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A clinical study of orbital lesions in a tertiary health center of central India: Sonological Evaluation

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Abstract

Purpose: To evaluate the role of B- scan Ultrasonography and color Doppler in orbital diseases, in differentiating ocular and extraocular diseases. Further to assess tumor location, configuration, extent and relationship to an adjacent structure and to establish the etiology of proptosis.

Methods: 100 eyes of 85 patients were examined with B- scan ultrasonography and colour Doppler flow imaging using linear high frequency probe (5 to 17 MHz) of the ultrasound system. The final diagnosis was made based on clinical findings with laboratory parameters or imaging with higher cross-sectional modality or surgery with histopathology (as applicable).

Results: The distinction between ocular and extraocular pathologies was made in 100% of cases. The overall sensitivity, specificity, (Positive Predictive Value) PPV, (Negative Predictive Value) NPV and accuracy of ultrasonography for the diagnosis of ocular pathologies were 94.2%, 98.8%, 99.1%, 92.2% and 94.9% (p-value < 0.0001) compared to 62.5%, 98.8%, 98.7%, 64.8% and 62.7% for ophthalmoscopic examination respectively. The sensitivity, specificity, PPV, NPV and accuracy of ultrasound for the diagnosis of extraocular pathologies were 94.2%, 99.2%, 98.8%, 95.9% and 95.2% respectively with a p-value < 0.0001.

Conclusion: B-scan Ultrasonography was the initial imaging modality opted for in most the cases as it was a readily available, simple, cost-effective, nonionizing, noninvasive and reliable modality. It superseded the accuracy of ophthalmoscopic diagnosis with a significant difference (p-value < 0.0001) in the diagnosis of ocular pathologies.

Keywords: B-scan; Color Doppler flow imaging; CT; Orbital; MRI; Sonological.

Intruduction

Ultrasonography (USG) provides a detailed cross-sectional anatomy of the entire globe and an excellent topographic visualization combined with the real-time display of the moving organ which is critical in its ability to localize and characterize the pathology [1]. Recent studies have shown a specificity of 99% and a sensitivity of 93% with the use of non-dedicated eye scanners.

It is a powerful noninvasive tool for the accurate diagnosis and effective management of intraocular tumors4. It readily demonstrates intra-ocular tumor morphology, location, extent, and relationship to adjacent structures [2,3]. B- mode real-time ultrasonography is nonhazardous, atraumatic, and

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invaluable in evaluating orbital- ocular lesions, especially in the presence of opaque media when there is a suspicion of an intraocular mass [3,8].

Colour Doppler flow imaging (CDFI) is a new modality with the ability to detect and analyze low flows [6]. Its main indications are the diagnosis of intraocular tumors, the follow-up of malignant melanoma after conservative treatment, and the study of space-occupying lesions of the orbit [7].

The vascularity of these tumors is detected and quantified by this technique and this reduces even before the tumor diminishes in size, giving an early clue to the activity of therapy [7].

The superficial location of the eye, its cystic composition, presents a formidable challenge for both the radiologist and the ophthalmologist owing to the complicated anatomical structure of the orbit and its contents. The aim this study is to evaluate the role of B-scan Ultrasonography and color Doppler in orbital diseases, in differentiating ocular and extraocular diseases. Further to assess tumor location, configuration, extent and relationship to an adjacent structure and to establish the etiology of proptosis.

Methods

A prospective correlational study was conducted over a period of two years (November 2020 to October 2021) on 100 eyes of 85 patients with symptoms related to eye and orbit at a tertiart health care center. The patients were evaluated with high resolution ultrasonography and colour Doppler imaging using high frequency linear probe of ultrasound system. The ultrasonographic diagnoses were correlated with the clinical and laboratory findings. Correlation with advanced imaging modalities (CT / MRI) and surgery with histopathology were done as necessary. Patients with clinically suspected orbital lesions i.e. patients presenting with proptosis, suspected orbital mass, complete loss / diminution of vision, leucokoria, pain, redness and discharge were included in the study. Patients with orbital trauma were excluded from the study.

