesions in Tertiary Care Centre in Rural Population of North Maharashtra

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ABSTRACT

Introduction: Intraspinal lesions comprise a diverse group of pathological conditions involving the spinal cord, meninges, nerve roots, and surrounding structures. Early and accurate diagnosis is essential to prevent irreversible neurological deficits. Magnetic Resonance Imaging (MRI) is the imaging modality of choice owing to its superior soft tissue contrast and multiplanar capability.
Methodology: This descriptive cross-sectional observational study was conducted over 18 months in the Department of Radio-diagnosis at a tertiary care centre serving the rural population of North Maharashtra. A total of 37 patients with clinically suspected intraspinal lesions were included. MRI examinations were performed using a 1.5 Tesla scanner with standard T1-weighted, T2-weighted, STIR, GRE, and post-contrast sequences where indicated. Lesions were evaluated for location, compartment, MRI diagnosis, and imaging characteristics.
Results: The majority of patients were aged 41–50 years (62.2%), with a slight male predominance (54.1%). The cervical spine was the most commonly involved region (62.2%). Intradural extramedullary lesions constituted 59.5% of cases, followed by intramedullary lesions (37.8%). Schwannoma was the most common MRI diagnosis (40.5%), followed by ependymoma (21.6%) and myxopapillary ependymoma (16.2%). Contrast enhancement (91.9%), perilesional edema (67.6%), and diffusion restriction (64.9%) were the predominant MRI findings. A significant association was observed between MRI diagnosis and lesion compartment ($p<0.001$), whereas no significant association was found with spinal region or contrast enhancement pattern.
Conclusion: MRI is a highly reliable, non-invasive imaging modality for the detection, localization, characterization, and compartment-based classification of intraspinal lesions. It plays a pivotal role in accurate diagnosis, treatment planning, and clinical management, particularly in rural tertiary care settings.

Keywords: Magnetic Resonance Imaging; Intraspinal lesions; Schwannoma; Intradural extramedullary lesions; Spinal tumors.

INTRODUCTION

Intraspinal lesions encompass a wide spectrum of pathological conditions affecting the spinal canal and its contents, including the spinal cord, meninges, nerve roots, vertebral column, and adjacent soft tissues. Although these lesions occur less frequently than intracranial pathologies, they are of considerable clinical importance because they can lead to progressive neurological impairment, chronic pain, and irreversible disability if not identified and managed promptly.[1] Early diagnosis is often difficult, as patients commonly present with nonspecific symptoms such as back or neck pain, radicular pain, paresthesia, motor weakness, gait disturbances, and bladder or bowel dysfunction, which may mimic several other spinal disorders. [1,2]

Based on their anatomical location within the spinal canal, intraspinal lesions are broadly classified into extradural, intradural extramedullary, and intramedullary lesions. This classification is essential because the site of origin provides valuable information regarding the likely pathology, prognosis, and appropriate therapeutic approach. [3] Extradural lesions are most commonly associated with metastatic disease, vertebral infections, or degenerative processes. Intradural extramedullary lesions frequently include benign neoplasms such as schwannomas, neurofibromas, and meningiomas, whereas intramedullary lesions are predominantly represented by primary spinal cord tumors, including ependymomas and astrocytomas. [3] In addition to neoplastic conditions, the spinal canal may also be affected by inflammatory, infectious, vascular, traumatic, congenital, and demyelinating disorders, all of which require accurate differentiation for optimal patient management. [3,4]

The clinical manifestations of these lesions depend on their location, size, growth pattern, and degree of neural compression. Progressive involvement of the spinal cord or nerve roots may result in sensory deficits, motor weakness, altered reflexes, and autonomic dysfunction. Because these clinical features overlap considerably with those of degenerative spine disease and other neurological conditions, imaging plays a pivotal role in establishing an accurate diagnosis and guiding further treatment. [4,5]

Magnetic Resonance Imaging (MRI) has become the imaging modality of choice for evaluating intraspinal lesions owing to its superior soft tissue contrast, multiplanar imaging capability, and lack of ionizing radiation. [6] MRI provides detailed visualization of the spinal cord, meninges, intervertebral discs, vertebral bodies, nerve roots, and paraspinal soft tissues, enabling precise localization and characterization of pathological lesions. Compared with conventional radiography, computed tomography, and myelography, MRI offers greater sensitivity in detecting both neoplastic and non-neoplastic spinal abnormalities at an early stage. [6,7]

