A Comparative Analysis of Radiological and Histopathological findings in Space-Occupying Lesions of Spinal Cord

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ABSTRACT

Introduction: Spinal tumors typically manifest early with signs of compression and/or invasion, highlighting the critical importance of timely management to prevent irreversible neurological deficits. The aim of this study was to assess the diagnostic efficacy of radiology in accurately establishing a preliminary working diagnosis for various types of spine tumors.

Materials and Methods: This prospective study examined patients who underwent surgical resection and had histopathology samples collected, irrespective of age or gender. A comprehensive MRI examination from all perspectives, along with contrast-enhanced images, was conducted. Inclusion criteria encompassed patients of all age groups and genders who had surgery with tissue sample collection for histopathological diagnoses, as well as a complete MRI study including all views and contrast-enhanced images for preliminary diagnosis.

Results: According to senior radiologists' assessments, the most common tumor position was intradural-extramedullary relative to the dura, followed by intramedullary. Despite 20 cases being misdiagnosed, the overall diagnostic accuracy of MRI remained high at 69.2%.

Conclusion: MRI exhibits superior diagnostic accuracy in identifying meningiomas compared to nerve sheath tumors. Additionally, it demonstrates good predictive accuracy for intramedullary lesions such as ependymomas.

Key Words: Astrocytoma, ependymoma, Schwannoma, spinal canal stenosis.
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INTRODUCTION

The spinal cord's complex structure, comprising numerous ascending and descending tracts composed of billions of neurons, along with various layers and structures, gives rise to a range of distinct lesions, each presenting with unique clinical symptoms and signs [1,2]. The precise location of these lesions within the spinal canal plays a significant role in determining their symptomatology. However, due to limited space within the canal, there is often an overlap in symptoms, emphasizing the importance of early identification and management of spinal tumors to prevent irreversible neurological damage.

Intramedullary lesions exhibit a diverse and patchy heterogeneous enhancement pattern, whereas intradural-extramedullary lesions, such as meningiomas and schwannomas, typically display a uniform contrast enhancement [3]. While MRI plays a crucial role in identifying these lesions, tissue diagnosis obtained through surgical excision remains the gold standard for definitive diagnosis. Predicting the type of lesion based on imaging findings can assist in counseling patients and planning surgical interventions, considering the infiltrative nature of these lesions and the potential for residual disease post-surgery.

Lesions affecting the bony structures of the spinal canal often present with pain, with metastasis being the most common cause [4]. Bony lesions leading to spinal canal stenosis and neural element compression can result in radiculopathy and/or myelopathy. This pattern is observed across intradural-extramedullary, intramedullary, and bony spinal lesions. Intradural-extramedullary lesions commonly present with nighttime pain and radicular symptoms initially, progressing to myelopathic symptoms over time, characterized by motor weakness and sphincter disturbances [5,6]. The literature reports varying frequencies of meningiomas and schwannomas in this location, with ependymomas and astrocytomas being predominant among intramedullary lesions [7,8].

MRI serves as the gold standard for diagnosing spinal lesions, offering detailed imaging that aids in distinguishing different types of lesions based on their contrast enhancement patterns [9]. While MRI can predict a significant portion of these lesions, tissue diagnosis remains essential for accurate diagnosis and treatment planning. The objective of this study was to evaluate the diagnostic potential of radiology in providing a preliminary working diagnosis of various spinal tumors, guiding patient counseling and surgical management strategies.

MATERIAL AND METHODS

This prospective study was conducted at an Indian tertiary care hospital. A pre-designed proforma was utilized to gather demographic data, clinical symptoms and signs, radiological assessments, and histopathological diagnoses of the patients.

Patients of all age groups and genders who underwent surgical resection with histopathological sample collection were included in this study. A comprehensive MRI study with all views and contrast-enhanced images was mandatory. Patients who were not operated on, those with inadequate tissue samples for diagnosis, or samples not representative of the lesion were excluded. Patients with recurrent lesions or contraindications for MRI were also not part of the study.

Patients' presenting complaints, such as backache, radiating pain, lower or upper limb weakness, etc., were documented. A detailed examination was conducted to assess neurological deficits and upper or lower motor neuron signs. Statistical analysis was performed using SPSS version 20.