Technique of Sonographic study:

With the patient in supine position, Ultrasound was performed with closed eyelid after application of coupling gel utilizing contact method. Linear high frequency probe (5 to 9 MHz) of ultrasound system was used for the study.

Longitudinal and transverse axis scans were performed, both in static and with dynamic movements of eye after instructing the patients. Colour Doppler flow imaging was done in all cases.

Ultrasonographic diagnosis was made based on various acoustic characteristics studied in conjunction with clinical data. Higher imaging modalities (CT/ MRI) were employed where necessary and findings were correlated with ultrasonographic diagnosis. Surgery with histopathological correlation was done as applicable. Final diagnosis was made based on these findings and compared with the ultrasonographic diagnosis.

Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean+/- SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance. Fisher Exact test has been used to find the significance of association of Sonological diagnosis with Final diagnosis. Diagnostic statistics such as sensitivity, Specificity, PPV, NPV and Accuracy has been used to find the correlation of CT scan with final diagnosis.

Results / Case report

In the study, the maximum percentage of patients were in the age group of 41- 50 yrs (26%) with mean age of presentation being 42.6 years. Maximum number of cases of vitreous haemorrhage was in the age range of 31 to 50 years and those of retinal detachment in 31 to 40 years. Degenerative entities like posterior vitreous detachment (PVD) and vitreous floaters (VF) were in 41 to 60 years All cases of retinoblastoma and primary hyperplastic vitreous (PHPV) were in the first decade. Choroidal melanoma and metastasis were noted in the 5th and 6th decades. Inflammatory conditions like scleritis and endophthalmitis were in the 3rd and 4th decades.

Orbital pathologies observed in our study were predominant in the 5th decade (26%) with a near uniform gender predilection (M: F: 1:1.04). A slight predilection for involvement of right eye (45%) was noted with 17% of cases having bilateral involvement. The presenting complaints were predominantly proptosis followed by loss of vision. Retinoblastoma was the common ocular pathology to cause proptosis and hemangioma was the common extraocular pathology to do so. 31% of referrals were made for the evaluation of proptosis followed by 28% for suspected orbital mass. Commonest ocular pathology was vitreous haemorrhage followed by retinal detachment. Commonest extraocular pathology was extraocular cysticercosis followed by hemangioma in our study. The distinction between ocular and extraocular pathologies was made in 100% of cases. The overall sensitivity, specificity, PPV, NPV and accuracy of ultrasound for the diagnosis of ocular pathologies were 94.2%, 98.8%, 99.1%, 92.2% and 94.9 (p- value < 0.0001) respectively compared to 62.5%, 98.8%, 98.7%, 64.8% and 62.7% for ophthalmoscopic examination. The overall sensitivity, specificity, PPV, NPV and accuracy of ultrasound for the diagnosis of extraocular pathologies were 94.2%, 99.2%, 98.8%, 95.9% and 95.2% respectively with a p- value < 0.0001. Most of the cases of vitreous hemorrhage (VH) and retinal detachment (RD) were predominantly

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seen in male patients, PHPV and retinoblastoma (RB) were predominantly seen in females. Choroidal melanoma was equally distributed among both genders. One case of choroidal metastasis was seen in female patient with carcinoma thyroid Inflammatory conditions like scleritis and endophthalmitis were seen predominantly in male patients. Cataract were predominant in female patients. Optic glioma had an equal gender predilection in our study whereas one case of optic nerve meningioma was seen in middle aged female patient. Hemangiomas were predominant in males Graves orbitopathy were predominant in females. Extraocular cysticercosis had a female predilection Lymphoma predominantly involved male patients. Lacrimal gland pleomorphic adenoma and lacrimal sac carcinoma were seen in females in our study. One case of AV Malformation involved an elderly female patient. Bilateral lesions were seen in 15 patients (17%). Most common indication for ultrasound examination was proptosis followed by suspected orbital mass in our study. Indication for USG are mentioned in figure 1.

There were overall 42 cases in extraocular space of which 41% were extraconal, 27% intraconal, 24% conal and 8% preseptal respectively (Fig 2). Extracocular cysticercosis was the most common pathology followed by hemangioma.

