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Original Article

Radiology Section

Efficacy of High Frequency Ultrasound in Localization and Characterization of Orbital Lesions

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ABSTRACT

Background: The complicated anatomy of orbit and the wide spectrum of pathological conditions present a formidable challenge for early diagnosis, which is critical for management. Ultrasonography provides a detailed cross sectional anatomy of the entire globe with excellent topographic visualization and real time display of the moving organ.

Objectives of the study: To evaluate the efficacy of high frequency Ultrasound in localization of orbital diseases and to characterize various orbital pathologies sonologically.

Materials and Methods: Hundred eyes of 85 patients were examined with ultrasound using linear high frequency probe (5 to 17 MHz) of PHILPS IU22 ultrasound system. Sonological diagnosis was made based on location, acoustic characteristics, kinetic properties and Doppler flow dynamics. Final diagnosis was made based on clinical & laboratory findings/higher cross-sectional imaging/surgery & histopathology (as applicable). Diagnostic accuracy of ultrasonography was evaluated and compared with final diagnosis.

Results: The distinction between ocular and extraocular pathologies was made in 100% of cases. The overall sensitivity, specificity, NPV and accuracy of ultrasonography were 94.2%, 98.8%, 92.2% & 94.9% respectively for diagnosis of ocular pathologies and 94.2%, 99.2%, 95.9% & 95.2% respectively for extra ocular pathologies.

Conclusion: Ultrasonography is a readily available, simple, cost effective, non ionizing and non invasive modality with overall high diagnostic accuracy in localising and characterising orbital pathologies. It has higher spatial and temporal resolution compared to CT/MRI. However, CT/MRI may be indicated in certain cases for the evaluation of calcifications, bony involvement, extension to adjacent structures and intracranial extension.

Keywords: Colour doppler, CT, MRI

INTRODUCTION

The superficial location of the eye and its cystic composition make ultrasound ideal for imaging the eye. It is a simple, non ionizing, cost effective, real time imaging modality providing detailed cross sectional anatomy of the entire globe [1]. It can be safely performed in outdoor patient without any use of anaesthetics or sedative therapy [2]. In experienced hands there is a high correlation of sonological and clinico- pathological findings even in the absence of a dedicated eye scanner [3].

It is non hazardous, atraumatic and invaluable in the evaluation of orbito- ocular lesions, especially in the presence of opaque media [3]. Vitreoretinal diseases, ocular inflammatory diseases and intraocular masses can be effectively diagnosed using sonography [4-6]. Ultrasound is also of great help in the assessment of the orbit, outside the globe [7].

Ultrasound contributes more to tissue diagnosis due to its high spatial and temporal resolution compared to CT or MRI [8]. Ultrasonography helps us to establish kinetic properties of the tumours such as its consistency and vascularity (with the help of colour Doppler). Colour Doppler flow imaging (CDFI) helps in the diagnosis and follow up of space occupying lesions of the orbit [7].

AIMS & OBJECTIVES OF THE STUDY

To evaluate the efficacy of high frequency Ultrasound in localization of orbital diseases and to characterize various orbital pathologies sonologically.

MATERIALS AND METHODS

A prospective correlation study was conducted in Victoria Hospital, Bangalore over a period of two years (from November 2009 to November 2011) on 100 eyes of 85 patients with symptoms related to eye and orbit. 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.

All clinical and ultrasound examination were performed by a single investigator. Ultrasound of the orbit was performed with general purpose ultrasound machine - Philips IU 22 using linear high frequency probe (5 to 17 MHz). The patient was positioned supine with head slightly turned to the opposite side. The eye was kept closed during the examination and adequate amount of gel was applied on the closed eyelid. Static scans were performed in transverse and sagittal planes and dynamic scans during eye movements after instructing the patient [9].

Ultrasonographic diagnosis was made based on various sonological features (including location, acoustic characteristics, kinetic properties and Doppler flow dynamics) studied in conjunction with clinical data. Higher imaging modalities (CT) were employed where necessary and findings were correlated with ultrasonographic diagnosis. Surgery with histopathological correlation was done in few patients as applicable, whereas few patients were followed up conservatively. Final diagnosis was made based on these findings and compared with the ultrasonographic diagnosis.