Modern MRI techniques further enhance diagnostic accuracy by providing information regarding lesion morphology, signal characteristics, extent of disease, contrast enhancement patterns, hemorrhage, cystic degeneration, edema, syrinx formation, and diffusion characteristics. [7] These imaging findings help distinguish between different pathological entities, determine the exact anatomical compartment involved, assess spinal cord compression, and facilitate preoperative planning. MRI is also invaluable for monitoring treatment response, evaluating postoperative changes, and detecting residual or recurrent disease during follow-up. [7,8]

In rural regions, delayed presentation and limited availability of advanced diagnostic facilities often contribute to late diagnosis of spinal disorders, resulting in increased morbidity and poorer neurological outcomes. [9,10] Tertiary care centres equipped with MRI play a crucial role in providing timely diagnosis and appropriate management for these patients. Studying the spectrum of MRI findings in individuals from rural populations not only enhances understanding of the regional disease profile but also

supports early intervention and improved clinical decision-making.

Therefore, the present study has been undertaken to evaluate the role of Magnetic Resonance Imaging in the detection, localization, characterization, and classification of intraspinal lesions in patients attending a tertiary care centre serving the rural population of North Maharashtra. The findings of this study are expected to contribute to a better understanding of the MRI spectrum of intraspinal lesions and reinforce the importance of MRI in the diagnostic evaluation and management of spinal diseases.

Aim

To evaluate the role of Magnetic Resonance Imaging (MRI) in the assessment of intraspinal lesions.

Objectives

1. To evaluate the role of Magnetic Resonance Imaging (MRI) in the diagnosis of intraspinal lesions at a tertiary care centre.
2. To classify intraspinal lesions into extradural, intradural extramedullary, and intramedullary types based on MRI findings.

METHODOLOGY

This descriptive cross-sectional observational study was conducted over a period of 18 months in the Department of Radio-diagnosis at a tertiary care centre serving the rural population of North Maharashtra.

A total of 37 patients with clinical suspicion of intraspinal pathology who were referred for MRI examination were included using convenience sampling. Patients of all age groups and both sexes undergoing MRI for suspected intraspinal lesions were included, while those with contraindications to MRI such as cochlear implants or severe claustrophobia were excluded.

After obtaining informed consent, detailed clinical history and demographic data were recorded, and all participants underwent MRI of the spine using a GE Healthcare BRIVO 1.5 Tesla MRI scanner. Imaging was performed in axial, sagittal, and coronal planes using standard sequences including T1-weighted, T2-weighted, STIR, GRE, and post-contrast T1 fat-suppressed sequences whenever indicated. MRI findings were analyzed to determine the presence, anatomical location, and imaging characteristics of intraspinal lesions, which were classified as extradural, intradural extramedullary, or intramedullary.

Ethical approval was obtained from the Institutional Ethics Committee of SMBT Institute of Medical science and Research centre, Igatpuri, Nashik (Approval number: 1401/SMBT/IMSRC/10/IEC/24/89), and written informed consent was obtained from all participants prior to enrolment.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS software (IBM SPSS Statistics for Windows, Version 26.0; IBM Corp., Armonk, NY, USA). Categorical variables were summarized as frequencies and percentages. Associations between categorical variables were evaluated using Fisher's exact test because of the small sample size and sparse cell frequencies. A two-tailed p-value of <0.05 was considered statistically significant.