The sensitivity, specificity and accuracy of ultrasound diagnosis of extraocular pathologies were calculated. The values were 75.0%, 99.5% & 80% for hemangioma and 62.5%, 99.5% & 66.7% for lymphoma respectively. The overall sensitivity was 94.2%, specificity was 99.2% and accuracy was 95.2% for ultrasound diagnosis (table 1).

The extraocular masses were divided into four categories based on various acoustic characteristics as described in the pathogenesis. Acoustically cystic masses were predominantly hemangioma and dermoid. Figure 3a,3b and 3c summarize Colour Doppler signal in various orbital pathologies

Acoustically solid masses were predominantly optic glioma. One case of AV Malformation was acoustically angiomatous. Lymphomas followed by pseudo tumours were acoustically infiltrative masses. Ocular pathologies

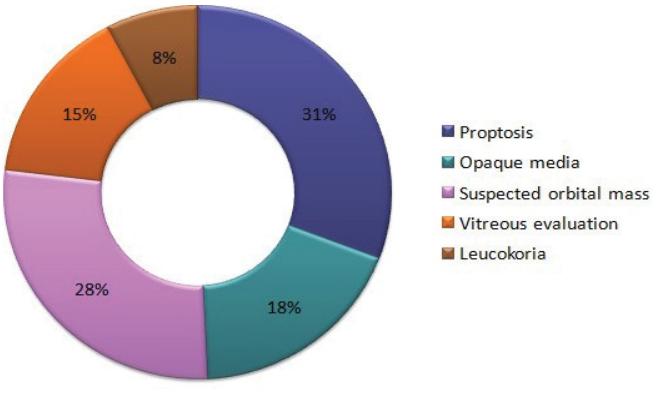

Figure 1: Indication for ophthalmic ultrasound

Table 1: Orbital pathologies: Sonological diagnosis

PARAMETER	SONOLOGICAL DIAGNOSIS	
	OCULAR	EXTRAOCULAR
SENSITIVITY	94.2%	94.2%
SPECIFICITY	98.8%	99.2%
PPV	99.1%	98.8%
NPV	92.2%	95.9%
ACCURACY	94.9%	95.2%
p- VALUE	<0.0001	<0.0001

