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Original Research Article

Role of B-scan Ultrasonography before Cataract Surgery in Eyes with Mature and Hyper mature Cataract in a Tertiary Care Center

Dr. Pragyil Chaturvedi[1], Dr. Harpal Singh[2], Dr. Shubham Gupta[3], Dr. Purva Lal[4], Dr. Swinal Patel[5], Dr. Raj Kumar Dejwar[6]

[1]Third year Postgraduate Resident, Department of Ophthalmology, Peoples College of Medical Sciences and Research Centre Bhopal, Madhya Pradesh, India.
[2]Professor & HOD, Department of Ophthalmology, Peoples College of Medical Sciences and Research Centre Bhopal, Madhya Pradesh, India.
[3]Third year Postgraduate Resident, Department of Ophthalmology, Peoples College of Medical Sciences and Research Centre Bhopal, Madhya Pradesh, India.
[4]Third year Postgraduate Resident, Department of Ophthalmology, Peoples College of Medical Sciences and Research Centre Bhopal, Madhya Pradesh, India.
[5]Second year Postgraduate Resident, Department of Ophthalmology, Peoples College of Medical Sciences and Research Centre Bhopal, Madhya Pradesh, India.
[6]First year Postgraduate Resident, Department of Ophthalmology, Peoples College of Medical Sciences and Research Centre, Bhopal, Madhya Pradesh, India.

Corresponding Author
Dr. Harpal Singh, Professor & HOD, Department of Ophthalmology, Peoples College of Medical Sciences and Research Centre Bhopal, Madhya Pradesh, India.

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ABSTRACT

Background
In order to design the surgical strategy and explain the visual prognosis following surgery, we aimed to assess the nature of posterior segment diseases in pre-operative cataract patients using B-scan ultrasonography.

Methods
This was a hospital based prospective descriptive observational study conducted among 100 patients having mature and hyper mature cataract visiting the OPD of the Department of Ophthalmology and Department of Radio Diagnosis of Peoples College of Medical Sciences and Research Center a Tertiary Care Center, Bhopal, Madhya Pradesh, India, from November 2022 to April 2024, after obtaining clearance from institutional ethics committee and written informed consent from the study participants. After detailed ocular and systemic history, a thorough ocular examination including visual acuity, refraction, keratometry, ocular movement, and slit lamp examination were done. B-scan was done using 12 RL linear probe of frequency range 7-12 MHz of voluson s8 Ultrasound Scanner.
The patients were examined in supine position after application of the thick layer of commercially available sonographic gel. Scanning was done using contact method and the probe will be placed over closed eyes coated with coupling gel.

Results
Total 56 eyes had vitreous degeneration changes on B-scan examination. Out of these 56 patients 43 (33.3% of total 129 cataractous eyes) patients had age related vitreous degeneration, 8 (6.2%) had diabetic vitreous degeneration, 3 (2.3%) patients had post traumatic vitreous degeneration and 2(1.55%) had inflammatory vitreous degeneration (associated with complicated cataract). None of the

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patient had myopic vitreous degeneration. In comparison of vitreous changes between diabetic and non-diabetic patients, the chi-square statistic is 13.69. The p-value is 0.001. The result is highly significant at p<.05. Vitreous degeneration with detachment, vitreous detachment with degeneration and vitreous hemorrhage was seen respectably in one eye (0.7%). Vitreous detachment was seen in 7 eyes. Out of these7 vitreous detachment all were partial vitreous detachment. None of our patients had complete vitreous detachment. There was no apparent association of retinal detachment with diabetes or hypertension was identified in our study. One out of total three patients of Retinal detachment had both hypertension and diabetes. Visually significant posterior segment pathologies were seen in 5 (3.87%) eyes. Retinal detachment was seen in 3(2.33%) eyes while vitreous hemorrhage was present and in 2 (1.55%) eyes.

Conclusion

When medial haziness prevents the posterior segment from being evaluated, B-Scan ultrasonography can be helpful in determining the prognosis and examining the lesions in the posterior segment of patients having mature and hyper mature cataract.

Keywords: B-scan Ultrasonography, Cataract Surgery, Mature and Hyper Mature cataract.

