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Original Article

Diagnostic Accuracy of Magnetic Resonance Imaging in Intramedullary Spinal Cord Tumors: Correlation with Histopathological Diagnosis

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ABSTRACT

Background: Intramedullary spinal cord tumors are uncommon lesions that may cause progressive neurological impairment. Magnetic resonance imaging (MRI) is central to their preoperative evaluation, but histopathological examination remains essential for definitive diagnosis. This study assessed the diagnostic accuracy of MRI in intramedullary spinal cord tumors using histopathology as the reference standard. **Methods & Materials:** This observational cross-sectional study included 32 patients with clinically suspected intramedullary spinal cord masses who underwent MRI followed by surgical intervention and histopathological evaluation. MRI examinations were performed using T1-weighted, T2-weighted, FLAIR and post-gadolinium T1-weighted sequences. MRI diagnoses were compared with histopathological findings. Sensitivity, specificity, accuracy, positive predictive value (PPV) and negative predictive value (NPV) were calculated. **Results:** The mean age was 36.75 ± 13.41 years, with most patients aged 21–40 years (53.1%). MRI identified ependymoma in 17 (53.1%), astrocytoma in 13 (40.6%) and hemangioblastoma in 2 (6.3%) patients. Histopathology confirmed ependymoma in 15 (46.9%), astrocytoma in 13 (40.6%), hemangioblastoma in 2 (6.3%), metastasis in 1 (3.1%) and schwannoma in 1 (3.1%). MRI showed sensitivity, specificity and accuracy of 93.3%, 82.3% and 87.5% for ependymoma and 92.3%, 94.7% and 93.8% for astrocytoma, respectively. Hemangioblastoma showed 100% for all validity measures. **Conclusion:** MRI demonstrated high diagnostic accuracy for the common intramedullary spinal cord tumors, particularly ependymoma and astrocytoma. Histopathological examination remains essential for definitive diagnosis, especially for uncommon lesions.

Keywords: *Magnetic resonance imaging; Intramedullary spinal cord tumor; Ependymoma; Astrocytoma; Hemangioblastoma; Histopathology; Diagnostic accuracy.*

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INTRODUCTION

Intramedullary spinal cord tumors are uncommon lesions that arise within the substance of the spinal cord and represent a clinically important cause of progressive neurological dysfunction [1]. Although relatively rare compared with other spinal and central nervous system tumors, they can produce substantial morbidity because of their location within the spinal cord [2]. Patients may present with gradually progressive weakness, sensory disturbances, pain, gait abnormalities, sphincter dysfunction, or a combination of these manifestations [3]. The clinical presentation is often nonspecific, making accurate imaging assessment essential for appropriate diagnosis and treatment planning.

Magnetic resonance imaging (MRI) is the principal imaging modality for evaluating suspected intramedullary spinal cord tumors because of its excellent soft-tissue contrast and multiplanar capability [4]. MRI provides valuable information regarding the location, extent, internal characteristics and relationship of a lesion to the spinal cord [5]. T1-weighted, T2-weighted, fluid-attenuated sequences and contrast-enhanced images can further characterize tumor morphology, signal intensity, enhancement patterns, associated cystic changes and surrounding spinal cord abnormalities. These imaging features may assist in differentiating common intramedullary tumors such as ependymoma, astrocytoma and hemangioblastoma from less common lesions [6].

Despite advances in MRI technology, considerable overlap may exist among the imaging characteristics of different intramedullary tumors [7]. Tumor location, enhancement pattern, signal characteristics, hemorrhagic components, cyst formation and cord expansion may provide important diagnostic clues, but these findings may not always permit definitive histological classification [8]. Accurate preoperative identification of the likely tumor type is important because it can influence surgical planning, counseling and subsequent clinical management [9]. Histopathological examination remains the reference standard for definitive tumor classification [10]. Correlating MRI findings with histopathological diagnosis therefore provides an opportunity to determine how reliably MRI can characterize intramedullary spinal cord tumors [11]. Diagnostic accuracy can be assessed using measures such as sensitivity, specificity, positive predictive value, negative predictive value and overall accuracy [12].