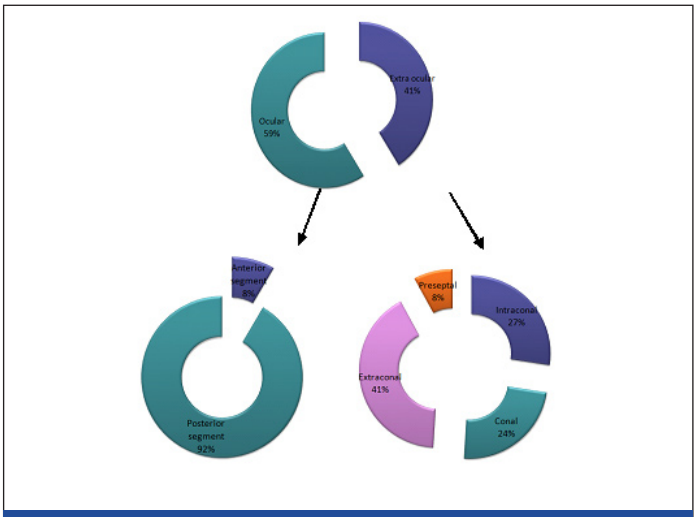
RESULTS

In the present study, the maximum percentage of patients was in the 5th decade (26%) with mean age of presentation being 42.6 years. There was nearly equal gender distribution of cases in our study with a male to female ratio of 1:1.04. Out of 85 patients, 15 had bilateral involvement, 38 had right eye and 32 had left eye involvement.

Most common indication for ultrasound examination was proptosis followed by suspected orbital mass. Predominant presenting complaint was proptosis followed by complete loss of vision. Ocular pathology causing proptosis was predominantly retinoblastoma in our study. Extraocular pathology presenting with proptosis was predominantly haemangioma followed by cysticercosis.

Out of 100 cases in the present study, 58 were in ocular and 41 in extra ocular compartment. One case had both components [Table/Fig-1]. Totally 56 out of 59 cases of intraocular pathologies were correctly diagnosed by ultrasound. Two cases of vitreous haemorrhage and a case of choroidal melanoma were missed on ultrasound [Table/Fig-2]. Out of 42 extraocular pathologies, 40 were correctly diagnosed by ultrasound. One case of haemangioma and a case of lymphoma were missed on ultrasound [Table/Fig-3]. The overall sensitivity, specificity, PPV, NPV and accuracy of ultrasound were 94.2 %, 98.8 %, 99.1 %, 92.2 % and 94.9 % (p- value < 0.0001) respectively for the diagnosis of ocular pathologies and 94.2 %, 99.2 %, 98.8%, 95.9 % and 95.2 % (p-value < 0.0001) respectively for the diagnosis of extraocular pathologies [Table/Fig-4].

Out of 59 cases in ocular compartment 12 cases underwent CT, for better identification of calcification and intracranial extension, especially in retinoblastoma and other mass lesions. Of 42 extraocular cases 30 cases required CT for evaluation of bony involvement, extension to adjacent structures and intracranial extensions.



[Table/Fig-1]: Distribution of cases based on location

Pathology	Number of patients	Ultrasonographic diagnosis (UD)	Sensitivity of UD	Specificity of UD	Accuracy of UD
Cataract	4	4	100.0	100.0	100.0
VH	11	9	95%	99.4	81.8
RD	7	7	100.0	100.0	100.0
PVD	4	4	100.0	100.0	100.0
VF	3	3	100.0	100.0	100.0
RB	5	5	100.0	100.0	100.0
PHPV	4	4	100.0	100.0	100.0
Ch Mel	4	3	87.5%	99.5	75.0
Ch Mets	1	1	100.0	100.0	100.0
Ch Osteoma	1	1	100.0	100.0	100.0
Scleritis	4	4	100.0	100.0	100.0
OD Drusen	2	2	100.0	100.0	100.0
Endo	6	6	100.0	100.0	100.0
Phthisis	2	2	100.0	100.0	100.0
Chloroma	1	1	100.0	100.0	100.0
Total	59	56	94.2	98.8	94.9