INTRODUCTION

As per the World Health Organization (WHO), cataract is the primary cause of blindness globally, accounting for 17.7 million blind individuals and 47.8% of all blindness cases[1,2]. In our country (Indian population) 80% of the blindness is due to cataract.[3,4] In developing parts of the world and in India, the burden of cases presenting with advanced cataract is high. Inadequate doctor-patient ratio and growing elderly community leads to inaccessibility of medical resources in developing countries. Many of time various posterior segment pathologies are associated with cataract (lenticular opacity). Pre-operative evaluation is essential for those posterior segment pathologies for better visual outcome and for early recognition and prompt management of these pathologies. Hazy media can be due to dense cataracts, vitreous hemorrhages, anterior chamber opacities, corneal opacities, inflammatory opacities, Ultrasonography has become important and most accurate modality because in these patients ophthalmoscopic examination and clinical examination is difficult as well as less informative. B-Scan ultrasonography is now a days widely used in Ophthalmology for investigation and evaluation of posterior segment lesions. Ultrasound has become an important part in ophthalmic diagnosis because of its characteristic ability to detect, outline and characterize the nature of soft tissue of orbit and eye ball, regardless the degree of transparency of ocular media. The definition of ocular structure is better understood with ultrasound than with C.T. scan or M.R.I. [5]. Ocular ultrasound operates on the same principles as previous novel applications of this technology. Over 20,000 Hz (20 kHz) is the frequency at which sound waves are generated, and any tissue in their path reflects the waves back to the transducer. A piezoelectric crystal in the transducer vibrates in response to the return of these sound waves, producing electrical impulses that are converted into a picture or other data.[6] Although they do not get as far into tissue, higher frequency waves offer superior resolution. Lower frequency waves, on the other hand, penetrate deeper but have worse resolution. Similar to other waves, ultrasound waves exhibit predictable behaviors that are determined by the characteristics of the medium they pass through. For example, sound waves move through solids more quickly than they do through liquids.[7] Sound waves can reflect, scatter, or refract when they pass across tissue interfaces with varying acoustic impedances, or densities. Tissue also absorbs a certain amount of sound waves. Echoes are sound waves that bounce back to the transducer. There are three types of echo zones in ultrasound imaging: hypoechoic, anechoic, and hyperechoic.[8] Distal to a highly dense lesion such as a stone or tissue calcification, shadowing can occur. This results in an anechoic area that we refer to as the posterior acoustic shadow. Currently, A-Scan and B-scan ultrasounds are the two primary varieties used in ophthalmologic practice. Sound waves are produced at 8 MHz in A-scan, also known as TIME-AMPLITUDE SCAN, and then transformed into spikes that match tissue interface zones. In B-scan, or BRIGHTNESS AMPLITUDE SCAN, sound waves are generated at 10 MHz The data

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collected by the transducer produces a corresponding image. Ultrasonography is especially useful in cases in which the fundus is obscured from visualization by slit lamp and laser interferometry, as in patients with dense cataracts, corneal opacities and anterior chamber opacities.[9] In our study population, the use of ocular ultrasonography may result in earlier detection of other posterior chamber pathologies like vitreous degeneration/vitreous detachment / vitreous opacity / vitreous hemorrhage / sub-hyaloid hemorrhage / retinal detachment/retinal tears / choroidal detachment etc. The benefits of ultrasound include improved visualization of structures obscured by opaque substances, such as vitreous hemorrhage or dense cataracts. Second, real time information is available to the practitioner regarding conditions such as retinal detachment. Ultrasound is safe, does not expose the patient to radiation, is widely accessible, and is low cost. B-scan, or brightness scan can be performed directly on the anesthetized eye. In cases of trauma or in children, B-scan can be performed over the eyelid with coupling jelly. Measurements derived from B-scan consists of visualization of the lesion, including anatomic location, shape, borders, and size. It can be used for detection of a wide-range of pathological structures, including retinal or choroidal detachment, foreign bodies, and tumors. The purpose of the study is to visualize the status of posterior segment of eye with the diagnostic tool of B-scan ultrasound and to find out any posterior segment lesions that are present in mature and hyper mature cataracts where fundus cannot be evaluated with other means.