MRI scans in various sequences and cuts were analyzed to determine the general characteristics of the lesions, including spinal location, level, and position within the vertebral column (e.g., bone, extradural, intradural extramedullary, and intramedullary). Specific characteristics such as signal intensity on different sequences, presence or absence of contrast enhancement, as well as patterns and features typical to different lesions were evaluated. This included assessing involvement of neural foramina, presence of a dural tail, cord dilatation, etc. A preliminary diagnosis was established based on these radiological parameters.

Following surgical intervention, a tissue diagnosis of the lesion was made and compared with the preliminary radiological diagnosis to ascertain the presence of a strong radiological and histopathological correlation.

RESULTS

During the study period, 88 patients with spinal SOLs underwent surgery and were included in the analysis, comprising 44 males and 44 females. Six patients who did not meet the study criteria were excluded. The mean age of the patients was 32.34 ± 16.5 years. Pain was a universal complaint among all patients, with its presentation correlating with the lesion's location. Motor deficit, specifically lower limb weakness, was the second most common complaint. Urinary incontinence was more prevalent than urinary retention. Sensory deficits were observed in 53.41% of patients, while radicular pain was reported by 38.64%. Tenderness at the lesion site was uncommon. Dorsal spine lesions were the most frequently observed in our study, followed by lesions in the lumbar spine. Table 1 provides an overview of the demographic characteristics of the study population, along with presenting symptoms and signs.

Based on the assessment by senior radiologists, the lesions were most commonly intradural-extramedullary in position relative to the dura, followed by intramedullary, as indicated in Table 2. Table 3 presents the correlation between radiological and histopathological diagnoses of SOLs and illustrates the accuracy of MRI compared to histopathology. Despite our series having a total of 20 misdiagnosed cases, the overall diagnostic accuracy of MRI remained high at 77.27%. Tables 4 and 5 summarize the radiological parameters in correctly diagnosed and misdiagnosed cases of meningiomas and ependymomas.

. **Table 1: Demographics and symptoms among study population**

Variables	**n**	**%**
Age Groups (Years)		0.00
<10	10	11.36
10 – 18	10	11.36
19 – 30	27	30.68
31 – 50	27	30.68
50 years	14	15.91
Gender		
Males	44	50.00
Females	44	50.00
Location of SOL		
Dorsal	46	52.27
Lumbar	20	22.73
Dorsolumbar	8	9.09
Cervical	7	7.95
Cervicodorsal	5	5.68
Lumbosacral	2	2.27
Sacral	0	0.00
Presentation		
Motor deficit	69	78.41
Radicular pain	34	38.64
Sensory deficit	47	53.41
Sphincter dysfunction	69	78.41

Table 2: Radiological diagnosis of spinal SOLs

Diagnosis	n	%
Arachnoid Cyst	5	5.68
Astrocytoma	8	9.09
Dermoid	2	2.27
Ependymoma	18	20.45
Giant cell tumor	2	2.27
Inconclusive	2	2.27
Lymphoma	3	3.41
Meningioma	19	21.59
Metastasis	2	2.27
Neuroblastoma	2	2.27
Plasmacytoma/Multiple myeloma	3	3.41
Schwannoma/Neurofibroma	12	13.64
Tuberculoma/Abscess	10	11.36

Table 3: Correct Diagnosis by Radiology

Radiological Diagnosis	Total No.	Diagnosed	Misdiagnosed	%
Arachnoid Cyst	5	4	1	80.00
Astrocytoma	8	4	4	50.00
Ependymoma	18	14	4	77.78
Meningioma	19	16	3	84.21
Schwannoma	12	9	3	75.00
Tuberculoma	10	6	4	60.00

Table 4: Radiological parameters in correctly diagnosed and misdiagnosed Meningioma