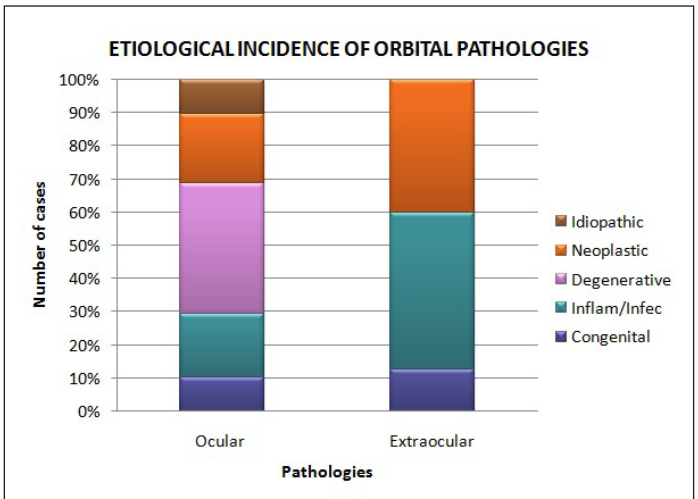
[Table/Fig-2]: Intraocular pathologies- Sensitivity, Specificity and Accuracy of Ultrasound diagnosis

Pathology	Number of patients	Ultrasonographic diagnosis	Sensitivity of UD	Specificity of UD	Accuracy of UD
Optic glioma	4	4	100.0	100.0	100.0
Optic meningioma	1	1	100.0	100.0	100.0
Haemangioma	5	4	75.9%	99.5	80.0
Pseudotumour	2	2	100.0	100.0	100.0
Graves' ophthalmopathy	2	2	100.0	100.0	100.0
Myositis	1	1	100.0	100.0	100.0
Cysticercosis	7	7	100.0	100.0	100.0
Dermoid	4	4	100.0	100.0	100.0
Dacrocystocele	2	2	100.0	100.0	100.0
Mucocele	3	3	100.0	100.0	100.0
Lymphoma	3	2	62.5	99.5	66.7
Lacrimal pleomorphic adenoma	2	2	100.0	100.0	100.0
Mucormycosis	1	1	100.0	100.0	100.0
Chloroma	1	1	100.0	100.0	100.0
AV malformation	1	1	100.0	100.0	100.0
Sebaceous cell carcinoma	1	1	100.0	100.0	100.0
Lid abscess	1	1	100.0	100.0	100.0
Lacrimal sac carcinoma	1	1	100.0	100.0	100.0
Total	42	40	94.2%	99.2	95.2

[Table/Fig-3]: Extraocular pathologies-Sensitivity, Specificity & Accuracy - Ultrasound diagnosis

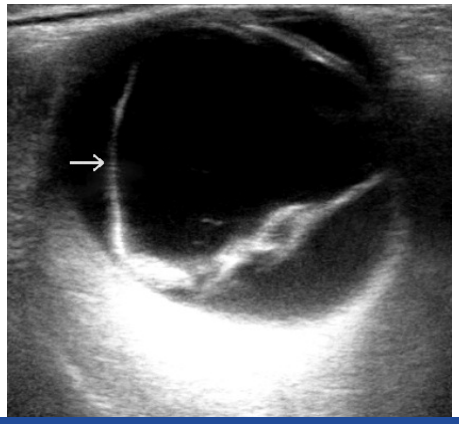
Parameter	Ultrasonographic diagnosis	
	Intra ocular	Extra ocular
Sensitivity	94.2	94.2
Specificity	98.8	99.2
PPV	99.1	98.8
NPV	92.2	95.9
Accuracy	94.9	95.2
p-value	<0.001	<0.001

