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Original Research Article

Comparative Analysis of B-Scan Ultrasonography and MRI for Intraocular and Orbital Mass Lesions at a Tertiary Care Hospital

Siddharth Nakra[1], Parikshit Dnyaneshwar Morey[2*]

[1]**Assistant Professor, Department of Ophthalmology,**
Mayo Institute of Medical Sciences, Barabanki, Lucknow, Uttar Pradesh, India.
[2*]**Assistant Professor, Department of Radiodiagnosis,**
Gouri Devi Institute of Medical Sciences & Hospital, Durgapur, West Bengal, India.

ABSTRACT

Background: Intraocular and orbital mass lesions comprise a broad spectrum of pathological entities, including benign and malignant neoplastic, inflammatory, vascular, congenital, and metastatic lesions. Accurate diagnosis and delineation of lesion extent are essential for appropriate management, treatment planning, and prognosis. Imaging plays a central role in the evaluation of these lesions, with B-scan ultrasonography serving as a rapid and accessible initial modality and magnetic resonance imaging (MRI) providing superior soft tissue characterization and assessment of deeper extension.

Aim: To comparatively analyze B-Scan ultrasonography and MRI for intraocular and orbital mass lesions at a tertiary care hospital.

Materials and Methods: A total of 82 patients with clinically suspected intraocular and orbital mass lesions were included. All patients underwent detailed clinical evaluation followed by both B-scan ultrasonography and MRI. Imaging findings were assessed for lesion location, size, internal characteristics, calcification, retinal detachment, optic nerve involvement, extraocular muscle infiltration, orbital apex or intracranial extension, and delineation of lesion extent. Final diagnosis was established by histopathology, surgical findings, or clinicoradiological follow-up.

Results: The majority of patients were in the 41–60 years age group (26.83%), with a slight male predominance (56.10%). Orbital lesions (58.54%) were more common than intraocular lesions (41.46%). Retinoblastoma was the most common lesion overall (17.07%), followed by cavernous hemangioma (12.20%) and dermoid/epidermoid cyst (10.98%). B-scan ultrasonography showed significantly better detection of calcification than MRI (21.95% vs 13.41%, p = 0.031). MRI was significantly superior in detecting optic nerve involvement (23.17% vs 10.98%, p = 0.021), extraocular muscle involvement (20.73% vs 8.54%, p = 0.018), orbital apex/intracranial extension (18.29% vs 4.88%, p = 0.006), and accurate delineation of lesion extent (92.68% vs 70.73%, p < 0.001). MRI demonstrated higher sensitivity (92.68%), specificity (95.12%), and accuracy (93.90%) than B-scan ultrasonography.

Conclusion: Both B-scan ultrasonography and MRI are valuable in the evaluation of intraocular and orbital mass lesions; however, MRI is superior for lesion characterization and extent assessment. B-scan remains an excellent initial and complementary imaging tool, particularly for calcification and intraocular evaluation, while MRI is the preferred modality for comprehensive diagnosis and pre-treatment planning.

Keywords: B-Scan Ultrasonography; Magnetic Resonance Imaging; Intraocular Mass Lesions; Orbital Mass Lesions; Diagnostic Accuracy.

***Correspondence to:**

Dr. Parikshit Dnyaneshwar Morey,
Assistant Professor,
Department of Radiodiagnosis,
Gouri Devi Institute of Medical Sciences & Hospital,
Durgapur, West Bengal, India.

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INTRODUCTION

Intraocular and orbital mass lesions constitute a diverse group of disorders that include neoplastic, inflammatory, vascular, congenital, and metastatic conditions arising from the globe, optic nerve complex, extraocular muscles, lacrimal gland, orbital fat, vascular structures, or adjacent paranasal and intracranial compartments. These lesions may occur in both children and adults and often present with overlapping clinical manifestations such as proptosis, diminished vision, ocular pain, diplopia, leukocoria, restricted ocular movements, palpable mass, or eyelid swelling. Because the orbit is a compact anatomical space

containing multiple closely related structures, even a relatively small lesion may produce significant visual morbidity or cosmetic deformity. At the same time, similar symptoms may be produced by lesions of markedly different pathology and prognosis, making imaging a central component in diagnosis, localization, characterization, treatment planning, and follow-up.[1]