MRI Characteristic	Diagnosed	Misdiagnosed
Hyperintense on T1	0	3
Isointense on T1	11	0
Hypointense on T1	2	3
Hyperintense on T2	11	0
Isointense on T2	3	0
Hypointense on T2	2	3
Homogenous Contrast Enhancement	13	2
Heterogenous Contrast Enhancement	2	0
Patchy Contrast Enhancement	0	0
No Contrast Enhancement	0	2
Broad-based, Present	13	2
Broad-based, Absent	2	2
Dural Tail Present	12	2
Dural Tail Absent	3	2
Cystic changes Present	0	0
Cystic changes Absent	16	3

Table 5: Radiological parameters in correctly diagnosed and misdiagnosed Ependymoma

MRI Characteristic	Diagnosed	Misdiagnosed
Hyperintense on T1	0	2
Isointense on T1	10	3
Hypointense on T1	3	0
Hyperintense on T2	9	2
Isointense on T2	0	2
Hypointense on T2	1	0
Mixed on T2	2	2
Homogenous Contrast Enhancement	5	0
Heterogenous Contrast Enhancement	8	5
Patchy Contrast Enhancement	0	0
No Contrast Enhancement	0	0
Cord Expansion Present	8	3
Cord Expansion Absent	5	2
Cystic changes Present	8	2
Cystic changes Absent	5	3

DISCUSSION

The overall diagnostic accuracy of MRI in interpreting spinal lesions in our study was found to be 77.27%, consistent with a similar accuracy rate reported in the literature [10].

Meningiomas are among the most frequent spinal tumors, accounting for 25% to 45% of cases [11,12]. These tumors, which are benign and slow growing, often present early due to their compressive effects on adjacent neural structures within the confined space of the spinal canal. Meningiomas exhibit a distinctive appearance on MRI, characterized by well-defined margins and shapes. They are predominantly located intradurally and extramedullary, with a high occurrence in the thoracic spine [13-16]. Our study corroborates these findings, with the majority of meningiomas located in the dorsal spine, along with cases in other spinal regions. Notably, a study in Ethiopia reported a lower rate of correct meningioma diagnoses [17].

Schwannomas can be differentiated from meningiomas by features such as foraminal widening and dumbbell-shaped morphology [18,19]. Foraminal widening was observed in most schwannomas in our study, including misdiagnosed cases. However, a dural tail was absent in these lesions, aiding in their differentiation from meningiomas.

Spinal ependymomas typically exhibit heterogeneous contrast enhancement, as seen in our study and in misdiagnosed cases [20]. These lesions can be challenging to differentiate from other intramedullary lesions, as illustrated by the misdiagnosis of an intramedullary schwannoma.

Astrocytomas, originating eccentrically within the spinal cord parenchyma, present challenges in complete resection due to their poorly demarcated margins [21]. In our study, astrocytomas did not display cysts, consistent with literature findings. However, misdiagnoses were noted, with some lesions histologically identified as neurofibromas.

In summary, MRI plays a crucial role in diagnosing spinal lesions, although challenges in accurately differentiating specific tumor types persist. Understanding the radiological features and nuances of various spinal tumors is essential for improving diagnostic accuracy and guiding appropriate treatment strategies.

CONCLUSION

MRI is indeed a crucial tool for accurately interpreting the histopathological nature of spinal lesions. Its routine utilization in evaluating and planning the management of these lesions is of paramount importance. MRI demonstrates superior diagnostic accuracy in identifying meningiomas compared to nerve sheath tumors. It also exhibits good predictive accuracy for intramedullary lesions like ependymomas. However, astrocytomas were frequently misdiagnosed. The primary limitation of this study is its small sample size, emphasizing the need for larger studies evaluating a greater number of spinal cord lesions.