[Table/Fig-4]: Orbital pathologies: Ultrasound diagnostic validity

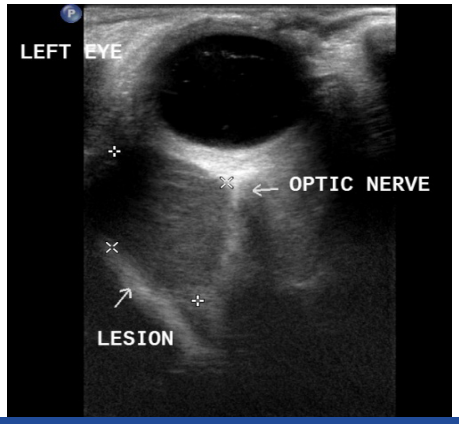


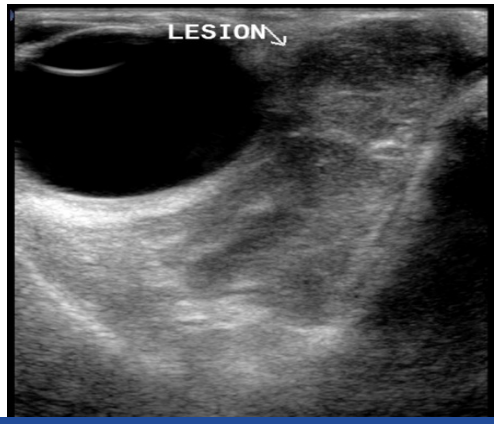
[Table/Fig-5]: Aetiological distribution of orbital pathologies

In the present study, inflammatory/infective pathologies predominated followed by neoplastic pathologies. Ocular pathologies were predominantly degenerative followed by neoplastic whereas extraocular pathologies were predominantly inflammatory / infective followed by neoplastic in our study [Table/Fig-5].



[Table/Fig-6]: Vitreous Haemorrhage: Dependent echogenic contents in the vitreous cavity **[Table/Fig-7]:** Retinal Detachment: Detached echogenic V- shaped retinal folds attached at the optic disc and ora serrata **[Table/Fig-8]:** Retinoblastoma: Heterogenous echogenic lesion filling the entire globe





[Table/Fig-9]: Choroidal Melanoma: Well circumscribed echogenic lesion arising from the choroid causing retinal detachment **[Table/Fig-10]:** Optic Nerve Meningioma: Well circumscribed homogenous hypoechoic lesion in the intraconal compartment with separately delineable optic nerve **[Table/Fig-11]:** Haemangioma: Fairly circumscribed hypoechoic lesion involving extraconal and intraconal space of orbit

[Table/Fig-12]: Maxillary sinus Lymphoma extending to orbit: Poorly circumscribed hypoechoic lesion causing erosion of maxillary sinus wall extending to extraconal space of orbit

[Table/Fig-13]: Chloroma of Orbit: Poorly circumscribed ehogenic mass lesion involving entire orbit, extending intraocularly causing distortion

DISCUSSION

Orbital pathologies are quite common in day to day practice and pose a diagnostic challenge for ophthalmologists. A wide variety of pathologies are known to affect orbit, including congenital, infective, inflammatory, vascular, neoplastic and degenerative conditions. They require detailed imaging evaluation for diagnosis and to assess the location, extension and characterization. Ultrasound is an easily available initial imaging modality which can be performed for evaluation of these cases. The superficial location and cystic structure of globe render themselves for characterization of these lesions. Orbital pathologies may be broadly divided into intraocular and extraocular, which may be further compartmentalized.

OCULAR PATHOLOGIES

Cataract: was the commonest anterior segment lesion. Four cases of cataract were correctly diagnosed by ultrasound which showed echoes in the anterior and posterior cortex of lens.

Vitreous haemorrhage [Table/Fig-6]: Vitreous haemorrhage was the commonest ocular pathology followed by retinal detachment in our study. Out of 11 cases, 2 were missed on ultrasound due to improper adjustment of gain. Ultrasound was 95% sensitive and 81.8 % accurate in diagnosing VH. OP Sharma found ultrasound to be 97 % sensitive for diagnosing VH [2].

Retinal detachment [Table/Fig-7]: All 7 cases of RD were correctly diagnosed and ultrasound was 100% sensitive in our

study. US formed an important tool in follow up of these cases. Jemeld B et al., found US to be 78 % accurate whereas Rabinowitz R et al., found US to be 100 % accurate in diagnosing RD [10,11].

Posterior Vitreous Detachment and Vitreous Floaters: US was 100% accurate in diagnosing all 4 cases of PVD and 3 cases of VF

Retinoblastoma [Table/Fig-8]: It was the most common ocular neoplasm in first decade. US was 100% accurate in diagnosing all 5 cases of RB in our study. These cases further underwent CT for detection of calcifications. All cases showed heterogenous lesion filling the vitreous cavities, few of them showing calcifications within. Zilelioglu G et al., in his study found US to be accurate in diagnosing 87.12% of retinoblastoma [12]. The results were false negative in 9.09% and false positive in 3.79% of cases.

