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Original Article

Diagnostic Accuracy of MRI in Detecting Orbital Masses Keeping Histopathology as Gold Standard

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ABSTRACT

Background: Orbital masses, encompassing a spectrum of benign and malignant lesions, pose significant diagnostic and therapeutic challenges. Magnetic resonance imaging (MRI) has been pivotal in the non-invasive evaluation of these lesions, owing to its superior soft tissue contrast and detailed anatomical resolution. The correlation between MRI findings and histopathological diagnosis remains crucial for accurate clinical decision-making.

Objective: The study aimed to evaluate the diagnostic accuracy of MRI in identifying orbital masses, with a focus on differentiating between benign and malignant lesions, using histopathology as the gold standard.

Methods: A prospective cross-sectional study was conducted at Jinnah Postgraduate Medical Centre (JPMC), Karachi, from January to December 2023. A total of 145 patients scheduled for surgery or biopsy, presenting with clinical symptoms indicative of orbital masses, were enrolled using a non-probability sequential sampling method. MRI evaluations were performed using a 1.5 Tesla machine. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy of MRI in detecting orbital masses were calculated, comparing MRI findings with histopathological results.

Results: Of the 145 patients, 55.2% were female, and 44.8% were male, with an age range predominantly between 18-30 years (87.6%). MRI identified 77.2% of cases as malignant and 22.8% as benign, whereas histopathology diagnosed 83.4% as malignant and 16.6% as benign. The diagnostic accuracy of MRI for benign masses showed a sensitivity of 81.82%, specificity of 96.43%, PPV of 87.10%, NPV of 94.74%, and an overall diagnostic accuracy of 93.10%. For malignant masses, MRI demonstrated a sensitivity of 90.16%, specificity of 86.90%, PPV of 83.33%, NPV of 92.41%, and a diagnostic accuracy of 88.28%.

Conclusion: MRI exhibits a high diagnostic accuracy in identifying orbital masses, with excellent sensitivity and specificity. It proves to be a reliable diagnostic tool in differentiating between benign and malignant orbital lesions, supporting its integral role in the preoperative assessment and clinical management of patients with suspected orbital masses.

Keywords: Orbital Masses, Magnetic Resonance Imaging, Diagnostic Accuracy, Histopathology, Benign Lesions, Malignant Lesions, MRI Sensitivity, MRI Specificity

INTRODUCTION

Orbital masses, which include a diverse spectrum of both benign and malignant lesions, each present unique clinical challenges and necessitate specific treatment approaches. The critical importance of achieving an accurate and timely diagnosis of these masses cannot be overstressed, as it directly influences the selection of appropriate treatment options and significantly impacts patient outcomes (1). Magnetic resonance imaging (MRI) has emerged as an indispensable diagnostic tool in this context, owing to its unparalleled capacity to differentiate between various types of soft tissues and provide detailed anatomical insights. This capability has rendered MRI a fundamental technique in the evaluation of eye disorders, particularly because of its enhanced soft tissue resolution, which is paramount in the precise characterization of orbital lesions (1-3).

The complexity of orbital lesions, which encompass a broad range of clinical conditions that are often challenging to diagnose, manage, and treat, highlights the need for accurate diagnostic tools. In situations where the clinical evaluation and medical history do not provide clear guidance, MRI's superior soft tissue characterization becomes a critical asset in the diagnostic process (4,5). The benchmark for determining tissue types and establishing accurate diagnoses, however, remains histopathological examination.

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The correlation of MRI findings with histopathology data is essential for assessing the reliability and effectiveness of MRI in identifying orbital masses (6). The diagnostic accuracy of MRI in this realm is influenced by a myriad of factors, including the lesion's nature, the imaging modalities applied, and the radiologist's expertise.

Vijayvargiya R, et al. provide valuable insights into the diagnostic performance of MRI, reporting a sensitivity of 83% and a specificity of 97% for benign orbital lesions. Their findings also included positive and negative predictive values of 83% and 97%, respectively, achieving a diagnostic accuracy of 95%. For malignant orbital lesions, the sensitivity was 91%, specificity was 83%, positive predictive value was 87%, and negative predictive value was 88%, with an overall diagnostic accuracy of 88% (8).