RESULTS

Among the 37 patients included in the study, the majority belonged to the 41–50 years age group (23 patients, 62.2%), followed by the 20–40 years age group (10 patients, 27.0%). Only 3 patients (8.1%) were older than 50 years, while 1 patient (2.7%) was younger than 20 years. Regarding gender distribution, 20 patients (54.1%) were male and 17 patients (45.9%) were female, indicating a slight male predominance among patients with intraspinal lesions undergoing MRI evaluation. **(Refer Table 1)**

Table 1 Distribution of Study Participants According to Age Group and Gender

Variable	Category	Frequency (n)	Percentage (%)
Age Group (years)	<20	1	2.7
	20–40	10	27
	41–50	23	62.2
	>50	3	8.1
	Total	**37**	**100**
Gender	Male	20	54.1
	Female	17	45.9
	Total	**37**	**100**

The cervical region was the most commonly affected site, accounting for 23 patients (62.2%), followed by the dorsal region in 9 patients (24.3%) and the lumbar region in 5 patients (13.5%). **(Refer Fig. 1)**

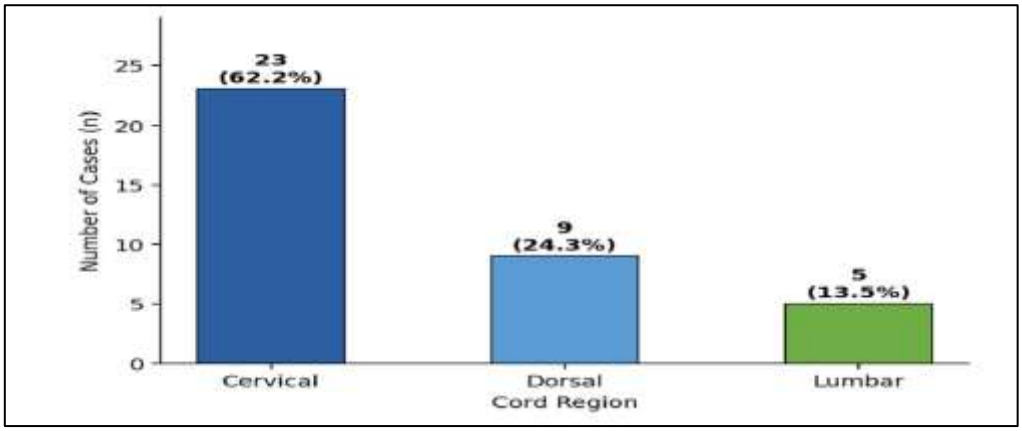

Fig 1. Distribution of Lesions According to Cord Region

In the MRI findings, it was observed that intradural extramedullary lesions were the most common, observed in 22 patients (59.5%), followed by intramedullary lesions in 14 patients (37.8%). Extradural lesions were the least common, occurring in only 1 patient (2.7%).

MRI evaluation revealed that schwannoma was the most common intraspinal lesion, diagnosed in 15 patients (40.5%), followed by ependymoma in 8 patients (21.6%) and myxopapillary ependymoma in 6 patients (16.2%). Meningioma was identified in 4 patients (10.8%), while neurofibroma was observed in 3 patients (8.1%). Metastatic lesions were the least common, occurring in only 1 patient (2.7%). **(Refer Fig. 2)**