A systematic anatomical approach is especially important in the evaluation of orbital and ocular masses. Localization of a lesion to the intraocular, optic nerve sheath, intraconal, extraconal, lacrimal gland, osseous, or diffuse orbital compartment helps narrow the differential diagnosis and guides the selection of the most appropriate imaging modality. Intraocular masses such as retinoblastoma, choroidal melanoma, choroidal hemangioma, and metastasis require different imaging priorities than lesions centered in the orbit, such as cavernous venous malformation, dermoid cyst, lymphoma, rhabdomyosarcoma, inflammatory pseudotumor, or optic nerve tumors. The need to distinguish benign from malignant disease, to assess local extension, and to identify associated complications underscores the value of combining careful clinical assessment with imaging techniques capable of showing both internal lesion characteristics and relationships to surrounding structures.[2]

B-scan ultrasonography remains one of the most useful first-line imaging modalities in ophthalmic practice because it is rapid, noninvasive, relatively inexpensive, widely available, and capable of real-time dynamic assessment. It is particularly valuable when direct ophthalmoscopic visualization is limited by cataract, vitreous hemorrhage, corneal opacity, hyphema, or poor pupillary dilatation. B-scan can demonstrate lesion size, shape, contour, reflectivity, internal echotexture, mobility, retinal detachment, vitreous pathology, choroidal detachment, and calcification, and it can be performed conveniently with the eyelids closed. Dynamic examination with multiple scan planes also improves visualization of membranes and posterior segment pathology. For these reasons, ultrasonography continues to serve as an important modality in the initial evaluation of intraocular masses and many orbital lesions, especially in settings where rapid bedside or outpatient assessment is required.[3] Despite its practical strengths, B-scan ultrasonography has recognized limitations. It is operator dependent, has a limited field of view beyond the globe and anterior orbit, and may be less reliable in demonstrating posterior orbital extension, orbital apex involvement, intracranial spread, bone changes, or subtle infiltration of adjacent soft tissues. Some lesions may also show overlapping sonographic patterns, particularly when deep-seated or associated with complex inflammatory changes. Consequently, although ultrasound can strongly suggest a diagnosis in many cases, it may not always provide complete lesion mapping or full tissue characterization. This has driven increasing reliance on cross-sectional imaging, particularly magnetic resonance imaging, for comprehensive evaluation of orbital disease and for better assessment of lesion extent, relation to the optic nerve, extraocular muscles, lacrimal gland, and intracranial structures.[4] MRI offers several advantages in the assessment of intraocular and orbital masses because of its excellent soft tissue contrast, multiplanar capability, absence of ionizing radiation, and ability to incorporate advanced sequences such as fat suppression, diffusion-weighted imaging, and contrast-enhanced imaging. These features make MRI particularly useful for evaluating lesion compartment, internal composition, enhancement characteristics, optic nerve involvement, muscle infiltration, bone marrow extension, orbital apex disease, and intracranial spread. In pediatric ophthalmic oncology, especially in retinoblastoma, MRI is preferred over radiation-based techniques for assessment of extraocular extension and associated intracranial abnormalities. More broadly, MRI has become central to the characterization of many orbital masses when clinical examination and ultrasound are insufficient to distinguish inflammatory, vascular, lymphoproliferative, and neoplastic lesions.[5]

Recent developments in orbital MRI have further expanded its diagnostic value. Diffusion-weighted imaging and related quantitative approaches have improved the ability to characterize tissue cellularity and assist in differentiating benign from malignant lesions, while still complementing rather than replacing conventional morphologic assessment. Multiparametric MRI may therefore provide additional confidence in difficult cases where appearances on routine sequences are not entirely specific. At the same time, the usefulness of MRI depends on appropriate protocol selection, careful interpretation in relation to the site of origin, and awareness of lesion-specific imaging patterns. Thus, a comparative understanding of what MRI adds beyond B-scan ultrasonography remains clinically relevant in both routine and complex cases. Modern orbital imaging practice increasingly emphasizes the complementary rather than mutually exclusive role of different modalities. While ultrasound is highly useful for rapid screening and posterior segment assessment, MRI contributes more detailed information regarding lesion extent and deep tissue involvement. Reviews of orbital imaging have stressed that no single modality is universally sufficient for all ocular and orbital pathologies, and that the choice of investigation should be tailored to the clinical question, suspected compartment of origin, patient age, and need for preoperative planning. In many patients, especially those with suspected neoplasms, the most accurate diagnostic pathway involves correlation of ultrasonographic findings with MRI features and, where required, tissue diagnosis.[6]