Although MRI is routinely used in the evaluation of spinal cord lesions, evidence regarding its diagnostic performance for specific intramedullary tumor types remains clinically relevant, particularly in settings where definitive diagnosis depends on surgical and histopathological evaluation. Therefore, this study was undertaken to assess the diagnostic accuracy of MRI in patients with intramedullary spinal cord tumors by comparing MRI-based diagnoses with histopathological findings.

METHODS & MATERIALS

This observational cross-sectional study was conducted in the Department of Radiology and Imaging at Sir Salimullah Medical College and Mitford Hospital, Dhaka, Bangladesh, in collaboration with the Departments of Neurosurgery and Pathology, from January 2018 to December 2019. A total of 32 patients with clinically suspected intramedullary spinal cord masses, referred for MRI and subsequently undergoing surgical intervention and histopathological evaluation, were enrolled using purposive convenient sampling. Patients unwilling or unfit for surgery and those without available histopathological reports, were excluded. After obtaining ethical approval from the Ethical Review Committee of SSMC & MH and informed written consent from each patient or attendant, complete history, physical examination and necessary laboratory tests were performed. All patients were scanned using a 1.5 Tesla MRI machine with T1-weighted, T2-weighted, FLAIR and post-gadolinium T1-weighted sequences in axial, coronal and sagittal planes. Images were independently reviewed by three experienced radiologists and MRI diagnoses were compared with histopathological findings, which served as the gold standard. Data were collected using a predesigned proforma and analyzed with SPSS. Sensitivity, specificity, accuracy, positive predictive value and negative predictive value were calculated to determine the diagnostic accuracy of MRI.

RESULT

Table I shows age of the study patients, it was observed that majority (53.1%) of the patients belonged to age 21-40 years. The mean age was 36.75 ± 13.41 years with ranged from 16 to 65 years.

Table I
Distribution of the study patients by age (*n*=32).

Age (in year)	Number of patients	Percentage
≤20	4	12.5
21-40	17	53.1
41-60	9	28.1
>60	2	6.3
Mean ± SD	36.75 ± 13.41 years	
Range (min-max)	16 – 65 years	

Figure 1 is a bar diagram that illustrates the sex distribution of different intramedullary tumors. The study findings show that ependymoma was more prevalent in males at 58.8% compared to females at 41.2%. Astrocytoma also showed a male predominance, accounting for 53.8% of cases versus 46.2% in females. In contrast, hemangioblastoma demonstrated an equal distribution, with a 50% occurrence rate in both males and females.

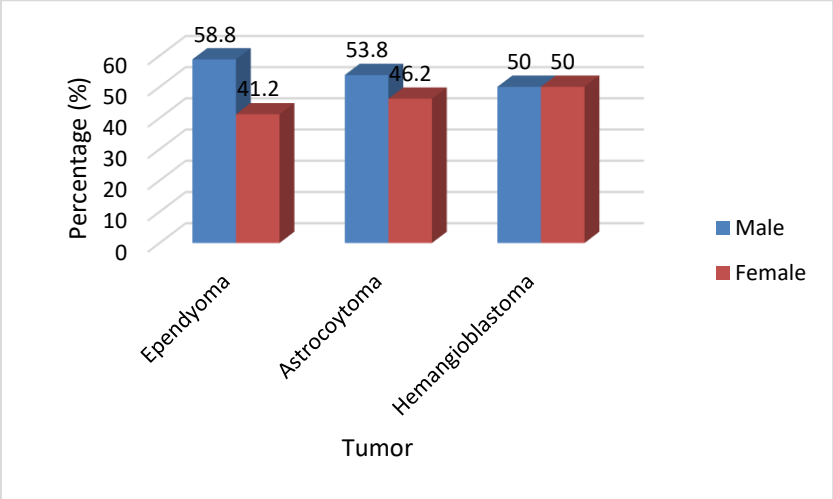

Figure 1 Bar diagram showing sex distribution of different intramedullary tumors.