Persistent Hyperplastic Primary Vitreous (PHPV): US with colour Doppler was 100% accurate in diagnosing all 4 cases of PHPV. It appeared as linear echogenic lesion extending from optic disc to posterior surface of lens with persistent posterior hyaloid artery showing signal on Doppler interrogation.

Choroidal Melanoma [Table/Fig-9]: Out of 4 cases of choroidal melanoma, 3 were correctly diagnosed whereas one case was missed. It had large associated exudative RD precluding visualization of small subretinal lesion. This lesion was identified subsequently at follow up scan after resolution of RD. Ultrasound was 87.5% sensitive and 75% accurate in diagnosing melanoma. These appeared as echogenic mass lesion arising from choroid and extending into vitreous cavity, with or without RD. Byrne et al., in the Collaborative Ocular Melanoma Study group (COMS) concluded that echographic tumour grading for ocular melanoma was 'moderate' to 'almost perfect' [13]. Boldt HC et al., in COMS group conducted study on 2320 patients for baseline echographic characteristics of choroidal melanoma and concluded that 96 % cases were consistent with diagnosis of melanoma [14]. Scott IU et al., showed ultrasound to be 100% effective in diagnosing extraocular extension of choroidal melanoma compared to 29% with CT/MRI [15].

Choroidal Metastasis: It appeared as a well circumscribed echogenic lenticular lesion arising from choroid. The primary was medullary carcinoma of thyroid which was operated several years back.

Choroidal Osteoma: Ultrasound showed curvilinear calcification involving posterior aspect of choroid bilaterally in a patient.

Scleritis: Four cases of scleritis were diagnosed correctly with ultrasound showing diffuse scleral thickening and increased colour flow signal around sclera suggesting active inflammation.

Optic Disc Drusen: Calcific focus noted at the optic disc bilaterally in a young patient.

Endophthalmitis: Six cases of endophthalmitis were correctly diagnosed sonologically which showed heterogenous echoes in vitreous cavity with scleral thickening and increased colour flow signal, in patients presenting with pain, loss of vision and fever.

Phthisis Bulbi: Two cases of Phthisis bulbi were correctly diagnosed by ultrasound which showed deformed collapsed globe with curvilinear wall calcification.

EXTRAOCULAR PATHOLOGIES

Optic Nerve Glioma: Of 4 cases of optic glioma in our study, 3 were in first decade and 1 in 2nd decade. They appeared as well circumscribed hypoechoic intraconal lesions involving optic nerve. Three cases were confined to orbit and 1 had suspicious intracranial extension for which CT was performed which confirmed orbital confinement of the lesion.

Optic Nerve Meningioma [Table/Fig-10]: Appeared as well circumscribed intraconal mass lesion in a middle aged female patient with gradual painless proptosis. CT showed bony involvement and intracranial extension.

Haemangioma [Table/Fig-11]: Out of 5 cases of cavernous haemangioma, 1 was in first decade and 4 in 5th decade. 2 cases involved both intraconal and extraconal compartments and 3 cases had calcific foci within. One case appeared solid and heterogenous and was wrongly interpreted as optic nerve tumour as it was intraconal in location. All of them showed signal on colour Doppler. Ultrasound was 75.9% sensitive and 80% accurate in diagnosing haemangioma in our study.

Pseudo tumour: Ultrasound showed features of infiltrative hypoechoic lesion with associated inflammatory changes. Both cases had intra and extraconal components. Harr DL et al., in their study concluded that US added specificity to the CT findings, especially in the tumefactive form of orbital inflammatory diseases [16].

Graves orbitopathy: A middle aged thyrotoxic female with gradually progressive symmetrical proptosis showed bulky extraocular muscles with inflammation of retrobulbar fat bilaterally.

Myositis: Ultrasound showed bulky medial rectus muscle with pain on ocular movements in a young male patient.

Extraocular Cysticercosis: Three cases presented with localized swelling in periocular region, ultrasound revealed solitary cystic lesion with eccentric echogenic scolex in one of the extraocular muscle. Two young female patients presented with gradual proptosis. Ultrasound showed multiple cystic lesions with eccentric scolex involving all extraocular muscles.