MATERIALS AND METHODS

This hospital-based observational study was conducted to comparatively analyze B-Scan ultrasonography and MRI for intraocular and orbital mass lesions at a tertiary care hospital. All eligible patients who were clinically suspected to have intraocular or orbital space-occupying lesions and were referred for imaging evaluation were included in the study.

A total of 82 patients with suspected intraocular and orbital mass lesions were enrolled in the study. Patients presenting with symptoms such as proptosis, diminution of vision, ocular pain, restricted ocular movements, leukocoria, palpable orbital swelling, or other clinical findings suggestive of intraocular or orbital mass lesions were considered for inclusion. Both adult and pediatric patients were included, irrespective of sex, provided they fulfilled the eligibility criteria and underwent both B-scan ultrasonography and MRI for comparative evaluation.

Inclusion criteria

Patients of any age and either sex with clinical suspicion of intraocular or orbital mass lesions were included in the study. Patients who underwent both B-scan ultrasonography and MRI as part of their diagnostic workup were considered eligible. Patients

with adequate clinical details, imaging findings, and final diagnosis based on histopathology, surgical findings, or clinicoradiological follow-up were included for final analysis.

Exclusion criteria

Patients who did not undergo both imaging modalities were excluded from the study. Patients with a history of recent major ocular trauma causing distorted anatomy unsuitable for meaningful comparative assessment were not included. Cases with severe motion artifacts on MRI, incomplete imaging records, poor patient cooperation leading to non-diagnostic examination, or lack of confirmatory final diagnosis were also excluded from analysis.

Methodology

A consecutive sampling technique was used, wherein all patients meeting the inclusion criteria during the study period of case recruitment were enrolled until the required sample size of 82 patients was achieved. This method was adopted to minimize selection bias and to ensure representation of the spectrum of intraocular and orbital mass lesions encountered in routine tertiary care practice.

Clinical Evaluation

All patients underwent detailed clinical assessment prior to imaging. Demographic data including age and sex were recorded. Relevant clinical history such as onset and duration of symptoms, pain, visual disturbance, proptosis, diplopia, history of prior ocular surgery, systemic malignancy, or inflammatory disease was noted. Ocular examination findings including visual acuity, anterior segment findings, fundus examination where feasible, ocular motility, pupillary reactions, and laterality of lesion were documented. The provisional clinical diagnosis was recorded before radiological assessment.

B-scan Ultrasonography Technique

B-scan ultrasonography was performed using a high-frequency ophthalmic ultrasound probe under standard aseptic precautions. Patients were examined in supine or comfortable sitting position with closed eyelids, and coupling gel was applied over the eyelid. Real-time axial, transverse, longitudinal, and dynamic scans were obtained in multiple planes to assess the globe and orbital contents. Lesions were evaluated for site, size, shape, margins, internal echotexture, reflectivity pattern, calcification, cystic changes, retinal detachment, choroidal detachment, vitreous hemorrhage, optic nerve involvement, extraocular muscle involvement, and retrobulbar extension. Dynamic examination was also used to assess lesion mobility, vascular pulsation where appreciable, and associated membrane aftermovements. Special attention was given to differentiating solid, cystic, vascular, and calcified lesions.

MRI Technique

MRI of the orbit and brain, wherever indicated, was performed using a standard dedicated protocol. Patients were examined in supine position with appropriate head immobilization using a surface coil or head coil. Imaging sequences included axial and coronal T1-weighted images, axial and coronal T2-weighted images, fat-suppressed sequences, diffusion-weighted imaging, and post-contrast T1-weighted fat-suppressed images in multiple planes following intravenous gadolinium administration, unless contraindicated. MRI assessment included lesion localization, compartment of origin, size, margins, signal intensity characteristics on T1- and T2-weighted images, contrast enhancement pattern, diffusion restriction, scleral or choroidal involvement, optic nerve infiltration, extraocular muscle involvement, orbital apex extension, intracranial extension, bone marrow involvement, and adjacent soft tissue infiltration. MRI was also evaluated for lesion multiplicity, perineural spread, and relationship of the mass to surrounding orbital structures.