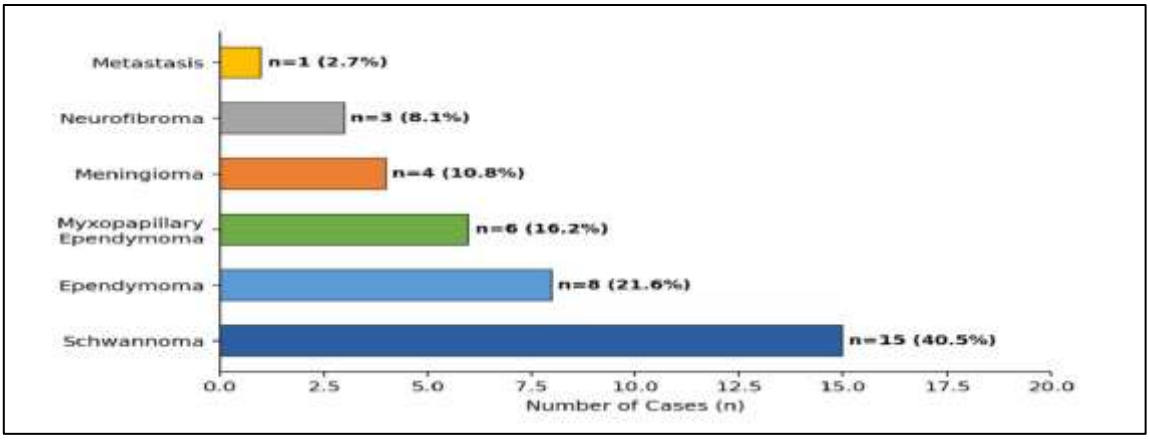

Figure 2 - Spectrum of MRI Diagnoses

Contrast enhancement was the most frequent MRI finding, observed in 34 patients (91.9%), followed by perilesional edema in 25 patients (67.6%) and diffusion-weighted imaging (DWI) restriction in 24 patients (64.9%). Cord expansion was present in 13 patients (35.1%), while syrinx formation and blooming on GRE sequences were each noted in 7 patients (18.9%). Vertebral metastasis was the least common finding, identified in only 1 patient (2.7**%). (Refer Table 2)**

Table 2 - Distribution of MRI Imaging Findings

MRI Finding	Present n (%)	Absent n (%)
Cord Expansion	13 (35.1)	24 (64.9)
Syrinx	7 (18.9)	30 (81.1)
Contrast Enhancement	34 (91.9)	3 (8.1)
Perilesional Edema	25 (67.6)	12 (32.4)
DWI Restriction	24 (64.9)	13 (35.1)
Blooming	7 (18.9)	30 (81.1)
Vertebral Metastasis	1 (2.7)	36 (97.3)

A statistically significant association was observed between the MRI diagnosis and the anatomical compartment of the lesion (Fisher's Exact test, $p < 0.001$). All schwannomas (15 cases), meningiomas (4 cases), neurofibromas (3 cases), and myxopapillary ependymomas (6 cases) were located in the intradural extramedullary compartment, whereas all ependymomas (8 cases) were intramedullary. The single case of metastasis was extradural.

The majority of lesions across different MRI diagnoses were located in the cervical region, with schwannoma (9 cases), ependymoma (5 cases), and myxopapillary ependymoma (5 cases) being the most frequent. Schwannoma also showed involvement of the dorsal (4 cases) and lumbar (2 cases) regions. However, the association between MRI diagnosis and cord region was not statistically significant (Fisher's Exact test, $p = 0.714$), indicating that the anatomical distribution of lesions across the cervical, dorsal, and lumbar regions did not differ significantly among the various MRI diagnoses in the present study.

Contrast enhancement was observed in all cases of ependymoma, meningioma, metastasis, myxopapillary ependymoma, and neurofibroma (100%), while 12 of 15 schwannomas (80.0%) demonstrated contrast enhancement and 3 cases (20.0%) did not. Although contrast enhancement was a common MRI feature across all lesion types, the association between MRI diagnosis and contrast enhancement pattern was not statistically significant (Fisher's Exact test, $p = 0.325$).

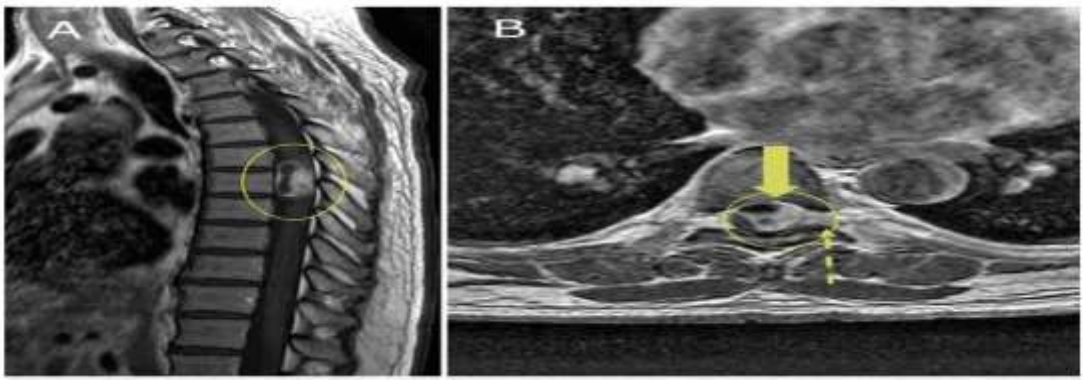

Image 3 - MRI showing intradural extramedullary schwannoma. (A) Sagittal postcontrast T1-weighted MRI of the thoracic spine showing a well-defined enhancing intradural extramedullary lesion at the thoracic level causing compression of the spinal cord (yellow oval). (B) Axial post-contrast T1-weighted MRI at the same level demonstrating intense enhancement of the lesion (solid arrow) with mild lateral extension and compression of the adjacent spinal cord, consistent with schwannoma.