Dermoid: Four cases of dermoid presented in 1st and 2nd decade with periocular localized swelling at the lateral aspect of globe. All were cystic lesions with 2 of them showing low level internal echoes. Two lesions had adjacent bony involvement suspected on ultrasound and were confirmed by CT.

Dacrocystocele: Cystic lesions at medial canthus of the eye in 2 cases.

Mucocele: Two cases of ethmoidal mucocele and 1 case of fronto ethmoidal mucocele were noted in our study presenting with proptosis. These patients underwent CT for further evaluation of the intracranial extensions.

Lymphoma [Table/Fig-12]: Totally 3 cases of lymphomas were noted in our study. Ultrasound showed diffusely infiltrative lesion in the extraconal region with significant vascularity. One case had destruction of floor of bony orbit.

Lacrimal gland pleomorphic adenoma: Acoustically solid heterogenous lesion involving the lacrimal gland and showing signal on colour Doppler.

Mucormycosis: US revealed a diffuse heterogenous hyperechoic lesion in a middle aged immunocompromised patient. It was involving subcutaneous plane of nose extending deeply to extraconal compartment of orbit showing significant internal vascularity.

Sebaceous cell carcinoma: US showed a solid well defined irregular swelling in upper eyelid with internal vascularity. Location and ultrasonographic features favoured diagnosis.

Lacrimal sac carcinoma: US revealed an irregular solid swelling with internal vascularity causing destruction of underlying bone.

Preseptal cellulitis with lid abscess: Irregular heterogenous collection in the eyelid with internal echoes and adjacent inflammatory oedema in typical clinical setting.

Arterio-venous malformation: Diffuse angiomatous swelling with multiple interfaces which showed both arterial and venous flow signal within. The lesion involved all the compartment of extraocular space and extended to face and scalp region. CT showed bony involvement and intracranial extension.

Chloroma [Table/Fig-13]: Diffuse heterogenous hyperechoic mass lesion involving all compartments of extraocular space, extending to involve entire globe and showing significant internal

vascularity in a known case of acute myelogenous leukemia. CT showed intracranial extension.

COMPARISON WITH OTHER STUDIES [Table/Fig-14]:

Hafiz MA et al., studied 50 cases with B-scan and found it to be significantly accurate in diagnosing orbital masses including neoplastic and inflammatory conditions [17]. Glasier CM et al., examined 26 infants and children with orbital and ocular pathology with ultrasound and concluded that high resolution US examination of the eye and periorbital tissues is readily performed using widely available equipment and often delineates subtle structural abnormalities not shown by CT or MRI [18]. Ukponmwan CU et al., found 92.3% correlation between clinical and ultrasonographic diagnosis [19]. SB Adebayo et al., reviewed 29 patients to assess if ocular B scan ultrasonography can assist the ophthalmologists in making diagnosis and noted that management decisions were influenced by ultrasound findings in 95% of patients [20]. Zhang w et al., examined 288 cases with orbital diseases by using the technique of CDI ultrasound and concluded that CDI can provide the information of colour blood flow in orbital diseases, especially the tumours with rich vascular tissue and orbital vascular diseases, in combination with B-mode ultrasound, CT or MRI [21]. Scott IU et al., found 96% correlation between final clinical or pathological diagnosis and ultrasonographic diagnosis in their study [15]. JA Fielding in their study found ultrasound to be 92% sensitive in diagnosing intraocular pathologies [22]. Itani KM et al., found ultrasound to be 100% successful in diagnosing orbital mass [23]. Accurate diagnosis was made in 78% of cases with ultrasound, 52% with clinical and 55% with radiologic examination. Ferrer E et al., studied 79 ocular diseases in 52 patients and concluded ophthalmic ultrasonography as an important adjuvant for the clinical assessment of various ocular and orbital diseases [25]. Parchand S et al., studied 130 patients and found ultrasound to have overall sensitivity and specificity of 92.31% and 98.31% for identification of rhegmatogenous retinal detachment, and 96.2% and 100% for posterior vitreous detachment, respectively, whereas it was 100% for vitreous haemorrhage, preretinal bleed, and vitreous exudates [26].