Imaging Parameters Assessed

For comparative evaluation, both B-scan ultrasonography and MRI findings were analyzed using predefined imaging parameters. These included lesion location as intraocular, intraconal, extraconal, optic nerve related, or diffuse orbital; lesion dimensions; shape; margin definition; internal architecture; presence of calcification; cystic or necrotic areas; retinal or choroidal detachment; optic nerve involvement; extraocular muscle involvement; retrobulbar or orbital apex extension; intracranial extension; and associated complications. The ability of each modality to characterize the lesion as benign or malignant, vascular or non-vascular, cystic or solid, and its capability to define local extent was also assessed. Final radiological impression from each modality was recorded separately and later correlated with the reference standard diagnosis.

Statistical Analysis

The collected data were entered into Microsoft Excel and analyzed using SPSS software version 21.0. Quantitative variables such as age and lesion size were expressed as mean and standard deviation or median and interquartile range, as appropriate. Qualitative variables such as sex, lesion location, type of lesion, imaging characteristics, and diagnostic categories were expressed as frequencies and percentages. The diagnostic performance of B-scan ultrasonography and MRI was assessed by calculating sensitivity, specificity, positive predictive value, negative predictive value, and accuracy. Agreement between imaging modalities and the final diagnosis was evaluated using appropriate statistical tests such as the chi-square test or Fisher's exact test wherever applicable. Kappa statistics were used to assess agreement between B-scan ultrasonography and MRI findings. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The present study included a total of 82 patients with suspected intraocular and orbital mass lesions. The age distribution showed that the majority of patients were in the 41–60 years age group (26.83%), followed by the 21–40 years age group (24.39%), indicating that middle-aged individuals constituted the largest proportion of cases. Pediatric patients (0–10 years) accounted for 17.07%, which is clinically significant as it reflects the presence of childhood tumors such as retinoblastoma. Similarly, patients above 60 years also contributed 17.07%, suggesting an increased incidence of age-related neoplastic conditions in the elderly population. There was a slight male predominance in the study, with 56.10% males compared to 43.90% females, suggesting a marginally higher occurrence or referral rate among males. With regard to laterality, unilateral involvement was more common, with the right eye affected in 42.68% and the left eye in 37.80% of patients, while bilateral involvement was observed in 19.51% of cases. (Table 1)

The distribution of lesions based on anatomical location revealed that orbital lesions (58.54%) were more common than intraocular

lesions (41.46%) in the study population. Among intraocular lesions, a higher proportion were malignant (29.27%) compared to benign (12.20%), indicating that intraocular masses were more likely to be malignant in nature. In contrast, orbital lesions were predominantly benign, with 37.80% benign lesions compared to 20.73% malignant lesions. Overall, the study demonstrated an equal distribution of benign and malignant lesions, each accounting for 50.00% of the total cases. The association between anatomical site and biological behavior was found to be statistically significant (p = 0.011), indicating that lesion location is an important determinant of malignancy. (Table 2)

The spectrum of final diagnoses in this study reflected a wide variety of intraocular and orbital pathologies. Retinoblastoma (17.07%) emerged as the most common lesion overall, highlighting its clinical importance, particularly in the pediatric population. Among orbital lesions, cavernous hemangioma (12.20%) was the most frequent benign tumor, followed by dermoid/epidermoid cysts (10.98%) and inflammatory pseudotumor (9.76%), which are commonly encountered in clinical practice. Malignant lesions included choroidal melanoma (8.54%), orbital lymphoma (6.10%), rhabdomyosarcoma (7.32%), and lacrimal gland tumors (7.32%), demonstrating the diversity of malignant pathologies affecting the orbit and globe. Tumors involving the optic nerve, such as optic nerve glioma (7.32%) and optic nerve sheath meningioma (4.88%), were also observed. Metastatic lesions accounted for a smaller proportion (3.66%), but remain clinically significant due to their systemic implications. (Table 3)

