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Ocular Ultrasonographic Findings in Patients Referred with Ocular Complaints

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Ocular USG, Ocular detachments, Vitreoretinal disorders

ABSTRACT:

Objectives: To describe the ocular ultrasonographic (USG) features in various types of ocular diseases; to evaluate the role of ocular sonography and color doppler in various ocular conditions; and to compare the USG findings in post-operative patients in selected cases.

Methods: This was a descriptive observational study conducted in the Department of Radiodiagnosis, Vinayaka Mission's Medical College, Karaikal, Puducherry between December 2022, and December 2023. The study included all the patients referred to the department for B-scan with ocular complaints and having a clinical suspicion of ocular disease.

Results: The study involved 100 patients, with 110 eyes examined due to some patients having both eyes affected. The mean age was 56.37 years, with a range of two to 86 years, predominantly in the age group of 51 to 70 years. Diminished vision was the most common complaint (99%), followed by pain, redness, and eye discharge. Most cases had no history of surgery or trauma (78%), while 22% had such a history. A significant portion were diabetic (28%) or hypertensive (18%), with some having both conditions (2%). Axial length of involved eyes ranged from 21.1 to 27.3 mm, with 98.2% falling between 22 to 25 mm. Common ultrasound findings included heterogeneous echogenicity of the lens (38.2%) and normal posterior segments (43%), with various abnormalities observed in the remaining cases, such as detached retina (16.4%) and choroid detachment (2.7%). Based on ultrasound, the most frequent diagnosis was cataract (30.3%), followed by retinal detachment (17.3%). Diagnostic accuracy compared to operative findings was 100%. Management included lensectomy with intraocular lens implantation (33.6%) and various vitrectomy procedures. Follow-up showed improved vision in 57.3% of cases, with different postoperative observations, including retina under gas or oil and clear secondary lens. The diagnosis which was made preoperatively with the help of USG was correct when compared against operative diagnosis, achieving 100% accuracy for all the diagnosis.

Conclusion: USG should be the first line of investigation in patients presenting with ocular complaints that can be used as a bedside imaging modality.

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Introduction

Patients presenting with ocular complaints must undergo detailed ocular evaluation. Conventional methods which have been used for many years for evaluating the eye have included slit lamp and fundoscopy examinations.[1] These procedures can be conducted in the outpatient clinic without much discomfort to the patient. Also, the diagnostic accuracy of these investigations is fairly high. However, these investigations required that the media should be non-opaque.[2] It is for this reason that these traditional investigations lose their importance if the clinician wants to diagnose patients with an opaque cornea and cataract and other pathologies which involve the retina and choroid membrane.[3]

Imaging modalities such as computer tomography (CT) and magnetic resonance imaging (MRI) have been used with high accuracy so as to investigate the various pathologies of the orbit and globe.[4] The CT scan has a very high exposure of radiation while the MRI scan is associated with prohibitive costs. As a result, previously published literature has demonstrated the increasing use of ultrasound in diagnosing ocular diseases.[5] Ultrasonography is not only cheap but also does not expose the patient to high doses of radiation. This investigation can be conducted with the help of a portable machine which increases the accessibility of this modality, and it can be conducted non-invasively as well.[6, 7]

Ultrasonography uses ultrasonic waves to detect the differences in the tissues. The ultrasound waves when returned from the tissue are read by the machine and analyzed by the computer software to generate high-resolution images. The use of ultrasound in diagnosing ocular diseases has been done for many years now. By analyzing the differences in the speed, direction, and depth of the returning waves the ultrasound machine is able to differentiate between the lesions and tissues. Amplitude scanning is also known as 'A' scanning which is the most commonly used type of ultrasound.[8] 'A' scanning is better suited to measure the length of the eye, distances within the eye, power of the lens, and visual axis of the eye. However, the internal structures cannot be visualized in great detail. As a result, experts have recommended that this type of scanning should be combined with 'B' scan.[9] One of the earliest uses of B mode ultrasound was for investigating the ocular pathology in patients with opaque media. Soft tissue regions and masses like melanoma can also be diagnosed with these. Foreign bodies produce excellent contrast on ultrasound and this property is utilized in detecting intraocular foreign bodies.[10] Recently, 3-D images based on ultrasound imaging can be reconstructed.[11] Briefly, ultrasonography is safe, non-invasive, with no special patient preparations required.

Against this background, the aim of the present study was to document the ultrasonographic findings in patients referred with ocular complaints. The specific objectives were to describe the USG features in various types of ocular diseases; to evaluate the role of ocular sonography and color doppler in various ocular conditions; and to compare the USG findings in post-operative patients in selected cases.