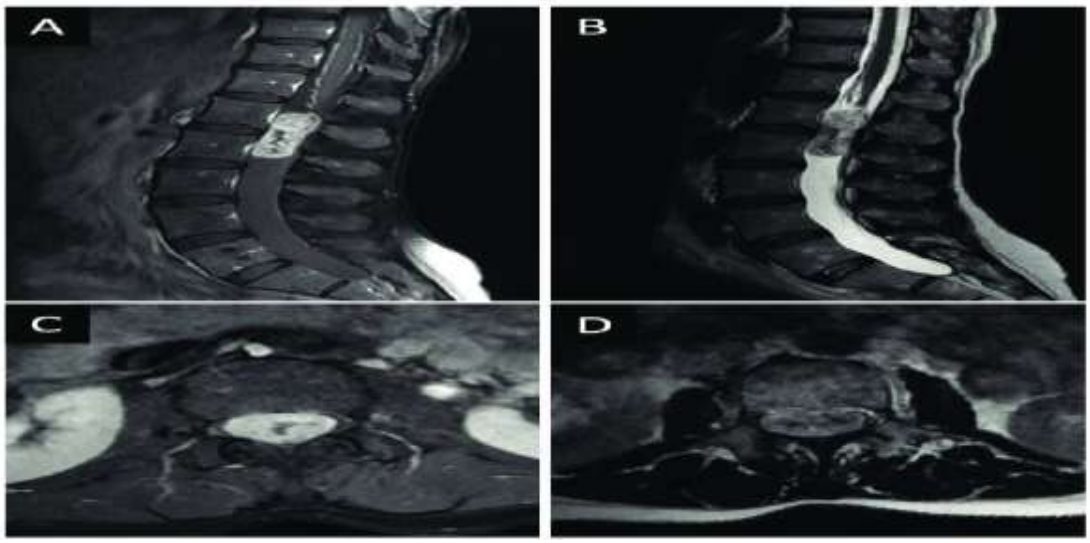

Image 4 - MRI showing myxopapillary ependymoma. (A) Contrast-enhanced sagittal T1-weighted MRI demonstrating a well-defined enhancing intradural lesion in the distal spinal cord region. (B) Sagittal T2-weighted MRI showing a hyperintense intradural lesion involving the conus medullaris/filum terminale region. (C) Axial post-contrast MRI demonstrating enhancement of the lesion within the spinal canal. (D) Axial T2-weighted MRI showing compression and displacement of the adjacent cauda equina nerve roots by the lesion.

DISCUSSION

The present descriptive cross-sectional study evaluated the role of magnetic resonance imaging (MRI) in the diagnosis and characterization of intraspinal lesions in patients attending a tertiary care centre serving the rural population of North Maharashtra. MRI proved to be an excellent imaging modality for accurately localizing lesions within the spinal canal, identifying their anatomical compartment, and characterizing their imaging features, thereby facilitating appropriate diagnosis and treatment planning.

The majority of patients belonged to the 41–50 years age group (62.2%), indicating that intraspinal lesions were most encountered during middle age. This finding is comparable to Xia et al., [11] who reported a mean age of 52.5 years among patients with benign intraspinal tumors, while Yasin et al. [12] observed that these lesions occur over a wide age range but are predominantly seen in adults. A slight male predominance (54.1%) was observed in the present study, which is consistent with the findings of Yasin et al., [12] although Xia et al. [11] and Tao et al. [13] reported female predominance, particularly in patients with spinal meningiomas.