The comparative analysis of imaging findings demonstrated distinct strengths and limitations of both modalities. B-scan ultrasonography showed significantly better detection of calcification (21.95%) compared to MRI (13.41%), and this difference was statistically significant (p = 0.031), underscoring the well-known superiority of ultrasound in identifying calcified intraocular lesions such as retinoblastoma. In contrast, MRI was significantly superior in detecting optic nerve involvement (23.17% vs 10.98%, p = 0.021), extraocular muscle involvement (20.73% vs 8.54%, p = 0.018), and orbital apex or intracranial extension (18.29% vs 4.88%, p = 0.006). These findings highlight the advantage of MRI in evaluating deep orbital structures and disease extent. Furthermore, MRI demonstrated markedly better performance in accurate delineation of lesion extent (92.68% vs 70.73%), with a highly significant difference (p < 0.001). There was no statistically significant difference between the two modalities in detecting retinal detachment (p = 0.289) or cystic/necrotic components (p = 0.581), indicating that both techniques are comparably effective for these parameters. (Table 4)

The diagnostic performance analysis demonstrated that both imaging modalities were effective in characterizing malignant lesions; however, MRI consistently outperformed B-scan ultrasonography across all parameters. MRI showed higher sensitivity (92.68%) compared to B-scan (82.93%), indicating a better ability to correctly identify malignant lesions. Similarly, MRI demonstrated superior specificity (95.12% vs 87.80%), reflecting its higher accuracy in ruling out benign conditions. The positive predictive value (95.00%) and negative predictive value (92.86%) of MRI were also higher than those of B-scan (87.18% and 83.72% respectively), indicating greater reliability in both confirming and excluding malignancy. The overall diagnostic accuracy of MRI (93.90%) was significantly higher than that of B-scan (85.37%), with a statistically significant difference (p = 0.041). Agreement with the reference standard diagnosis, as measured by kappa statistics, was substantial for B-scan (κ = 0.71) and almost perfect for MRI (κ = 0.88), with a highly significant difference (p < 0.001). (Table 5)

Table 1. Baseline demographic and clinical profile of study participants (n = 82)

Variable	Number (n)	Percentage (%)
Age group (years)		
0–10	14	17.07
11–20	12	14.63
21–40	20	24.39
41–60	22	26.83
>60	14	17.07
Sex		
Male	46	56.10
Female	36	43.90
Laterality		
Right	35	42.68
Left	31	37.80
Bilateral	16	19.51

Table 2. Distribution of lesions according to anatomical site and biological nature (n = 82)

Site of lesion	Benign n (%)	Malignant n (%)	Total n (%)	p value
Intraocular	10 (12.20)	24 (29.27)	34 (41.46)	
Orbital	31 (37.80)	17 (20.73)	48 (58.54)	
Total	41 (50.00)	41 (50.00)	82 (100.00)	0.011

Chi-square test applied.

Table 3. Final diagnosis of intraocular and orbital mass lesions (n = 82)

Final diagnosis	Number (n)	Percentage (%)
Retinoblastoma	14	17.07
Choroidal melanoma	7	8.54
Ocular/orbital metastasis	3	3.66
Choroidal hemangioma	4	4.88
Optic nerve glioma	6	7.32
Optic nerve sheath meningioma	4	4.88
Cavernous hemangioma	10	12.20
Dermoid/Epidermoid cyst	9	10.98
Inflammatory pseudotumor	8	9.76
Orbital lymphoma	5	6.10
Rhabdomyosarcoma	6	7.32
Lacrimal gland tumors	6	7.32
Total	82	100.00

Table 4. Comparative detection of important imaging findings by B-scan ultrasonography and MRI (n = 82)

Imaging parameter	B-scan USG n (%)	MRI n (%)	p value
Calcification	18 (21.95)	11 (13.41)	0.031
Retinal detachment	16 (19.51)	12 (14.63)	0.289
Cystic component/necrosis	21 (25.61)	24 (29.27)	0.581
Optic nerve involvement	9 (10.98)	19 (23.17)	0.021
Extraocular muscle involvement	7 (8.54)	17 (20.73)	0.018
Orbital apex/intracranial extension	4 (4.88)	15 (18.29)	0.006
Accurate delineation of lesion extent	58 (70.73)	76 (92.68)	<0.001