AIMS AND OBJECTIVES

- To evaluate the nature of posterior segment pathologies with the help of b-scan ultrasound in preoperative cataract patients for planning surgical strategy and explaining post-operative visual prognosis.
- Detection of posterior segment pathology with the help of B-scan in mature and hyper mature cataract.
- Categorization of posterior segment pathology using B-scan in mature and hyper mature cataract.

MATERIALS &METHODS

This was a hospital based prospective descriptive observational study conducted among 100 patients having mature and hyper mature cataract coming to eye OPD at Department of Ophthalmology and Department of Radio Diagnosis of Peoples College of Medical Sciences and Research Center a Tertiary Care Center, Bhopal, Madhya Pradesh, India, from November 2022 to April 2024. after obtaining clearance from institutional ethics committee and written informed consent from the study participants. After detailed ocular and systemic history, a thorough ocular examination including visual acuity, refraction, keratometry, ocular movement, and slit lamp examination were done. B-scan was done using 12 RL linear probe of frequency range 7-12 MHz of voluson s8 Ultrasound Scanner. The patients were examined in supine position after application of the thick layer of commercially available sonographic gel. Scanning was done using contact method and the probe will be placed over closed eyes coated with coupling gel.

Inclusion Criteria

- Patients with Mature Cataract
- Patients with Hyper Mature Cataract

Exclusion Criteria

- Immature cataract
- Known case of pre-existing posterior segment pathology
- History of previous ocular surgery for posterior segment pathology
- Not willing to participate

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Statistical Methods

All the data analysis was done using SPSS (Statistical Package for the Social Sciences). Data was entered in Microsoft excel and Chi Square test was used for statistical analysis.

RESULTS

Type	Frequency	Percentage(out of total cataractous eyes)	
Age Related	43	33.3%	
Diabetic	08	6.2%	
Post Traumatic	03	2.3%	
Inflammatory	02	1.55%	
Myopic	0	0%	
Total	56	43.41%	
Association of vitreous degeneration			
Vitreous changes	**Diabetes**	**Non diabetic**	**Total**
Positive	14	28	42
Normal	3	55	58
Total	17	83	100
Comparison of vitreous changes between diabetic and non-diabetic patients			
Table 1			

In our study total 56 eyes had vitreous degeneration changes on B-scan examination. Out of these 56 patients 43 (33.3% of total 129 cataractous eyes) patients had age related vitreous degeneration, 8 (6.2%) had diabetic vitreous degeneration, 3 (2.3%) patients had post traumatic vitreous degeneration and 2(1.55%) had inflammatory vitreous degeneration (associated with complicated cataract). None of our patient had myopic vitreous degeneration.

Total patients of DM2 were 17. Vitreous changes in right eye of diabetic patient were 6/17. Vitreous changes in left eye of diabetic patients were 8/17. Total vitreous changes in diabetic patients were 14/17.

CHI SQUARE TEST-The chi-square statistics 13.69. The p-value is 0.001. The result is highly significant at $p<.05$.

Vitreous Detachment	3
Vitreous Degeneration	8
Vitreous Detachment with Degeneration	3
Total	14
Table 2: Types of vitreous changes in diabetic eyes	

Out of 17 diabetic patients 14 had vitreous changes. Among them 3 had vitreous detachment, 8 had vitreous degeneration and 3 had both vitreous degenerations with detachment. None of the diabetic patient had vitreous hemorrhage.

Vitreous Change	Frequency	Percentage
Vitreous Degeneration	48	37.2%
Vitreous Detachment	4	3.10%
Vitreous Detachment with Degeneration	1	0.7%
Vitreous Detachment with Hemorrhage	1	0.7%
Vitreous Hemorrhage	1	0.7%

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Types of vitreous changes in non-diabetic eyes		
Types of Vitreous Detachment	**Frequency**	**Percentage**
Partial	7	5.42%
Complete	0	0%
Total	7	5.42%
Types of posterior vitreous detachment in all cataracts eyes		
Table 3		

Out of total examined 129 cataractous eyes, vitreous changes were seen in 55 non diabetic eyes. Out of these, 48 eyes (37.2%) had vitreous degeneration and 4 eyes (3.10%) had vitreous detachment. Vitreous degeneration with detachment, vitreous detachment with degeneration and vitreous hemorrhage was seen respectably in one eye (0.7%).