Materials and Methods

This was a descriptive observational study conducted in the Department of Radiodiagnosis, Vinayaka Mission's Medical College, Karaikal, Puducherry between December 2022, and December 2023. The study was approved by the Institutional Human Ethics Committee (IHEC). The study included all the patients referred to the department for B-scan with ocular complaints and having a clinical suspicion of ocular disease. However, patients with active ocular surface infection, with a high risk for or presents with extrusion of ocular contents and patients with orbital trauma were excluded from the present study. Also, patients not willing to provide informed written consent or assent (in case the patient was less than 18 years of age) were excluded.

The patients were examined with the help of a linear probe with frequency 5-12 MHz.[12] A predesigned, semi structured, and pretested proforma was used to note the study findings. A clinical history was obtained from the patient. Morphometry including axial length was noted. Ultrasonographic characteristics of lens, vitreous membrane, posterior segment, retina, choroid and optic nerve were noted for all the patients. The final clinical diagnosis of the patients was noted.[13]

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Statistical analysis: The data was entered into Microsoft Excel and the analyses were done with Statistical Package for Social Sciences (SPSS) version 23.0. Categorical variables were presented as numbers and percentages (%); continuous variables as mean (SD) or median (IQR). Normality of data was tested by Kolmogorov-Smirnov test. Quantitative variables were compared using paired 't' test. Qualitative variables were analyzed using Chi-Square test or Fisher's exact test. Statistical significance was considered at $p<0.05$.

Ethical considerations: The study conforms to the Declaration of Helsinki. Written informed consent was taken from all the patients and parent's consent was taken in case of minor patients. No harm was intended for the subjects. The participants were not subjected to any extra cost because of the study.

Results

A total of 100 patients were included in the present study – 10 patients had both eyes affected, so a total of 110 eyes were studied. The mean (SD) age was 56.37 (15.9) years, ranging from two years to 86 years; more than half (58%) the patients were in the age group of 51 to 70 years and 22% patients were between 31 and 50 years. The distribution of males and females was equal (50% each). The most common complaint reported was diminished vision (99%). There were nine cases with pain, and five cases each with redness of eye and eye discharge. It was observed that 78% of the cases were without any history of surgery or trauma. Of the rest (22%), 11% had a history of trauma and 10% were previously operated for cataract and one case for retinal detachment. More than one in four patients (28%) were diabetics, 18% hypertensive and 2% were both diabetic and hypertensive. Nearly half (46%) the patients had right eye involved, 44% had left eye involved, and 10% had both the eyes involved.

The axial length of the involved eye ranged from 21.1 to 27.3 mm, with a mean (SD) of 23.38 (0.57). It was observed that 98.2% of the involved eyes had axial length in the range of 22 to 25 mm. Only one case had an axial length less than 22 and one case had axial length more than 25 mm. The location of the lens was normal in 88.2% of the involved eyes; dislocated in 5.5% and was absent in 6.4%. On USG, lens was heterogeneously echogenic in 38.2%. On USG, posterior segment was normal in 43% of the involved eyes. Free floating membranes attached at optic disc was observed in 17% and free-floating echogenic foci in posterior segment of eye was present in 13% of the involved eyes. Dislocated lens in the posterior segment (6%), detached vitreous membrane showing to & fro after movements (11%), freely floating membrane attached at optic disc head with freely floating echogenic foci (4%), freely floating choroid membrane in posterior segment appearing to meet in midline (3%), free floating thickened membrane attached at optic disc with hypoechoic areas within (1%), freely floating membrane attached at optic disc head with echogenic foci in subretinal region (1%) and small echogenic focus at optic nerve head with vascularity (1%) were the other USG findings of the posterior segment in the affected eyes. Retina was observed to be normal in 75.5% of the affected eyes. Among the rest, 16.4% were completely detached, 6.4% were partially detached and 1.8% had single layer detached. Choroid was normal in 97.3% of the involved eyes; three cases had detached choroid. The optic nerve had normal USG impression in all involved eyes, except one eye, which had a small echogenic focus at optic nerve head with vascularity within.

Based on USG, the most common diagnosis was cataract (30.3%); followed by retinal detachment (17.3%), and vitreous haemorrhage (11.8%). Cataract with posterior vitreous detachment was diagnosed in 7% cases. The less common diagnoses were aphakia in 6.4%, dislocated/subluxated lens in 5.5%, retinal detachment with vitreous haemorrhage in 3.6%, only posterior vitreous detachment in 3.6%, choroidal detachment in 2.7% and retinoschisis in 1.8%. There was one case each having old RD with cyst, optic glioma, posterior staphyloma, RD + subretinal haemorrhage, phthisis bulbi, uveitis and VH with neovascularization glaucoma. There were 4 patients (3.6%) who had no abnormality detected on USG.