Criteria	Present study	OP Sharma study [2]	Nzeh DA study [3]	Chaudhari study [24]
Age	5th decade	4th & 5th decade	4th decade	4th & 5th decade
Gender	M~F (1:1.04)	M>F (2:1)	M>F (2.6:1)	M>F (1.3:1)
Complaints	Complete loss of vision	Diminution of vision	Diminution of vision	Diminution of vision
Indication	Proptosis	Orbital mass	Trauma	Diminution of vision
MC ocular pathology	VH > RD	VH > RD	RD > VH	RD > VH
MC ocular neoplasm	Retinoblastoma	Retinoblastoma	-	Retinoblastoma
MC extra ocular pathology	Cysticercosis > Haemangioma	Pseudotumour and Graves'	-	Retro orbital abscess
Accuracy for VH	81.8	97.0	-	-
Accuracy for RD	100.0	99.0	-	-
Lacrimal gland & Optic nerve tumours	100.0	100.0	-	-
Sensitivity for ocular pathology	94.2	-	93.0	-

[Table/Fig-14]: Comparison of present study with other studies

LIMITATIONS OF ULTRASOUND

The major limitation of US is its high operator dependence, requiring skills and knowledge of trained personnel. There can be difficulty in performance in cases with gross proptosis. US is also less sensitive for identification of calcification, bony involvement, extension to adjacent structures and brain.

SUMMARY AND CONCLUSIONS

The distinction between ocular and extraocular pathologies was made in 100% of cases in the present study, highlighting the efficacy of high frequency ultrasound in localizing orbital lesions. Ultrasonography had overall high diagnostic validity and accuracy in localising and characterising orbital pathologies. Further evaluation with higher cross sectional imaging modalities (CT) were indicated in certain cases; for evaluation of bony involvement, extension to adjacent structures and intracranial extensions. Surgery and histopathology (as applicable) formed gold standard for the diagnosis in few cases.

Ultrasound diagnosis correlated very well with the final diagnosis established by higher modalities and histopathology. It thus formed a major basis for management decisions in significant number of cases.

LIST OF ABBREVIATIONS USED

AVM Arterio-venous Malformation
CDFI Colour Doppler flow imaging
Ch Mel Choroidal Melanoma
Ch Mets Choroidal Metastasis
CT Computed Tomography
DCC Dacrocystocele
Endo Endophthalmiits
LGPA Lacrimal Gland Pleomorphic Adenoma
Lym Lymphoma
MRI Magnetic Resonance Imaging
PHPV Persistent Hyperplastic Primary Vitreous
PPV Positive Predictive Value
PVD Posterior Vitreous Detachment
RB Retinoblastoma
RD Retinal Detachment
USG Ultrasonography
VF Vitreous Floaters
VH Vitreous Haemorrhage

REFERENCES

[1] Bedi DG, Gombos DS, Ng CS, Singh S. Sonography of the eye. *AJR*. 2006;87:1061-72.
[2] Sharma OP. Orbital Sonography with its Clinico- Surgical Correlation. *Ind J Radiol Imag*. 2005;15(4):537-54.
[3] Nzeh DA, Owoeye JFA, Ademola- Popoola DS, Uyanne I. Correlation of Clinical and Ultrasound Findings in Orbito- ocular Disease using Non- Dedicated Scanners: Experience at Ilorin, Nigeria. *European Journal of Scientific Research*. 2007;16(3):352-7. ISSN 1450-216X.
[4] Evelyn X Fu, Brandy C, Hayden, BS, Arun D, Singh. *Intraocular Tumours. Ultrasound Clin.* 2008;3:229-44.
[5] Sharma S, Ventura ACM, Waheed N. Vitroretinal Disorders. *Ultrasound Clin*. 2008;3(2):217-28.
[6] Ventura C, Hayden BC, Taban M, Lowder CY. Ocular Inflammatory Disorders. *Ultrasound Clin*. 2008;3:245-55.
[7] Ronald G. Grainger, David Allison, Andreas Adam, Adrian K. Dixon. Diagnostic Radiology. A Textbook of Medical Imaging. Fourth Edition, Volume 3, 2519-2540.
[8] Hylton B Meire, David O Cosgrove, Keith C Dewbury, Pat Farrant. Clinical Ultrasound, A Comprehensive Text: Abdominal and General Ultrasound. Second Edition, Volume 2:661-96.

