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Original Article

Role of Magnetic Resonance Imaging in Evaluation of Spinal Cord Lesions

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Abstract

Introduction: In this cross-sectional study, we study the role of magnetic resonance imaging (MRI) as non-invasive imaging modality for the evaluation of spinal cord lesions.

Materials and Methods: This study was conducted as an observational study in the department of radiodiagnosis, GMC Bhopal, during the study period of 1 year on patients with a history of quadriparesis. The study comprised 100 patients who underwent an MRI spine scan study. MRI was done and findings are being studied.

Results: Out of 100 participants, 91% were found to have abnormal MRI findings. The most common spinal lesions were found in the 41–50 years age group (64%), with more male predilection of 53% in comparison to 47% female in the present study. Out of neoplastic lesions, the most common type of intradural extramedullary lesion is schwannoma (41%), and intramedullary spinal cord tumor is ependymoma (22%).

Conclusion: MRI images are usually chosen as the pre-operative modality of choice for the evaluation of tumors of the spinal cord. Variable enhancement is demonstrated by Gd-DTPA images. The variegated presentation of these spinal cord tumors must be recognized to form a differential diagnosis and plan surgical resection, the in-depth evaluation is being provided by MRI. MRI serves as an accurate and non-invasive, non-ionizing imaging method for the evaluation of spinal cord lesions.

Key words: Infective, Magnetic resonance imaging, Neoplastic, Spinal cord

INTRODUCTION

There are various diseases involving the spinal cord which include heterogeneous group of abnormalities such as inflammatory, neoplastic, vascular, metabolic, infectious, and traumatic origin. Making the clinical differentiation between different entities is often difficult, magnetic resonance imaging (MRI) being the diagnostic method of choice. Although neuroimaging findings are not pathognomonic however many are quite suggestive and the radiologist will therefore assist in the diagnosis and consequently, in the therapeutic guidance. In this article, the objective is to review the MRI findings of the main neoplastic and other spinal cord lesions.

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The spinal cord is the most important part of the central nervous system which is found within the vertebral column's spinal canal. Spinal cord is extending from corticomedullary junction at the level of foramen magnum to tip of conus medullaris which is at the level of L1/L2. It is surrounded by the spinal pia mater and contained by spinal meninges in the thecal sac.

There are many diseases which can affect the spinal cord, leading to motor, sensory, and autonomic disturbances, and MRI findings are essential for diagnostic clarification. MRI findings assessment along with various patterns of cord involvement and detailed clinical data will provide diagnosis or in other words significantly limit the differential diagnosis in most cases. In this article, our aim is to review the most common and important intramedullary and extramedullary spinal tumors with an emphasis on their morphologic characteristics on MRI.

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The modality of choice for evaluating spinal cord lesions is currently MRI. Imaging of the entire spine is important to establish a baseline and to screen for skip lesions or drop metastasis. There has been a series of recent articles in the literature of radiology of Brazil regarding the evaluation of the nervous system by imaging methods.[1-5] Our main objective is to evaluate the MRI findings of spinal cord lesions.

MATERIALS AND METHODS

The present study was carried out for a period from June 2023 to June 2024. The study was performed at Gandhi Medical College, and associated hospital (Hamidia Hospital) Bhopal. The study was done with the help of 100 participants. It is a facility-based cross-sectional study. Patients clinically presented with paraplegia and quadriplegia are included in this study. Patients having primary neoplastic lesions elsewhere in the body except the spine are excluded from the study. All the patients first underwent MRI after taking written MRI Consent. After obtaining informed consent, and explaining the purpose of the study to the participants, data collection was done and information was recorded on a pre-designed, pre-tested, and semi- structured pro forma. The pro forma included sociodemographic variables such as age, gender, contact number, and address. All patients underwent an MRI scan with 1.5 Tesla machine using a spine coil (body coil) and various required sequences are taken and images are obtained. MRI protocols used are T1 axial, T2 axial, T1 sagittal, T2 sagittal, short tau inversion recovery coronal, diffusion-weighted imaging, and T2*GRE, T1 + c.

Statistical Analysis

Data were entered into MS Excel 2007, and analysis was done with the help of Epi info Version 7.2.2.2. Frequency and percentages were calculated. Quantitative variables were expressed as the mean and standard deviation. Categorical data were expressed as percentage. Microsoft Office was used to prepare the graphs.