In our study population out of 129 screened eyes, vitreous detachment was seen in 7 eyes. Out of these 7 vitreous detachments all were partial vitreous detachment. None of our patients had complete vitreous detachment.

Retinal Detachment	3 (3%)	
Normal Retina	97(97%)	
Total	100	
Retinal changes identified on B-scan in study population		
Pathology	Frequency	Percentage
Retinal Detachment	3	2.33%
Vitreous Hemorrhage	2	1.55%
Total	5	3.88%
Showing visually significant posterior segment pathologies identified on B-scan examination		
Table 4		

In our study population retinal detachment was identified in total 3 patients on B-scan examination. Out of 3 retinal detachments, one was smooth rhegmatogenous retinal detachment and two were long standing open funnel shaped retinal detachment.

There was no apparent association of retinal detachment with diabetes or hypertension was identified in our study. One out of total three patients of Retinal detachment had both hypertension and diabetes.

In our study out of total screened 129 eyes, visually significant posterior segment pathologies were seen in 5 (3.87%) eyes. Retinal detachment was seen in 3(2.33%) eyes while vitreous hemorrhage was present and in 2 (1.55%) eyes.

DISCUSSION

To ascertain the number of patients with posterior segment pathology, we assessed every patient admitted to our hospital for a cataract. Examining the fundus before cataract extraction is crucial for diagnosing and treating diseases like diabetic retinopathy, retinal tears, etc., as well as for predicting the visual prognosis. If the posterior region is not properly examined, the outcomes of cataract surgery shouldn't be overstated because abnormalities in the posterior segment might have a significant impact on Best Corrected Visual Acuity (BCVA). Gross diseases such as retinal detachment, posterior staphyloma, vitreous hemorrhage, and vitreous degeneration can all be diagnosed by B-scan Ultrasonography (USG). Finer diseases, however, are more challenging to evaluate. In certain situations of bilateral lesions exclusively, a fundus examination of the partner eye may be helpful.[10].

Perpendicular position of probe in relation to area of interest gives a greater reflection on to the probe, while loss of inclined angle leads to loses of intensity and clarity. Denser mediums have greater absorption of ultrasonic waves and thus compromising the resolution of the image. Image

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resolution of a hyper mature cataract is compromised as compared to a normal crystalline lens, as also with a calcification mass. This leads to loss of signal posterior to the denser medium, which is termed as posterior acoustic shadowing. Pulse-echo system enables to compensate for this by amplifying the display through adjustment of the gain.[11] According to a 1997 study by Anteby et al. evaluating the usefulness of the B-scan, the analysis of the B-scan revealed posterior segment disease in 19.6% of the patients. Retinal detachment (4.5%), vitreous hemorrhage (2.5%), and posterior staphyloma (7.2%) were the most common abnormalities identified.[12] In our study retinal detachment was seen preoperatively in total 3(3%) of the mature and hyper mature cataract and vitreous hemorrhage was seen in only 1 (1%) patient. These observations of our study are very close to this study. However, in our study in 53.48% (69 cataractous eyes) cataractous eyes have posterior segment pathology, most common pathology was posterior vitreous degeneration (seen in 56(43.41%) eyes).

Similar to this study, the most common posterior segment pathology in our study was vitreous degeneration (in 43.41% eyes), and retinal detachment in 3 eyes.