[9] Dudea SM. Ultrasonography of the eye and orbit. *Medical Ultrasonography*. 2011;13(2):171-74.
[10] Jemeld B, Algvere P, Singh G. An ultrasonographic study of diabetic vitreo- retinal disease with low visual acuity. *Acta Ophthalmologic*a. 1980;58(2):193-201.
[11] Rabinowitz R, Yagev R, Shoham A, Lifshitz T. Comparison between clinical and ultrasound findings in patients with vitreous haemorrhage. *Eye (Lond)* 2004;18(3):253-56.
[12] Zilelioglu G, Gündüz K. Ultrasonic findings in intraocular retinoblastoma and correlation with histopathologic diagnosis. *Int Ophthalmol.* 1995;19(2):71-5.
[13] Byrne SF, Marsh MJ, Boldt HC, Green RL, Johnson RN, Wilson DJ. Consistency of observations from echograms made centrally in the Collaborative Ocular Melanoma Study COMS Report No. 13. *Ophthalmic Epidemiol.* 2002;9(1):11-27.
[14] Collaborative Ocular Melanoma Study Group, Boldt HC, Byrne SF, Gilson MM, Finger PT, Green RL, et al. Baseline echographic characteristics of tumours in eyes of patients enrolled in the Collaborative Ocular Melanoma Study: COMS report no. 29. *Ophthalmology*. 2008;115(8):1390-7. 1397.e1-2. Epub 2008 Feb 11.
[15] Scott IU, Smiddy WE, Feuer WJ, Ehlies FJ. The impact of echography on evaluation and management of posterior segment disorders. *Am J Ophthalmol*. 2004;137(1):24-29.
[16] Harr DL, Quencer RM, Abrams GW. Computed tomography and ultrasound in the evaluation of orbital infection and pseudotumour. *Radiology*. 1982;142(2):395-401.
[17] Hafiz MA, Mustansar MW. Ultrasound of the Eye and Orbit. *Canadian Journal on Medicine*. 2011;2(1):39.
[18] Glasier CM, Brodsky MC, Leithiser RE, Williamson SL, Seibert JJ. High resolution ultrasound with Doppler: a diagnostic adjunct in orbital and ocular lesions in children *Pediatr Radiol*. 1992;22(3):174-78.
[19] Ukponmwan CU, Marchien TT. Ultrasonic diagnosis of orbito-ocular diseases in Benin City, Nigeria. *Niger Postgrad Med J*. 2001;8(3):123-26.
[20] Adebayo SB, Onabolu OO, Bodunde TO, Ajibode HA. Ocular B-scan Ultrasound using non-dedicated Ultrasound system: Preliminary Report from Sagamu. *Nigerian Medical Practitioner.* 2007;52(4):82-84.
[21] Zhang W, Zhao H, Song G. The value of colour Doppler imaging ultrasound in diagnosis of orbital diseases. *Zhonghua Yan Ke ZA Zhi,* 2001;37(6):447-50
[22] Fielding JA. Ultrasound imaging of the eye through the closed lid using a nondedicated scanner. *Clin Radiol* 1987;38(2):131-35.
[23] Itani KM, Frueh B, Nelson C. The value of orbital echography in orbital practice. *Ophthal Plast Reconstr Surg*. 1998;14(6):432-35.
[24] Chaudhari HD, Thakkar GN, Gandhi VS, Darji PJ, Banker HK, Rajwadi H. Role of ultrasonography in evaluation of orbital lesions. *Gujarat Medical Journal*. 2013;68(2):73-78.
[25] Ferrer E, Ros Mendoza LH, Dessi G, Stefanini T, Zaragoza ES, La spezia IT. Role of B-scan ocular ultrasound as adjuvant for the clinical assessment of eyeball diseases. 10.1594/ecr2013/C-1323
[26] Parchand S, Singh R, Bhalekar S. Reliability of Ocular Ultrasonography Findings for Pre-surgical Evaluation in Various Vitreo-retinal *Disorders*. 2014;29(4):236-41.

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