REFERENCES

1. Aftab S, Akbar R, Ahmed T, Rehman L, Bokhari I, Akbar S. Radiological Verses Histological Evaluation of Spinal Space Occupying Lesions. Pak J Neurol Surg. 2023;27(4):464-474.
2. Lewandrowski KU, Anderson ME, McLain RF. Tumors of the Spine. In: Herkowitz HN, Garfin SR, Eismont FJ, Bell GR, Balderston RA, et al., editors. Philadelphia: Elsevier Saunders; 2011: pp. 1480–1512.
3. Jeon JH, Hwang HS, Jeong JH, Park SH, Moon JG, Kim CH. Spinal schwannoma; analysis of 40 cases. J Korean Neurosurg Soc. 2008;43(3):135.
4. Jellema K, Van Overbeeke JJ, Teepen HL, Visser LH. Time to diagnosis of intraspinal tumors. Eur J Neurol. 2005;12(8):621-4.
5. Westwick HJ, Shamji MF. Effects of sex on the incidence and prognosis of spinal meningiomas: a Surveillance, Epidemiology, and End Results study. J Neurosurg Spine. 2015;23(3):368–373.
6. Ruggeri AG, Fazzolari B, Colistra D, Cappelletti M, Marotta N, Delfini R. Calcified spinal meningiomas. World Neurosurg. 2017;102:406–412.
7. Azad TD, Jiang B, Bettegowda C. Molecular foundations of primary spinal tumors-implications for surgical management. Ann Transl Med. 2019;7(10):222.
8. Koeller KK, Shih RY. Intradural extramedullary spinal neoplasms: radiologic-pathologic correlation. Radiographics. 2019;39(2):468-90.
9. Davies AM, Cassar-Pullicino VN. Principles of detection and diagnosis. Imaging of Bone Tumors and Tumor-Like Lesions: Techniques and Applications. 2009:111-37.
10. Asilturk M, Abdallah A, Sofuoglu E. Radiologic–Histopathologic correlation of adult spinal tumors: A retrospective study. Asian J Neurosurg. 2020;15(02):354-62.
11. Duong LM, McCarthy BJ, McLendon RE, Dolecek TA, Kruchko C, Douglas LL, Ajani UA. Descriptive epidemiology of malignant and nonmalignant primary spinal cord, spinal meninges, and cauda equina tumors, United States, 2004-2007. Cancer. 2012;118(17):4220-7.
12. Weber C, Gulati S, Jakola AS, Habiba S, Nygaard ØP, Johannesen TB, Solheim O. Incidence rates and surgery of primary intraspinal tumors in the era of modern neuroimaging: a national population-based study. Spine. 2014;39(16):E967-73.
13. Voldřich R, Netuka D, Beneš V. Spinal meningiomas: is Simpson grade II resection radical enough? Acta neurochirurgica. 2020;162:1401-8.
14. Soderlund KA, Smith AB, Rushing EJ, Smirniotopolous JG. Radiologic-pathologic correlation of pediatric and adolescent spinal neoplasms: Part 2, intradural extramedullary spinal neoplasms. AJR Am J Roentgenol. 2012;198:44-51.
15. Setzer M, Vatter H, Marquardt G, Seifert V, Vrionis FD. Management of spinal meningiomas: Surgical results and a review of the literature. Neurosurg Focus. 2007;23:E14.
16. Birch BD, McCormick PC, Resnick DK. Intradural extramedullary spinal lesions. In: Spine Surgery. Churchill Livingstone; 2005. pp. 948-960.

17. Antonescu CR, Louis DN, Hunter S, Perry A, Reuss DE, Stemmer-Rachamimov AO. Schwannoma. In: Louis DN, Ohgaki H, Wiestler OD, et al, editors. WHO classification of tumours of the central nervous system. Revised 4th ed. Lyon, France: IARC; 2016. p. 214–218.
18. Abul-Kasim K, Thurnher MM, McKeever P, Sundgren PC. Intradural spinal tumors: current classification and MRI features. Neuroradiol. 2008;50(4):301–314.
19. Santos Junior EC, Dantas F, Caries ACV, Cariri GA, Reis MTD, Botelho RV, et al. Evaluation Of surgically Treated Primary Spinal Cord Tumors In a single Brazillin institution. A Case series study of 104 patients. Cureus. 2022;14(3):e23408.
20. Seo HS, Kim JH, Lee DH, Lee YH, Suh SI, Kim SY, et al. Nonenhancing intramedullary astrocytomas and other MR imaging features: A retrospective study and systematic review. AJNR Am J Neuroradiol. 2010;31:498-503.
21. Navarro Fernández JO, Monroy Sosa A, Cacho Díaz B, et al. Cervical intramedullary schwannoma: case report and review of the literature. Case Rep Neurol. 2018;10(1):18–24.