Adebayo S.B. et al. conducted a retrospective study in 2004–2005 to determine "whether ocular B-SCAN ultrasound can assist in ophthalmology in making the diagnosis" in approximately 29 patients with opaque ocular media. They concluded that it serves a diagnostic purpose and facilitates the choice of how to treat a number of orbital and ocular lesions with opaque ocular media.[13]

In a prospective observational study conducted by Sooraj Singh Kubrey et al. from April 2013 to February 2014, B-Scan ultrasound was used to search for posterior segment diseases in 100 eyes with mature cataracts who were unable to view beyond the lens with a direct or indirect ophthalmoscope. Of the 100 eyes examined for posterior segment pathology, 73 were found to be normal, and 27 eyes (or 27%) had some pathology that could be detected by ultrasonography. Nine percent of the eyes had vitreous opacities, nine percent had retinal detachment, and five percent had posterior vitreous separation. In one eye, asteroid hyalosis, vitreous hemorrhage, and silicon oil were found, in that order. Two eyes (2%) had coloboma choroid/disc found in them.[14] If we compare these observations with our study, out of 129 examined eyes posterior segment pathologies were present in 69(53.48%) eyes with 3(2.32%) eyes had retinal detachment and 7(5.42%) eyes had vitreous detachment with 4 (3.10%) eyes had both vitreous degeneration and detachment.

23 patients (both traumatic and non-traumatic cataract) with posterior region diseases were identified from a total of 200 cataract patients in an Indian prospective diagnostic study conducted by Navneet Saxena between July 2013 and 2014. Of the 23, nine patients are in the group of traumatic cataract patients, and fourteen patients are in the non-traumatic cataract group. Five patients (25%) experienced posterior vitreous detachment, two patients (1%), intraocular foreign body in one patient (0.55), and posterior staphyloma in two individuals (1%).[15]

A retrospective observational study done at Hyderabad, between October 2018 till March 2019 by Gayatri Ravulaparthi et al observed that prevalence of posterior segment eye disease in 1109 subjects in their study was 9.56%. Within the study population, posterior segment illness was identified as the cause of moderate visual impairment in 42 patients (3.78%), severe visual impairment in 11 patients (0.99%), and blindness in seven individuals (0.63%). The three most prevalent posterior segment disorders among the study participants were retinal vein occlusions (1.26%), diabetic retinopathy (1.62%), and glaucoma-related optic neuropathy (approximately 4.15% of patients). Out of all the patients in the study who were completely blinded by posterior segment disease, three of them had retinitis pigmentosa, two had glaucomatous optic neuropathy, one had vitreous hemorrhage as a result of diabetic retinopathy, and one patient had wet age-related macular degeneration.[16] In an observational study as like our study done by Deb K. Boruah et al. between 2018-2021, find out that among 81 patients of cataract, posterior segment pathologies were found in 27(33.3%) patients, whereas 14 (51.9%) patients had posterior vitreous detachment, 10 (37%)patients had retinal detachment, and 1 (3.7%) patient had choroidal detachment. The B- scan had a sensitivity of 87.32%, specificity of 80%, and accuracy of 86.42% with a statistically significant difference between the USG findings and clinical examination (p-value of 0.0005).[17]

Meenakshi V, Jyothirmayi Tetal studied the role of B- scan ultrasonography in cataract patients in a

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tertiary care Centre. 54 patients, or 11.02% of the 475 patients, had posterior segment disease identified by B-SCAN out of 490 eyes. Fifteen of the fifty-four positive cases involved patients who had previously experienced trauma. Bilateral developed cataracts were observed in 15 instances. Among the positive instances, 14 cases (2.85%) had RD, 10 cases (2.09%) had vitreous hemorrhage, 6 cases (1.22%) had PVD, and 4 cases had posterior staphyloma discovered. When medial haziness prevents the posterior region from being evaluated, B-Scan ultrasonography can be helpful in determining the prognosis and examining the lesions in the posterior segment of mature cataract patients.[18]