In addition to USG, some other investigation modalities were used to diagnose the patients. Indirect ophthalmoscopy and direct ophthalmoscopy were used in 40.9% and 38.2% respectively. Both direct and indirect ophthalmoscopy was done in 15.5% of the

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involved eyes. Optical coherence tomography was done in 3 eyes, fundus fluorescein angiography in 2 and slit lamp with indirect ophthalmoscopy in 1 eye. The results also showed that the diagnosis which were made preoperatively with the help of USG were correct when compared against operative diagnosis, achieving 100% accuracy for all the diagnosis.

Regarding management, lensectomy with IOL implantation was done in 33.6% of the involved eyes. Vitrectomy + membrane peeling + endolaser + tamponade (silicon gas) was done in 27.3% of the involved eyes. Vitrectomy + membrane peeling + endolaser + tamponade (silicon oil) was done in 11.8% of the eyes. Follow-up without any specific treatment was done in 8.2% of the involved eyes. Secondary IOL implantation was done in 7.3% of the eyes. In addition, corneal repair followed by cataract surgery, lensectomy + vitrectomy + IOL implantation and re- lensectomy + secondary IOL implantation with follow up was done in 2.7% of the eyes each, while silicon oil removal was done in 1.8%. Intravitreal inj. Bevacizumab and treatment of underlying myopia with follow up was done in one eye each. At the end of one week follow up, vision improved in 57.3%. Retina under gas was observed in 27.3%, retina under oil was observed in 10.9% and clear secondary lens was observed in 2.7% of the involved eyes. No abnormality was detected in 1.8% of the involved eyes.

Discussion

The present observational study was carried out among patients who were referred with a clinical suspicion of ocular pathology to the Department of Radiodiagnosis for undergoing ocular B-scan ultrasonography. The present study was conducted between December 2022 and December 2023, during which they underwent B-scan USG. Based on the ocular USG findings of lens, vitreous membrane, choroid, retina, and optic nerve were noted for all cases and a diagnosis was made. We included 100 patients in the present study, of which 10 patients had both eyes affected, so a total of 110 eyes were studied. We observed that all the diagnosis which were made preoperatively with the help of USG were correct when compared against operative diagnosis, achieving 100% accuracy for all the diagnosis. In another comparative study done by Yang et al. on alkali burn eyes, 56 cases were evaluated using both USG biomicroscopy and immersion B-scan USG.[14] Compared with the intraoperative findings, the diagnostic concordance rate of B-scan appearance of lens was 100% (56/56). Shazlee et al. reported an overall 98% diagnostic validity of ultrasound B-scan in detecting ocular trauma.[15]

The present study is not without limitations. The interpretation of ultrasound images can vary with the years of experience and training levels. Therefore, the results of the present study, which was conducted at a high-volume center, might not concur with other centers. All interpretations of ultrasound images were performed by the same radiologist, so we could not comment on the inter-rater agreement. Also, the radiologist was not blinded to the medical history of the patient. It can be argued that this could introduce an observer's bias, though this would be like a real-life scenario, in which the radiologist is not blind to patients' medical history. The study site was a tertiary level care teaching hospital. The results of the present study would have been more representative if the patients were recruited from a community setting.

In conclusion, this research study adds to the existing evidence on the USG findings of patients presenting with ocular complaints: Ultrasound was the initial imaging modality opted in many cases as it was readily available, simple and it establishes the diagnosis in significant number of cases. It is particularly well suited in cases of opaque conducting media when direct ophthalmoscopy is not possible. It is a sensitive modality and can reliably differentiate various ocular detachments, vitreoretinal disorders, and neoplastic lesions with significant accuracy. Ocular ultrasound evaluation provides valuable information to ophthalmologist prior to surgical exploration within a short span of time, avoiding unnecessary procedures. In selected cases, sonography gives accurate diagnosis and if it is compared against operative diagnosis, accuracy is 100%. Each imaging modality has strengths and limitations. B-scan ultrasonography of the eye is simple, easily accessible, non-invasive, non-ionizing and cost-effective imaging modality, which cannot be replaced by CT or MRI because of its high resolution, as eye is a superficial structure. However, experience and

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understanding of the principles of B-scan ultrasonography are essential for accurate diagnosis. The role of color Doppler imaging is also limited in ocular pathologies. Overall, USG should be the first line of investigation in patients presenting with ocular complaints that can be used as a bedside imaging modality.