RESULTS

In the present study of 100 cases, different spinal cord lesions were found. The most common spinal cord lesions were neoplastic (91%) and the rest were normal (16%). The most common spinal lesions were found in the 41–50 years age group (64%) Table 1, with more male predilection of 53% in comparison to 47% of female in the present study Table 2. Out of neoplastic lesions, the most common type of intradural extramedullary lesion is schwannoma (41%), and intramedullary spinal cord tumor is ependymoma (22%) Graph 4. The most common location of the lesion is the cervical cord Graph 1. Meningiomas, which are intradural extramedullary lesions, constituted 11%. Neurofibroma constituted 8% which are intradural extramedullary with extradural component noted in neurofibromatosis type 1. Spinal cord metastasis constituted 3%. Intradural extramedullary lesions constituted 61% followed by intradural extramedullary lesions 38% followed by extradural lesions 1% Graph 2.

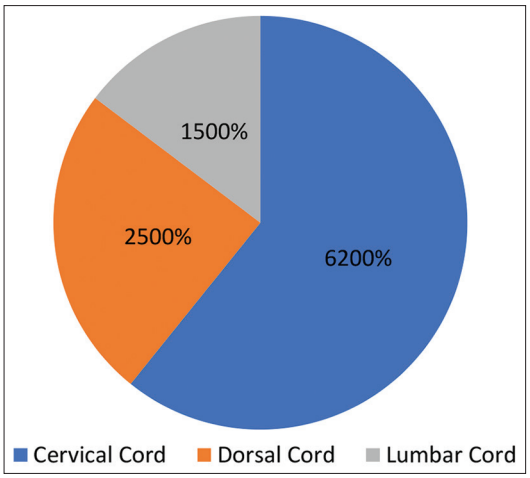
DISCUSSION

Neoplastic lesions of the spine are important due to their devastating clinical effects and demanding radiographic appearance. For the differential diagnosis for a spinal lesion, location is the most important feature, but the clinical presentation and the patient's age and gender are also important in the diagnosis. MRI plays a significant role in the imaging of spinal tumors allowing tumors to be classified as extradural tumors, intradural-extramedullary tumors, or intramedullary tumors Figures 1-6. These characteristics will help radiologists and give a reasonable differential diagnosis for spinal tumors Graph 3.

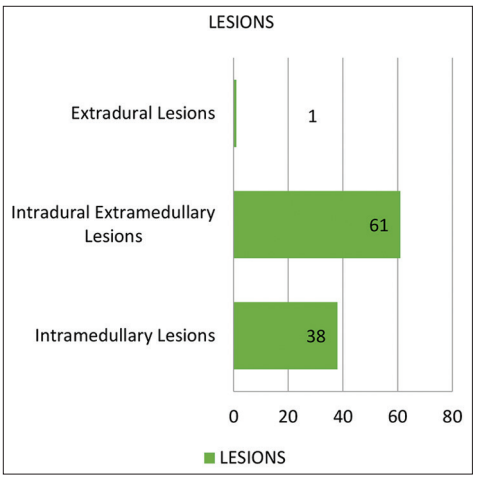
According to our study, spinal neoplasms were more common in the male population and in adults. Similar to the study conducted by Panda *et al*.[6] mentioned that out of spinal tumor patients, 57.3% were males and 42.7% were females. Among them, 5.6% were in pediatric age group and 94.4% were adults. Majority of spinal tumors are seen in elderly patients with the most common age group being 41–50 years. This observation is similar to the study by Panda *et al*.[6] which also found the most common affected age group to be 41–50 years.