The proficient identification and characterization of orbital disorders through expert imaging techniques facilitate the timely initiation of appropriate treatments, ranging from pharmacological interventions to surgical options. This approach not only aims to preserve the patient's visual acuity but also reduces the likelihood of adverse outcomes, such as the progressive infiltration or destruction of surrounding tissues. A comprehensive understanding of the common orbital lesions, their distinctive imaging patterns, and appearances on various diagnostic platforms, including computed tomography, MRI, and ultrasound, is crucial for radiologists. High-resolution MRI of the orbit is particularly recognized for its reliability in diagnosing a wide array of orbital diseases and malignancies. When precise diagnoses are necessary, histopathology stands as the most reliable method for identifying orbital masses in the fields of ophthalmology and radiology (9,10,12).

By evaluating the sensitivity, specificity, positive and negative predictive values, and the accuracy of MRI, this study aims to provide healthcare professionals with crucial insights for the prompt diagnosis and management of patients. The ultimate goal is to enhance the non-invasive detection of orbital diseases using MRI, thereby optimizing ophthalmological care tailored to individual patients' needs and advancing diagnostic modalities in the field (11,12).

MATERIAL AND METHODS

The study was conducted as a prospective cross-sectional study between January and December 2023, the Department of Radiology at Jinnah Postgraduate Medical Centre (JPMC), Karachi,. This research aimed to evaluate the diagnostic accuracy of magnetic resonance imaging (MRI) in identifying orbital masses, with histopathology serving as the reference standard. A total of 145 patients who were scheduled for surgical operations or biopsies were enrolled in the study using a non-probability sequential sampling technique. The inclusion criteria mandated participants to be adults aged 18 years or older, of any gender, presenting with suspected orbital masses that persisted for more than a few weeks. These individuals exhibited clinical symptoms such as pain, proptosis, or a lesion indicative of an orbital mass, yet lacked a confirmed diagnosis.

The recruitment process involved a comprehensive clinical evaluation, encompassing a detailed review of medical histories, physical examinations, and diagnostic imaging modalities. Imaging checks were conducted using a 1.5 Tesla MRI scanner. Exclusion criteria for MRI included hypersensitivity to contrast agents, claustrophobia, and impaired renal function indicated by blood creatinine levels exceeding 1.5 mg/dl. Additionally, individuals unwilling to undergo histological testing were excluded from the study.

Histological examinations were performed upon admission and at a three-month follow-up, representing the gold standard for the identification of orbital masses. This approach facilitated the distinction between benign and malignant orbital tumors by correlating MRI findings with biopsy data. Ethical guidelines were rigorously adhered to throughout the study, ensuring patient safety and data confidentiality. Informed consent was obtained from all participants, aligning with the ethical principles outlined in the Declaration of Helsinki.

Data were analyzed using SPSS version 26, with a 95% confidence interval adopted for statistical significance. Descriptive statistics, including mean ± standard deviation and the frequency and percentage of observed characteristics, were calculated. Furthermore, the study assessed the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy of MRI in detecting orbital masses. This comprehensive methodological approach was designed to contribute significantly to the field of diagnostic radiography, facilitating informed clinical decision-making for the care of patients with suspected orbital masses.

RESULTS

In the study conducted at Jinnah Postgraduate Medical Centre (JPMC), Karachi, involving 145 participants, the distribution of gender among the study population showed a slight predominance of female participants over males, with females constituting 55.2% (n=80) and males making up 44.8% (n=65) of the total participants. The age of the participants ranged broadly, with a mean age of 26.63 years and a standard deviation of 11.92 years. The majority of the study participants, 87.6% (n=127), were between the ages of 18 and 30 years, while those older than 30 years accounted for 12.4% (n=18) of the population. The analysis of the side of orbital tumors revealed that the left side was more frequently affected, with 57.9% (n=84) of cases, compared to 42.1% (n=61) on the right side (Table I).