Table II shows MRI diagnosis of the study patients, it was observed that 17(53.1%) patients had ependymoma, followed by 13 patients (40.6%) had patients had astrocytoma, 02(6.3%) patients had hemangioblastoma.

Table II
Distribution of the study patients by MRI diagnosis (*n*=32).

MRI diagnosis	Number of patients	Percentage
Ependymoma	17	53.1
Astrocytoma	13	40.6
Haemangioblastoma	2	6.3

Table III shows histopathological diagnosis of the study patients, it was observed that 15(46.9%) patients had ependymoma, 13 (40.6%) patients had astrocytoma, 02 (6.2%) patients had astrocytoma, 1 patient had schwannoma and metastases in each case.

Table III
Distribution of the study patients by histopathological diagnosis (*n*=32).

Histopathology	Number of patients	Percentage
Ependymoma	15	46.9
Astrocytoma	13	40.6
Hemangioblastoma	2	6.3
Metastasis	1	3.1
Schwannoma	1	3.1

Table IV shows comparison between MRI and histopathological diagnosis of intramedullary spinal cord tumour. It was observed that 17(53.1%) patients had ependymoma on MRI diagnosis followed by 15(46.9%) on histopathological diagnosis, 13(40.6%) patients had astrocytoma on MRI as well as histopathological diagnosis, 02(6.3%) patients were diagnosed as hemangioblastoma on MRI as well as histopathology. No patient was diagnosed as metastasis or Schwannoma on MRI but 01(3.1%) patient was diagnosed as metastasis and 01(3.1%) patient was diagnosed as intramedullary spinal cord Schwannoma on histopathology.

Table IV
Comparison between MRI diagnosed intramedullary spinal cord tumour with histopathological diagnosis (*n*=32).

Diagnosis	MRI		Histopathology	
	n	%	n	%
Ependymoma	17	53.1	15	46.9
Astrocytoma	13	40.6	13	40.6
Hemangioblastoma	02	6.3	02	6.3
Metastasis	00	0.0	01	3.1
Schwannoma	00	0.0	01	3.1

Table V presents the validity test of Magnetic resonance imaging (MRI) in the evaluation of intramedullary spinal cord tumours compared to histopathology for a total of 32 cases. For ependymoma, the sensitivity was 93.3%, specificity 82.3%, accuracy 87.5%, PPV 83.3.5.2 and NPV 93.3%. Astrocytoma demonstrated a sensitivity of 92.3%, specificity of 94.7%, accuracy of 93.8%, PPV of 92.3% and NPV of 94.7%. Haemangioblastoma showed perfect validity with 100% for sensitivity, specificity, accuracy, PPV and NPV. For both schwannoma and metastasis, the sensitivity and PPV were 00 and 0.0 respectively, while specificity, accuracy and NPV were recorded as 100%, 96.8% and 100% respectively.

Table V
Validity test of Magnetic resonance imaging (MRI) in the evaluation of intramedullary spinal cord tumour compared to histopathology (*n*=32).

Lesion	Validity				
	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV (%)	NPV(%)
Ependymoma	93.3	82.3%	87.5	83.3.5.2	93.3
Astrocytoma	92.3	94.7	93.8	92.3	94.7
Haemangioblastoma	100	100	100	100	100
Schwannoma	00	100	96.8	00	100
Metastasis	00	100	96.8	0.0	100

DISCUSSION

Intramedullary spinal cord tumors are uncommon and diagnostically challenging lesions because their clinical and radiological characteristics may overlap among different tumor types. In the present study, the mean age of the patients was 36.75 ± 13.41 years, with an age range of 16–65 years and the largest proportion belonged to the 21–40-year age group (53.1%). This relatively young age distribution is compatible with the broad age range described in studies of intramedullary tumors. Jecko et al. reported a median age of 43 years in their single-center series of 48 patients with intramedullary tumors, demonstrating that these lesions may occur across a wide age spectrum [13].