Ependymomas are the most common intramedullary neoplasm in adults and usually occur in the cervical region.[7] These are slightly more common in women of 40–50 years of age. There is an increased incidence of these tumors in patients with neurofibromatosis Type 2. Ependymomas are characterized by slow growth and compress rather than infiltrate adjacent spinal cord tissue, generally yielding a cleavage plane that aids in surgical resection.[8] These lesions tend to be central in location with respect to the spinal cord. Almost all spinal cord ependymomas are of low grade, classified as either Grade I or Grade II by the World Health Organization; malignant ependymomas are quite rare.[9]

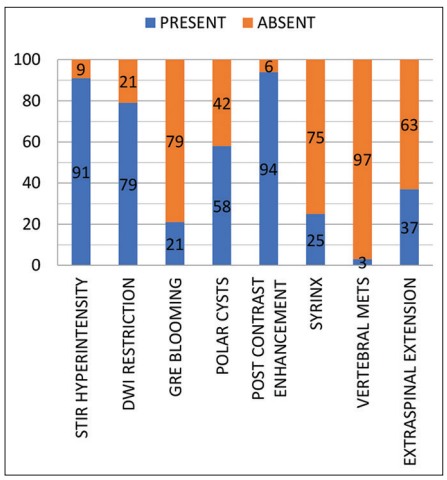
Ependymomas are iso- to hypointense on T1-weighted images (T1-WI) and hyperintense on T2-WI. Ependymomas tend to produce symmetric spinal cord expansion and usually have solid and cystic components. Cysts can be peritumoral (polar) or intratumoral usually occurs at the cranial or caudal aspects of the tumor. Intratumoral cysts



Graph 1: Distribution of spinal cord lesions based on cord involvement

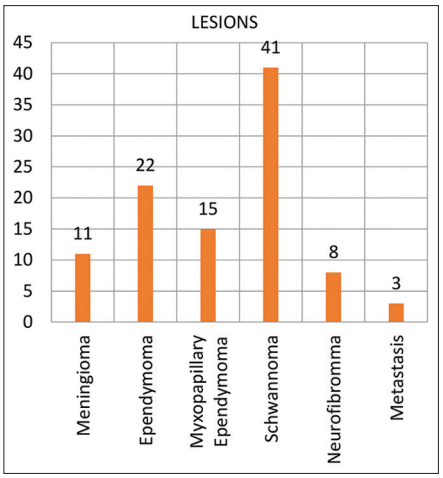


Graph 2: Distribution of spinal cord lesions



Graph 3: Magnetic resonance imaging spine imaging findings

should be resected with the solid tumor, as they may contain tumor cells within them.[9] However, polar cysts do not contain malignant cells.[9]



Graph 4: Diagnosis based on magnetic resonance imaging findings

Table 1: Age distribution

S. No.	Variables	Frequency	Percent
1	<20 years	4	4.0
2	20–40 years	26	26.0
3	41–50 years	64	64.0
4	>50 years	6	6.0
	Total	100	100

Table 2: Distribution of participants based on gender

S. No.	Variables	Frequency	Percent
1	Male	53	53.0
2	Female	47	47.0
	Total	100	100.0

Ependymomas have hemorrhage which will result in the "cap sign," a hypointense rim at the periphery of the tumor on T2WI that is related to hemosiderin deposition from prior hemorrhage. They show more uniform enhancement and central locations. Parizel *et al.*[10] also reported ependymomas are the most common tumor in adults. Ependymomas and nerve sheath tumors were the commonest of tumors accounting for 23% of cases each followed in decreasing order of frequency by meningioma, epidural metastases, intradural extramedullary metastases, hemangioblastoma, astrocytoma, lipoma, hemangioma, oligodendroglioma and epidermoid cyst. Chung *et al.*[11] and Panda *et al.*[6] reported schwannomas as the commonest tumor similar to our study followed by meningioma, ependymomas, etc.

Study conducted by Ravi *et al.*[12] found that intradural extramedullary tumors were commoner than intramedullary tumors.

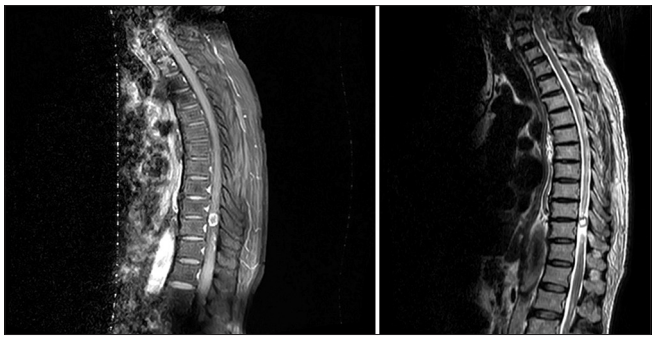


Figure 1: T1+c sagittal image of a patient showing post-contrast enhancement and T2 sagittal image showing a well-defined hypointense lesion with surrounding edema. Features are in favor of likely schwannoma