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When examining the gender distribution across different types of orbital tumors (Table II), hemangiomas were evenly distributed between genders, each accounting for 9.0% (n=13) of the total cases. In contrast, meningiomas were more common in females, who represented 7.5% (n=11) of these cases, compared to 2.8% (n=4) in males. Pseudotumors, gliomas, and lacrimal adenomas also showed a varied distribution, with pseudotumors occurring in 6.9% (n=10) of males and 5.5% (n=8) of females, gliomas in 2.1% (n=3) of males and 6.2% (n=9) of females, and lacrimal adenomas in 3.4% (n=5) of males and 4.1% (n=6) of females. Dermoid cysts, schwannomas, and other tumor types exhibited a range of distributions among genders, further highlighting the diversity of orbital tumors encountered in the study population.

Table 1: Demographic Characteristics of Study Participants (n=145)

Variable	Total n (%)
Gender	
Male	65 (44.8%)
Female	80 (55.2%)
Age (Mean ± SD)	26.63 ± 11.92
18-30 years	127 (87.6%)
>30 years	18 (12.4%)
Side of Orbital Tumors	
Left	84 (57.9%)
Right	61 (42.1%)

Table 2: Gender Distribution of Each Tumor Type (n=145)

Type of Tumor	Total n (%)	Male n (%)	Female n (%)
Hemangioma	26 (18.0%)	13 (9.0%)	13 (9.0%)
Meningioma	15 (10.3%)	4 (2.8%)	11 (7.5%)
Pseudotumor	18 (12.4%)	10 (6.9%)	8 (5.5%)
Glioma	12 (8.3%)	3 (2.1%)	9 (6.2%)
Schwannoma	8 (5.5%)	3 (2.1%)	5 (3.4%)
Lacrimal Adenoma	11 (7.5%)	5 (3.4%)	6 (4.1%)
Dermoid Cyst	9 (6.2%)	6 (4.1%)	3 (2.1%)
Fibrous Dysplasia	3 (2.1%)	0 (0.0%)	3 (2.1%)
AVM	4 (2.8%)	3 (2.1%)	1 (0.7%)
Lymphoma	19 (13.1%)	9 (6.2%)	10 (6.9%)
Metastasis	14 (9.6%)	8 (5.5%)	6 (4.1%)
Choroid Melanoma	6 (4.1%)	1 (0.7%)	5 (3.4%)

Table 3: Comparison of MR Imaging and Histopathological Diagnosis (n=145)

Orbital Masses	MRI Diagnosis n (%)	Histopathology Diagnosis n (%)	P-Value
Benign Cases	33 (22.8%)	24 (16.6%)	0.313
Malignant Cases	112 (77.2%)	121 (83.4%)	

Table 4: Diagnostic Accuracy of MRI in Detecting Benign Orbital Masses

Diagnostic Variables	MRI
Sensitivity	81.82%
Specificity	96.43%
Positive Predictive Value	87.10%
Negative Predictive Value	94.74%
Diagnostic Accuracy	93.10%

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Table 5: Diagnostic Accuracy of MRI in Detecting Malignant Orbital Masses

Diagnostic Variables	MRI
Sensitivity	90.16%
Specificity	86.90%
Positive Predictive Value	83.33%
Negative Predictive Value	92.41%
Diagnostic Accuracy	88.28%

The comparison between MR imaging and histopathological diagnosis of orbital masses showed a higher incidence of malignant cases diagnosed through MRI, with 77.2% (n=112) of the MRI diagnoses being malignant compared to 83.4% (n=121) confirmed through histopathology. Benign cases comprised 22.8% (n=33) of the MRI diagnoses, which slightly differed from the histopathology results at 16.6% (n=24), indicating a degree of discrepancy between the two diagnostic methods (Table III).