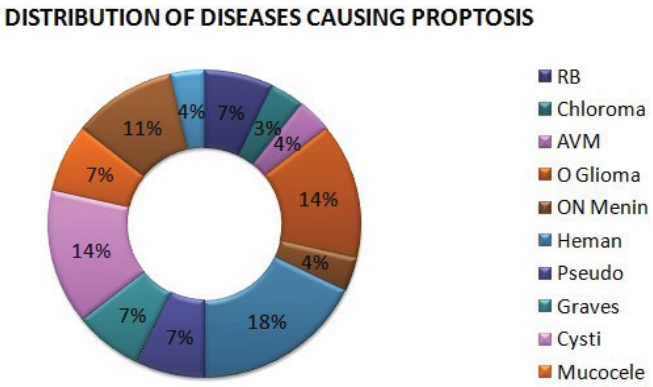

Figure 2: Distribution of disease causing proptosis

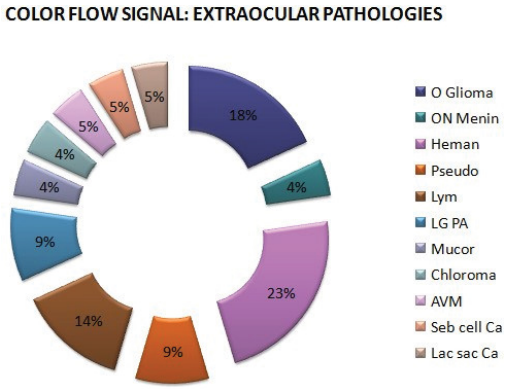

Figure 3a: Colour flow signal: extraocular pathology

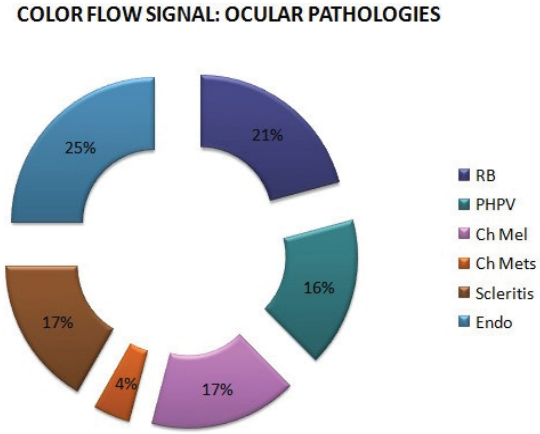

Figure 3b: Colour flow signal: Ocular pathology

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were predominantly degenerative followed by neoplastic. Extraocular pathologies were predominantly inflammatory / infective followed by neoplastic in our study. Overall inflammatory / infective pathologies predominated followed by neoplastic pathologies in this study.

Discussion

In our study, the maximum percentage of patients were in the 5th decade (26%) with the mean age of presentation being 42.6 years. The most common indication for sonographic examination was proptosis followed by suspected orbital mass in our study. There was a total of 59 cases in the ocular space, with 5 in anterior segment and 54 in posterior segment of the globe. Of the 11 vitreous haemorrhage cases, 2 were missed on ultrasound and out of 4 choroidal melanoma, one was missed. Totally 56 out of 59 cases were correctly diagnosed by ultrasound. Out of 59 cases, only 37 were correctly diagnosed on ophthalmoscopic examination. Higher cross sectional imaging modalities like CT / MRI were required in 29 cases for evaluation of bony involvement, involvement of adjacent structures like para nasal sinuses and intracranial extension. The overall sensitivity, specificity, PPV, NPV and accuracy of ultrasound for the diagnosis of ocular pathologies were 94.2%, 98.8%, 99.1%, 92.2% and 94.9% (p-value < 0.0001) respectively compared to 62.5%, 98.8%, 98.7%, 64.8% and 62.7% for ophthalmoscopic examination.

There were overall 42 cases in extraocular space, of which 41% were in extraconal, 27% in intraconal, 24% in conal and 8% in preseptal compartments respectively. One case of hemangioma (Figure 4) and one case of lymphoma were falsely diagnosed as optic nerve tumor and pseudotumor respectively on ultrasound. Out of 42 cases, 40 were correctly diagnosed by ultrasound.

Ocular pathology causing proptosis was predominantly retinoblastoma in our study. Extraocular pathology presenting with proptosis was predominantly hemangioma followed by cysticercosis. Ultrasound was 100% effective in differentiating ocular and extraocular pathologies.

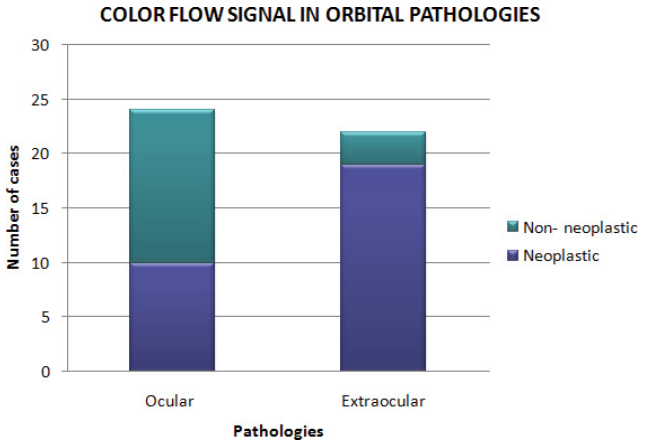

Figure 3c: Colour flow signal in orbital pathology

Sharma OP in his study found VH followed by RD to be the most common intraocular pathology whereas pseudo tumor and Graves formed predominant extraocular pathologies [2]. The most common intraocular pathology causing proptosis was retinoblastoma and extraocular pathologies were pseudo tumor and Graves [4].