Table 5. Diagnostic performance of B-scan ultrasonography and MRI in characterization of malignant lesions (reference standard-based analysis)

Parameter	B-scan USG (%)	MRI (%)	p value
Sensitivity	82.93	92.68	
Specificity	87.80	95.12	
Positive predictive value	87.18	95.00	
Negative predictive value	83.72	92.86	
Accuracy	85.37	93.90	0.041
Kappa value	0.71	0.88	<0.001

DISCUSSION

In the present study, the largest proportion of patients belonged to the 41–60 year age group (26.83%), followed by 21–40 years (24.39%), with a slight male predominance (56.10%) and predominantly unilateral disease. This pattern is broadly in agreement with the age-related behavior of orbital and ocular masses reported by Shields et al. (2004), who analyzed 1,264 orbital tumors and simulating lesions and found that malignancy increased with age, accounting for 20% of lesions in children, 27% in patients aged 19–59 years, and 58% in older patients aged 60–92 years. Our study also showed that patients older than 60 years constituted 17.07% of the cohort, supporting the observation that advancing age is associated with a higher probability of serious neoplastic pathology, although our overall sample included both intraocular and orbital lesions and therefore showed a more mixed age distribution than a pure orbital oncology series.[7] With respect to anatomical distribution and biological nature, orbital lesions were more common than intraocular lesions in our series (58.54% vs 41.46%), while intraocular lesions were more often malignant (29.27%) than benign (12.20%). This site-based difference was statistically significant (p = 0.011). Bonavolontà et al. (2013), in their analysis of 2,480 orbital space-occupying lesions, similarly observed a predominance of benign lesions overall, with 1,697 benign lesions (68%) and 783 malignant lesions (32%), and also noted that benign lesions were more frequent below 60 years whereas malignancy increased in older patients. Compared with that series, our study demonstrated a relatively higher malignant burden, likely because intraocular tumors such as retinoblastoma and choroidal melanoma were included alongside orbital lesions, thereby shifting the benign–malignant balance toward equivalence (50.00% benign and 50.00% malignant).[8] The histopathological spectrum in our study was heterogeneous, with retinoblastoma being the single most common lesion overall (17.07%), followed by cavernous hemangioma (12.20%), dermoid/epidermoid cyst (10.98%), and inflammatory pseudotumor (9.76%). In contrast, Shinder et al. (2011), in a comprehensive cancer-center-based series of 268 orbital tumors, found a much higher overall malignant proportion (63%), with lymphoma as the most frequent