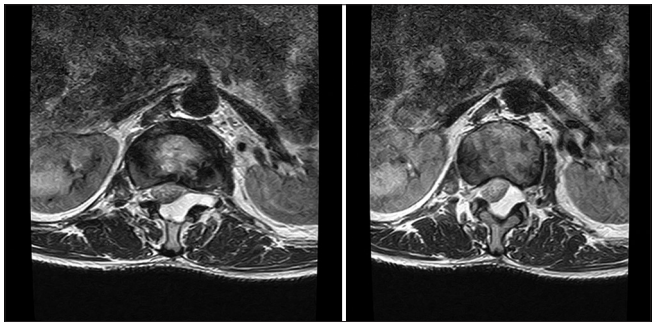


Figure 2: T2 axial image of a patient showing a well-defined extramedullary intradural hyperintense seen causing neural foramina widening on the left side. Features are in favor of likely extramedullary schwannoma

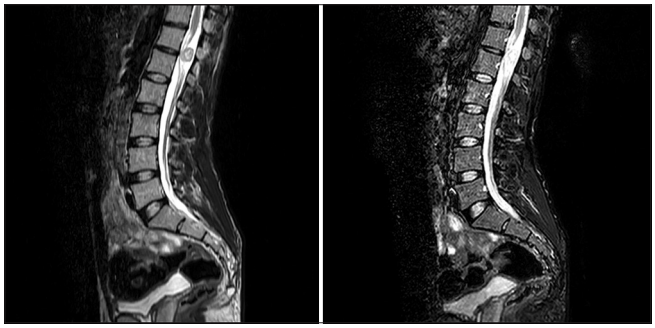


Figure 3: T2 sagittal image of a patient showing a well-defined extramedullary hypointense lesion and short tau inversion recovery hyperintense lesion at D12-L1 level with surrounding edema. Features are in favor of likely meningioma

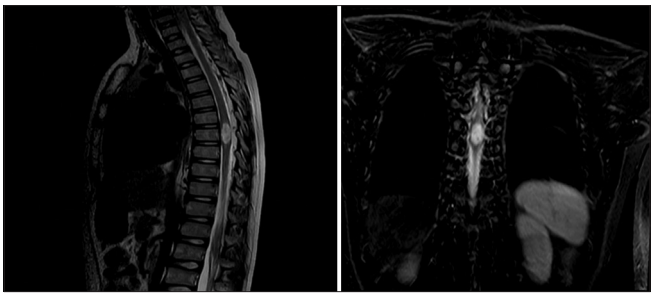


Figure 4: T2 short tau inversion recovery sagittal image of a patient showing a well-defined intramedullary hyperintense lesion in the dorsal spine. Features are in favor of likely ependymoma/astrocytoma

Figure 5: T1+c sagittal and axial image of a patient who is a known case of carcinoma lung showing a well-defined intramedullary enhancing lesion at L2-3 level with enhancing vertebral bodies. Features are in favor of likely intramedullary and vertebral metastasis

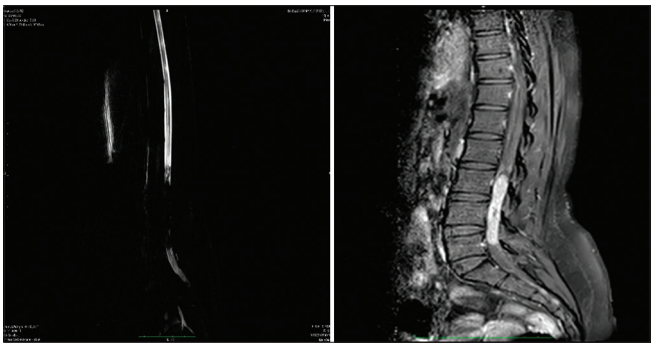


Figure 6: Magnetic resonance Myelogram and T1+c sagittal image of a patient showing cut off in myelogram and a well-defined intramedullary enhancing lesion in lumbar spine. Features are in favor of likely myxopapillary ependymoma