Ultrasound had 97% accuracy for diagnosing VH, 99% for RD and 100% for lacrimal gland and optic nerve tumors. Nzeh DA et al in their study found RD to be the commonest intraocular pathology and retinoblastoma formed the commonest intraocular neoplasm. Ultrasound was 93% sensitive and 99% specific in diagnosing oculo- orbital lesions [3].There was 88.6% agreement between clinical and ultrasonographic diagnosis. Ukponmwan CU et al found 92.3% correlation between clinical and ultrasonographic diagnosis [9]. Scott IU et al found 96% correlation between final clinical or pathological diagnosis and ultrasonographic diagnosis in their study [11]. Fielding JA in his study found ultrasound to be 92% sensitive in diagnosing intraocular pathologies [10]. Itani KM et al found ultrasound to be 100% successful in diagnosing orbital mass. Accurate diagnosis was made in 78% of cases with ultrasound, 52% with clinical and 55% with radiologic examination [18]. **Vitreous haemorrhage** was the commonest ocular pathology in our study. Ultrasound was 95% sensitive, 97.3% specific and 81.8% accurate in diagnosing VH. Sharma OP found ultrasound to be 97% sensitive for diagnosing VH [2]. **Retinal detachment**: Ultrasound was 100% sensitive and accurate in diagnosing all 7 cases of RD in our study. It also formed an important tool in following up these cases. Jemeld B et al found ultrasound to be 78% accurate for diagnosing RD [12]. Rabinowitz R et al found 100% accuracy in diagnosing RD with ultrasound [13]. **Posterior Vitreous Detachment and Vitreous Floaters**: All 4 cases of PVD and 3 cases of VF were correctly diagnosed by ultrasound. Retinoblastoma: All 5 cases of RB were in first decade in our study and were correctly diagnosed by ultrasound. They formed the most common ocular neoplasm and the commonest ocular pathology to cause proptosis (7%) and leucokoria in our study. Zilelioglu G et al in his study found ultrasound to be correct in diagnosing 87.12% of retinoblastoma [17].The results were false negative in 9.09% and false positive in 3.79% of cases. **Persistent Hyperplastic Primary Vitreous (PHPV)**: All 4 cases of PHPV were in first decade and were correctly diagnosed with ultrasound, especially with colour Doppler which demonstrated flow in posterior hyaloids artery in all 4 cases. **Choroidal Melanoma**: 4 cases of choroidal melanoma were present in our study, in 4th & 5th decades. 3 cases were correctly diagnosed whereas one case was missed due to small subretinal lesion with associated exudative RD which precluded its visualization. This lesion was picked up subsequently at the follow up scan. Ultrasound was 87.5% sensitive, 98.5% specific and 75% accurate in diagnosing

melanoma. Byrne et al in the Collaborative Ocular Melanoma Study group (COMS) concluded that the level of agreement for echographic tumour grading for ocular melanoma to be 'moderate' to 'almost perfect' [14]. Boldt HC et al in COMS group studied 2320 patients for baseline echographic characteristics of choroidal melanoma and found that 96% cases were consistent with diagnosis of melanoma [15]. Scott IU et al concluded that ultrasound was 100% effective in diagnosing extraocular extension of choroidal melanoma whereas CT/MRI were only 29% effective in doing so [16,5]. Ocular pathologies were predominantly degenerative followed by neoplastic whereas extraocular pathologies were predominantly inflammatory / infective followed by neoplastic in our study. Overall ultrasonography has reasonably high sensitivity and specificity with high diagnostic accuracy in the diagnosis of both ocular and extraocular lesions of orbit.

Conclusion

Ultrasonography was the initial imaging modality opted in most of the cases as it was readily available, simple, cost effective, non-ionizing, noninvasive and reliable modality. It superseded the accuracy of ophthalmoscopic diagnosis with significant difference (p- value < 0.0001). Sonological diagnosis correlated very well with the final diagnosis established by higher modalities, follow up and histopathology (as applicable). Sonological diagnosis formed a major basis for management decisions in significant number of cases. It was a major tool for the follow up of cases.

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