Diagnostic accuracy of MRI in detecting benign orbital masses was evaluated, showing a sensitivity of 81.82%, specificity of 96.43%, positive predictive value (PPV) of 87.10%, negative predictive value (NPV) of 94.74%, and an overall diagnostic accuracy of 93.10% (Table IV). For malignant orbital masses, MRI demonstrated a sensitivity of 90.16%, specificity of 86.90%, PPV of 83.33%, NPV of 92.41%, and a diagnostic accuracy of 88.28% (Table V). These findings underscore the effectiveness of MRI in the diagnostic assessment of orbital masses, with high sensitivity, specificity, and diagnostic accuracy for both benign and malignant lesions, thereby reinforcing the pivotal role of MRI in the clinical evaluation and management of patients with suspected orbital masses.

DISCUSSION

In comparing the diagnostic capabilities of magnetic resonance imaging (MRI) for identifying orbital masses, the present study aligns with and extends previous research findings in this domain. Vijayvargiya R et al. demonstrated the efficacy of MRI in diagnosing benign orbital lesions, noting a sensitivity of 83%, specificity of 97%, and an overall diagnostic accuracy of 95% (8). This study similarly highlighted the utility of MRI in detecting malignant orbital lesions, with reported sensitivity and specificity of 91% and 83%, respectively (8). These findings resonate with the outcomes observed in the research conducted by Ro SR, et al., where the accuracy for non-cancerous growths was marked at 71.87%, and for malignant lesions, the sensitivity and specificity were 68.75% and 100%, respectively (13). Moreover, the investigations by De Graaf P, et al. (14) and Soliman AF, et al. (15) further corroborate the robustness of MRI in this context, offering sensitivities and specificities that closely match those recorded in our study.

The prevalence of metastasis and meningioma tumors found in this research, 9.6% and 10.3% respectively, provides an interesting comparison to the findings of Shields JA, et al., who identified metastatic tumors and meningioma in 7% and 4% of their patients, highlighting a slight variance in tumor type distribution (16). Additionally, the occurrence of dermoid cysts and schwannomas in our study population contrasts with the findings of Bastola P, et al., who reported these at 21% and 1.7%, respectively, suggesting variability in the prevalence of specific orbital tumors across different study cohorts (17).

The critical role of MRI in the preoperative assessment of orbital and ocular lesions, particularly in differentiating between benign and malignant conditions, underscores the necessity of accurate diagnostic tools in the clinical management and treatment planning for patients (18-20). The high sensitivity of MRI in detecting true positive cases of malignant orbital masses, as evidenced by the present study's diagnostic accuracy of 88.28%, underscores its significance in clinical practice. Nevertheless, the moderate specificity and occurrence of false positives necessitate cautious interpretation of MRI findings and, when appropriate, the integration of additional diagnostic modalities to confirm or refute suspected diagnoses.

The strength of this study lies in its comprehensive sample size and balanced gender distribution, enhancing its external validity and applicability across diverse patient demographics. The inclusion of a wide age range, particularly the emphasis on the 18–30 age group, and the detailed examination of tumor type incidence and its association with gender, contribute to a deeper understanding of orbital diseases. By comparing MRI findings with histopathological data, the study not only confirms the diagnostic accuracy of MRI but also enriches the existing literature with precise numerical data and critical diagnostic metrics.

However, the study is not without limitations. Its single-center design may impact the generalizability of the findings, and the focus on a specific age demographic could limit the applicability of the results to a broader patient population. Additionally, the research did not delve into the underlying reasons for gender disparities observed in certain tumor types, which could provide valuable insights for future studies. Despite these limitations, the study offers significant contributions to the field of diagnostic radiology, particularly in the evaluation of orbital masses, setting a foundation for future research endeavors.

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CONCLUSION

In conclusion, MRI has demonstrated high diagnostic accuracy in identifying and excluding non-benign tumors, with a high positive predictive value and an effective negative predictive value for ruling out benign conditions. The sensitivity of MRI in detecting malignant tumors highlights its crucial role in clinical diagnostics. However, the moderate rate of false positives emphasizes the importance of integrating MRI findings with other diagnostic approaches to ensure comprehensive and accurate patient assessments. Future research should aim to address the limitations observed in this study and explore the underlying factors influencing tumor prevalence and distribution among different demographics.

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