In the present study, ependymoma was the most frequently identified tumor on MRI, accounting for 17 (53.1%) cases, followed by astrocytoma in 13 (40.6%) and hemangioblastoma in 2 (6.3%) cases. Histopathological examination similarly demonstrated ependymoma as the commonest tumor, with 15 (46.9%) cases, followed by astrocytoma in 13 (40.6%) and hemangioblastoma in 2 (6.3%) cases. This distribution is consistent with the recognized predominance of ependymal and astrocytic tumors among intramedullary spinal cord neoplasms. Park et al. reported spinal ependymoma as the most frequent primary intramedullary spinal cord tumor, followed by hemangioblastoma and astrocytic tumors [14]. Similarly, Jecko et al. found ependymoma to be the predominant pathological diagnosis in their series [13].

The close agreement between MRI and histopathological diagnoses for the major tumor categories suggests that conventional MRI can provide useful preoperative characterization of intramedullary tumors. In the present study, MRI and histopathology both identified 13 (40.6%) cases as astrocytoma and 2 (6.3%) cases as hemangioblastoma. Shah and Salzman emphasized that conventional contrast-enhanced MRI remains central to the evaluation of spinal cord tumors and that many intramedullary tumors demonstrate characteristic imaging features that can facilitate preoperative diagnosis [15]. Their review also highlighted ependymomas, astrocytomas, hemangioblastomas and metastases as important entities in the differential diagnosis.

The diagnostic validity measures in the present study further support the usefulness of MRI, particularly for the more frequently encountered tumor types. MRI demonstrated a sensitivity of 93.3%, specificity of 82.3% and accuracy of 87.5%

for ependymoma, while the corresponding values for astrocytoma were 92.3%, 94.7% and 93.8%, respectively. The high negative predictive values for ependymoma (93.3%) and astrocytoma (94.7%) indicate that MRI was effective in excluding these diagnoses when the imaging assessment was negative. Korkmazer et al., also demonstrated the value of advanced MRI-based assessment in intramedullary spinal tumors, particularly for improving preoperative characterization and surgical planning [16].

MRI showed perfect validity for hemangioblastoma in the present series, with sensitivity, specificity, accuracy, PPV and NPV all reported as 100%. However, this finding should be interpreted cautiously because only 2 histopathologically confirmed hemangioblastomas were present. Similarly, the absence of MRI-diagnosed metastasis and schwannoma resulted in sensitivities and PPVs of 0% for both lesions, while specificity was 100%. These results primarily reflect the very small number of such lesions rather than evidence that MRI is incapable of detecting them. Shah and Salzman noted that metastases and other uncommon spinal cord tumors can have variable imaging appearances, emphasizing the importance of considering the complete clinical and radiological context [15].

Histopathology remains essential for definitive tumor classification. Tanaka et al. highlighted the role and limitations of pathological assessment in spinal cord tumors, while Park et al. demonstrated the substantial pathological diversity of intramedullary tumors under contemporary classification systems [14,17]. Therefore, the findings of the present study support MRI as an important preoperative diagnostic tool, while histopathological examination remains necessary for definitive diagnosis, particularly in uncommon or radiologically indeterminate lesions.

LIMITATIONS

This study was conducted with a relatively small sample size and purposive sampling, which may limit the generalizability of the findings. The small number of uncommon tumor types, particularly hemangioblastoma, metastasis and schwannoma, also resulted in limited precision of their diagnostic accuracy estimates. In addition, being a single-center study, the findings may not represent the broader patient population.

CONCLUSION

MRI demonstrated high diagnostic accuracy for the common intramedullary spinal cord tumors, particularly astrocytoma and ependymoma and showed excellent diagnostic performance for hemangioblastoma in this series. However, histopathological examination remains essential for definitive tumor classification, especially in uncommon or diagnostically challenging lesions.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

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