In our study, meningioma showed female predominance (M:F:1:2). Similar to the study by Panda *et al*.[4] showed the male-to-female ratio in meningiomas to be 1:2 ependymomas and nerve sheath tumors were the most common spinal tumors in intramedullary and intradural extramedullary compartments, respectively, in our study. This is similar to the study results of Chung *et al*.,[11] Parizel *et al*.[10] and Panda *et al*.[6]

Myxopapillary ependymomas represent the most frequent type of ependymomas found at the conus medullaris-cauda equina-terminal filum level.[13]

Myxopapillary ependymomas are usually lobulated, sausage-shaped masses that are often encapsulated. They usually have non-specific radiologic appearance and are typically isointense relative to the spinal cord on T1WI and hyperintense on T2WI. If there is hyperintensity noted on both T1WI and T2WI then it reflects mucin content or hemorrhage.[14] The differential diagnoses of a mass arising in the filum terminale are ependymoma, astrocytoma, nerve sheath tumor, metastases, paraganglioma, and hemangioblastoma. Astrocytomas are eccentrically located within the cord. However, spinal cord astrocytomas tend

to infiltrate the cord and are, therefore, difficult to resect completely and have a worse prognosis.[9]

Pilocytic astrocytomas cause enlargement of the spinal cord. The cervicomedullary junction and the cervicothoracic cord are the most common locations. Tumors can show areas of necrotic-cystic degeneration (60% of cases), can have a "cyst with mural nodule" appearance, or can be structurally solid (about 40% of cases). The solid components are iso- to hypointense on T1WIs and hyperintense on T2WI. The pattern of enhancement can be focal nodular, patchy or inhomogeneous, diffuse enhancement, and does not define tumor margins.[15] Non-enhancing intramedullary astrocytomas are relatively common and comprise between 20% and 30% of intramedullary astrocytomas.[16]

Tumors of the spinal nerve sheath usually represent 30% of intradural/extramedullary tumors.[17] Tumor heterogenicity does not necessarily indicate malignant change.[10,18] Meningiomas usually comprise approximately of 25% of spinal tumors. Spinal cord meningiomas are originated from meningothelial cells near the distal root ganglia. Most of meningiomas are intradural extramedullary, and only 5% are extradural. 5% of intradural extramedullary are in a dumbbell shape.[19] These tumors appear as rounded, sharply marginated masses that are isointense on T1-WI and iso- or hypointense on T2-WI.[10] These tumors enhance homogeneously. Calcification presence helps to differentiate it from nerve sheath tumors. Differentiation may also be determined by evaluating for neurofibromas that are heterogeneous on T2WI and enhance more intensely than meningiomas. In our cases, magnetic resonance demonstrated homogeneous enhancement on Gd-DTPA images.

Tumors that metastasize to the bone structure of the spine include myeloma, breast cancer, lung cancer, prostate cancer, and lymphoma. Osteoblastic metastases occur frequently in the setting of prostate or breast cancer. The thoracic spine is more commonly involved than the lumbar/cervical spine. MRI is the best imaging modality for detecting and characterizing metastatic disease, but usually, bone scintigraphy is more useful in detecting multiple lesions and distant metastases. MRI is useful for diagnosis, staging, evaluation of soft tissue complications, and treatment planning. Metastatic lesions show low signal intensity on T1-WI and high signal intensity on T2-WI. Sclerotic metastases may show low signal intensity on T2-WI.[20] Contrast enhancement is required to diagnose metastatic lesions if epidural disease is suspected.

CONCLUSION

MRI images are usually chosen as the pre-operative modality of choice for the evaluation of tumors of the spinal cord. Variable enhancement is demonstrated by Gd-DTPA images. The variegated presentation of these spinal cord tumors must be recognized to form a differential diagnosis and plan surgical resection. Familiarity with the imaging characteristics of spinal neoplasms is required by the radiologist. A reasonable differential diagnosis can be developed for most spinal neoplasms based on the patient's age, lesion location, and radiological appearance. A multimodality approach can be used to fully characterize the lesion, and the diagnostic possibilities are usually narrowed down significantly by the combination of information obtained from different modalities. Intramedullary and extramedullary neoplasms are particularly well evaluated by MRI.

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