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Table 1: Distribution of patients, by sociodemographic characteristics and clinical profile

		N	**%**
Age (in years)	Up to 10	3	3.0
	> 10 to 30	4	4.0
	31 to 50	22	22.0
	51 to 70	58	58.0

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	> 70	13	13.0
Gender	Female	50	50.0
	Male	50	50.0
Presenting complaints	Diminished vision	99	99.0
	Pain	9	9.0
	Redness of eye	5	5.0
	Eye discharge	5	5.0
Previous history of ocular surgery or trauma	No	78	78.0
	Trauma	11	11.0
	Operated for cataract	10	10.0
	Operated for retinal detachment	1	1.0
Comorbidities	Diabetes mellitus	28	28.0
	Hypertension and DM	2	2.0
	Hypertension	18	18.0
	None	52	52.0
Involved eye	Only right	46	46.0
	Only left	44	44.0
	Both	10	10.0

Table 2: Distribution of patients, by ocular ultrasonography findings

		N	**%**
Axial length of involved eye (in mm)	Up to 22	1	0.9
	> 22 to 25	108	98.2
	> 25	1	0.9
Lens – location	Normal	87	88.2
	Dislocated	6	5.5
	Lens absent	7	6.4
Lens – USG findings	Normal	68	61.8
	Heterogeneously echogenic	42	38.2
Vitreous membrane	Normal	48	43.0
	Free floating membranes attached at optic disc	19	17.0

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	Free floating echogenic foci in post segment of eye	14	13.0
	Detached VM showing to & fro after movements	12	11.0
	Dislocated lens in PS	7	6.0
	Freely floating membrane attached at OD head with freely floating echogenic foci	4	4.0
	Freely floating CM in PS appearing to meet in midline	3	3.0
	Free floating thickened membrane attached at OD with hypoechoic areas within	1	1.0
	Freely floating membrane attached at OD head with echogenic foci in subretinal region	1	1.0
	Small echogenic focus at ON head with vascularity +	1	1.0
Retina	Normal	83	75.5
	Completely detached	18	16.4
	Partially detached	7	6.4
	Single layer of retina detached	2	1.8
Choroid	Normal	107	97.3
	Detached	3	2.7
Optic nerve	Normal	109	99.1
	Small echogenic focus at optic nerve head with vascularity within	1	0.9
VM, Vitreous membrane; OD, Optic disc; CM, Choroid membrane; PS, Posterior segment; ON, Optic nerve			

Table 3: Distribution of patients, by USG diagnosis and treatment

Diagnosis on USG	**N**	**%**
Cataract	33	30.3
Retinal detachment	19	17.3
Vitreous haemorrhage	13	11.8
Cataract with posterior vitreous detachment	8	7.1
Aphakia	7	6.4
Dislocated/subluxated lens	6	5.5
Retinal detachment + Vitreous haemorrhage	4	3.6
Posterior vitreous detachment	4	3.6

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Choroidal detachment	3	2.7
Retinoschisis	2	1.8
Old RD with cyst	1	0.9
Optic glioma	1	0.9
Posterior staphyloma	1	0.9
RD + subretinal haemorrhage	1	0.9
Phthisis bulbi	1	0.9
Uveitis	1	0.9
VH + neovascularization glaucoma	1	0.9
No Abnormality Detected	4	3.6
Other investigations done to confirm the diagnosis		
Indirect ophthalmoscopy	45	40.9
Direct ophthalmoscopy	42	38.2
Direct + Indirect ophthalmoscopy	17	15.5
Optical coherence tomography	3	2.7
Fundus fluorescein angiography	2	1.8
Slit lamp + Indirect ophthalmoscopy	1	0.9
Treatment given		
Lensectomy + IOL implantation	37	33.6
Vitrectomy + membrane peeling + endolaser + tamponade (silicon gas)	30	27.3
Vitrectomy + membrane peeling + endolaser + tamponade (silicon oil)	13	11.8
Follow-up	9	8.2
Secondary IOL implantation	8	7.3
Corneal repair f/b cataract surgery	3	2.7
Lensectomy + vitrectomy + IOL implantation	3	2.7
Re- lensectomy + 2º IOL implantation with follow up	3	2.7

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Silicon oil removal	2	1.8
Intravitreal inj. Bevacizumab	1	0.9
Treating underlying myopia with follow up	1	0.9

Table 4: Distribution of patients, by findings on follow up

One week follow up	**N**	**%**
Vision improvement	63	57.3
Retina under gas	30	27.3
Retina under oil	12	10.9
Clear secondary lens	3	2.7
No abnormality detected	2	1.8

Table 5: Comparison of USG findings with operative diagnosis

	Diagnosis on USG	**Operative diagnosis**	**Accuracy percentage of USG diagnosis**
	N	**N**	
Cataract	33	33	100%
Retinal detachment	19	19	100%
Vitreous hemorrhage	13	13	100%
Cataract with PVD	8	8	100%
Dislocated/ subluxated lens	6	6	100%
Retinal detachment with vitreous hemorrhage	4	4	100%
Choroidal detachment	3	3	100%
Retinoschisis	2	2	100%
Old retinal detachment with cyst	1	1	100%
Retinal detachment with subretinal hemorrhage	1	1	100%