The cervical spine (62.2%) was the most frequently involved region in the present study, followed by the dorsal and lumbar regions. This differs from the observations of Yasin et al., [12] who reported lumbar predominance, and Xia et al., [11] who found thoracic lesions to be more common. However, Mariniello et al. [14] also documented cervical involvement in solitary fibrous tumors, supporting the importance of careful MRI evaluation of the cervical spine. Based on anatomical compartment, intradural extramedullary lesions (59.5%) were the most common, followed by intramedullary lesions (37.8%), while extradural lesions were uncommon. Similar compartmental predominance has been described by Mariniello et al., [14] whereas Hu et al. [15] reported predominantly epidural lesions because their study focused specifically on spinal epidural angiolipomas. This emphasizes the value of MRI in accurately determining lesion compartment, which is fundamental for differential diagnosis.

Regarding MRI diagnosis, schwannoma (40.5%) was the most common lesion, followed by ependymoma (21.6%), myxopapillary ependymoma (16.2%),

meningioma (10.8%), neurofibroma (8.1%), and metastasis (2.7%). These findings are comparable with Xia et al., [11] who also reported schwannoma as the most common benign intraspinal tumor. In contrast, Yasin et al. [12] found metastatic lesions to be the most frequent, probably reflecting differences in patient selection and referral patterns.

Among MRI characteristics, contrast enhancement (91.9%) was the most frequent finding, followed by perilesional edema (67.6%), diffusion restriction (64.9%), cord expansion (35.1%), syrinx (18.9%), and blooming (18.9%). These observations are in agreement with Yasin et al., [12] who demonstrated frequent post-contrast enhancement in spinal tumors, while Hu et al. [15] and Zhou et al. [16] also highlighted the importance of contrast-enhanced MRI in lesion characterization and differentiation.

A highly significant association was observed between MRI diagnosis and lesion compartment ($p < 0.001$). All schwannomas, meningiomas, neurofibromas, and myxopapillary ependymomas were intradural extramedullary, whereas all ependymomas were intramedullary and the metastatic lesion was extradural. Similar compartment-specific distribution has been reported by Hu et al. [15] and Zhou et al., [16] confirming that anatomical localization is one of the strongest diagnostic indicators on MRI. In contrast, MRI diagnosis showed no significant association with cord region ($p = 0.714$) or contrast enhancement pattern ($p = 0.325$), suggesting that although lesion location and enhancement provide supportive information, they are less specific than compartmental localization. Comparable observations have been reported by Xu et al. [11] and Zhai et al., [17] who emphasized that MRI diagnosis is achieved by combining compartment, morphology, and enhancement characteristics rather than relying on any single imaging feature.

Overall, the present study confirms that MRI is the investigation of choice for evaluating intraspinal lesions because it accurately identifies lesion location, compartment, extent, and imaging characteristics. Early MRI evaluation in patients with suspected spinal pathology can significantly improve diagnostic accuracy, facilitate surgical planning, and contribute to better neurological outcomes, particularly in rural populations where delayed diagnosis remains a major challenge.

Limitations of this Study

1. The study was conducted at a single tertiary care centre with a relatively small sample size (n = 37), which may limit the generalizability of the findings to the wider population.
2. As a descriptive cross-sectional study, it evaluated MRI findings at a single time point and did not assess treatment outcomes, disease progression, or long-term follow-up.
3. Histopathological confirmation was not available for all cases, and advanced MRI techniques such as MR spectroscopy, perfusion imaging, and diffusion tensor imaging were not included, which may have limited further characterization of some lesions.

CONCLUSION

The present study demonstrated that Magnetic Resonance Imaging (MRI) is a highly effective, non-invasive imaging modality for the evaluation of intraspinal lesions. MRI accurately identified the location, anatomical compartment, and imaging characteristics of spinal lesions, thereby facilitating precise diagnosis.

Intradural extramedullary lesions were the most common lesion compartment, with schwannoma being the predominant MRI diagnosis. Contrast enhancement, perilesional edema, and diffusion restriction were the most frequent MRI findings.

A statistically significant association was observed between MRI diagnosis and lesion compartment, confirming that compartment-based localization is an important determinant in narrowing the differential diagnosis of intraspinal lesions. Thus, MRI remains the imaging modality of choice for the diagnosis, classification, and pre-

treatment evaluation of intraspinal lesions and plays a crucial role in guiding appropriate clinical and surgical management.

Declaration by Authors

Ethical Approval: Approved

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