diagnosis (19%), followed by orbital extension of sinus tumor (9%) and lacrimal gland adenoid cystic carcinoma (7%), whereas cavernous hemangioma accounted for only 6%. Our lower frequency of lymphoma (6.10%) and metastasis (3.66%) compared with their 19% and 10%, respectively, probably reflects the broader tertiary-care referral base of our study rather than the highly selected oncologic population studied by Shinder et al. (2011).[9] The pediatric component of our cohort was clinically important, with 17.07% of patients in the 0–10 year age group and retinoblastoma contributing 17.07% of all lesions. This finding is consistent with the recognized dominance of retinoblastoma among childhood intraocular malignancies. Gao et al. (2016), in a retrospective series of 253 children with retinoblastoma, reported a median age at onset of 21 months, bilateral disease in 19.8%, leukocoria in 71%, and intraocular disease in 91.3% of cases. Our proportion of bilateral disease in the entire mixed cohort was 19.51%, which is remarkably close to the bilateral retinoblastoma rate in that retinoblastoma-only study, suggesting that the bilateral cases in our series were likely driven largely by pediatric retinoblastoma and a small number of metastatic or multifocal lesions.[10] One of the most notable findings in our study was the significantly better detection of calcification by B-scan ultrasonography compared with MRI (21.95% vs 13.41%, p = 0.031). This observation is in line with the work of Rodjan et al. (2015), who studied 22 retinoblastoma eyes and showed that all calcifications seen on high-resolution CT could be matched with signal-intensity voids on T2*-weighted MRI; correlation was excellent in 77% and good in 23% of eyes, and 93% of intratumoral signal-intensity voids corresponded to calcification. Despite those promising MRI results, our routine MRI protocol still underperformed B-scan for calcification detection, which is understandable because dedicated gradient-echo or susceptibility-weighted retinoblastoma protocols are not always part of standard orbital MRI in all patients, whereas B-scan remains highly sensitive for echogenic calcific foci in daily practice.[11] In contrast to calcification, MRI was clearly superior in our study for defining lesion extent and deep structural involvement. Optic nerve involvement was detected in 23.17% on MRI versus 10.98% on B-scan (p = 0.021), extraocular muscle involvement in 20.73% versus 8.54% (p = 0.018), and orbital apex/intracranial extension in 18.29% versus 4.88% (p = 0.006). Schueler et al. (2003), in a histopathologic correlation study of 21 retinoblastoma cases, reported that MRI visualized all retinoblastomas, but subtle optic nerve infiltration remained difficult to define, with seven histologically proven optic disc or optic nerve infiltrations not being precisely differentiated on MRI, and all nine cases of vitreous seeding being missed. Their study therefore emphasized both the strength and limitation of MRI: superior spatial delineation of tumor bulk, but incomplete detection of microscopic invasion. Our results agree with the former point, because MRI was significantly better than B-scan for assessing deep extension, yet they also support the continued need for clinicopathologic correlation where microscopic spread is suspected.[12] Our finding that MRI was better for lesion characterization and overall delineation of lesion extent (92.68% vs 70.73%, p < 0.001) also parallels the dynamic contrast-enhancement behavior described by Tanaka et al. (2004). In their study of 16 unilateral orbital tumors, including eight cavernous hemangiomas and eight schwannomas, all hemangiomas showed early enhancement beginning from one point or one portion, whereas all schwannomas enhanced from a wide area; this difference was highly significant (p < 0.0001).[13]At the same time, the present data also confirm the practical value of ultrasonography as an initial and complementary modality. Although our B-scan showed lower overall accuracy than MRI for malignant lesion characterization (85.37% vs 93.90%), it still performed well for retinal detachment and cystic/necrotic change, with no statistically significant difference from MRI for these parameters. Nagaraju et al. (2015), in 100 eyes of 85 patients, reported that ultrasonography distinguished intraocular from extraocular pathology in 100% of cases; for intraocular lesions, overall sensitivity, specificity, and accuracy were 94.2%, 98.8%, and 94.9%, respectively, while for extraocular lesions they were 94.2%, 99.2%, and 95.2%. Their data, like ours, support the view that ultrasonography is highly valuable for localization and first-line characterization, but that cross-sectional imaging is still required when there is concern for extension to adjacent structures or intracranial spread.[14]

Finally, the diagnostic performance analysis in our study showed that MRI outperformed B-scan in every major statistical indicator for malignant lesion characterization, with sensitivity of 92.68% versus 82.93%, specificity of 95.12% versus 87.80%, and overall accuracy of 93.90% versus 85.37% (p = 0.041). Agreement with the reference standard was also higher for MRI (κ = 0.88) than for B-scan (κ = 0.71). These results compare favorably with the DWI-based MRI study of Hemat (2017), who evaluated 38 orbital masses and reported that an ADC cutoff of 0.93 × 10 differentiated malignant from benign lesions with 80.0% sensitivity, 83.3% specificity, and 82.0% accuracy. The higher values in our study likely reflect the fact that routine contrast-enhanced multiplanar MRI assessment was combined with morphologic evaluation rather than relying on diffusion metrics alone. Nevertheless, both studies point in the same direction: MRI, particularly when combined with advanced sequences, is the more reliable modality for distinguishing benign from malignant intraocular and orbital mass lesions.[15]

CONCLUSION

B-scan ultrasonography and MRI were both useful in the evaluation of intraocular and orbital mass lesions, but MRI showed superior overall diagnostic performance. B-scan was particularly valuable for detecting calcification and assessing intraocular details, whereas MRI was more effective in defining lesion extent, optic nerve involvement, extraocular muscle infiltration, and intracranial extension. MRI also demonstrated higher sensitivity, specificity, and diagnostic accuracy in differentiating malignant from benign lesions. Thus, B-scan serves as an excellent initial and complementary imaging modality, while MRI remains the investigation of choice for comprehensive characterization and pre-treatment assessment of intraocular and orbital mass lesions.

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