In a preoperative evaluation of the posterior segment in dense cataracts, Hegde R et al. conducted an observational study that provided important information on the vitreous, retina, choroid, and sclera. The purpose of the study was to assess the sensitivity and specificity of B-scan ultrasonography in identifying posterior segment anomalies associated with dense cataracts. A total of 161 patients' 184 eyes were examined. The study group's average age was 59.17 ± 10.65 years. The majority of individuals (76.4%) came from rural regions. 23 individuals had bilateral thick cataracts out of 161 total. Preoperative B-scan ultrasonography evaluation in 184 eyes revealed 1 case of asteroid hyalosis, 1 case of posterior staphyloma, 2 cases of retinal detachment, 1 case of vitreous hemorrhage, and 40 cases of posterior vitreous detachment. 173 eyes' B-scan sensitivity and specificity were examined. The B-scan ultrasonography's sensitivity, specificity, positive predictive value, and negative predictive value were found to be 64.2%, 100%, and 81.5%, respectively, according to the Pearson Chi-square test. The results of the study demonstrated the value of the B-scan in the diagnosis of posterior segment diseases in individuals with thick cataracts.[19]

Pre-Operative Detection of Posterior Segment Pathology in patients with Dense Cataract by B-Scan Ultrasonography was the subject of a study conducted similarly to ours by Parappallil RJ. 36 eyes (8.6%) out of the 418 eyes evaluated had posterior segment disease on ultrasonography. The most common defect found (17 eyes; 4.1%) was retinal detachment. Diabetes mellitus (OR=4.9, P=0.003) and age under 50 (OR=15.4, P=0.001) were shown to be patient variables that were linked to a higher frequency of abnormal ultrasound scans. The following ocular characteristics were linked to a high incidence of posterior segment pathology: elevated intraocular pressure (OR= 15.1, P=0.004), keratic precipitates (OR= 22.4, P=0.004), posterior synechiae (OR= 20.2, P=0.000), iris coloboma (OR= 34.6, P=0.000), and inaccurate ray projection (OR= 15.1, P=0.002). Ultrasonography revealed an aberrant posterior segment in just four eyes (1.5%) that lacked these traits.[20]

In our study total 100 patients were recruited Minimum age in our sample size was 16 years, in contrast maximum age was 90 years. Mean age of our study population is 59.71±11.74 year. The maximum number of patients were of age group 51-60 years of age (37%), followed by 61-70 years of age (27%). In age group 81-90 years there was only one patient who was of 90 years. Out of 100 patients 34 (34%) patients were male and 66 (66%) patients were female. Minimal IOP in our study population was 10.2mmHg and maximum IOP was 20.6mmHg. In our study population prevalence of hypertension was 48% and prevalence of diabetes in our study population was 17%. In our study population right eye cataract was present in 64 patients, left eye in 65 patients and in bilateral eyes cataract was present in 30 patients. In total 129 cataractous eyes were there in our study population.

In our study population 64 patients had cataract in right eye. Out of 64 patients, vitreous degeneration was present in 27(42.18%) patient, vitreous detachment was present in 1(1.56%) patient, both vitreous degeneration plus detachment was present in 3(4.67%) patients. Vitreous detachment with synechiae was seen in 1 (1.56%) patient and vitreous detachment with hemorrhage and vitreous hemorrhage was seen in one (1.56%) patient. In 30 (46.8%) patients vitreous was normal. In our study population cataract was present in left eye in 65 cases. Out of 65 cases of left eye cataract 30 cases had normal vitreous. In 29 patients (44.6%) had vitreous degeneration, 5 patients (7.69%) had vitreous detachment and one patient (1.5%) had both vitreous degeneration and detachment. These vitreous changes are almost comparable between two eyes.

In our study population (of 100 patients) total cataractous eyes were 129 (64 in right eye+ 65 in left eye+30 bilateral). Out of these total 129 cataractous eyes vitreous changes were present on B-scan

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ultrasonography examination in 69 (53.48%) cases. In 60 (46.51%) cases vitreous was normal on B-scan examination. Out of 129 cataractous eyes vitreous degeneration was observed in 56 (43.41%) eyes, vitreous detachment was observed in 6 (4.65%) eyes and both detachment and degeneration seen in 4(3.10%) eyes. Vitreous hemorrhage, vitreous detachment with synechiae and vitreous detachment with hemorrhage was seen respectively in one (0.77%) patient. Vitreous changes were found in 14 out of 17 diabetic patients. The result is *highly* significant at $p < .05$. In our study population pseudophakia was present in 29 (14.5%) eyes out of 200 screened eyes. Out of these 29 eyes vitreous abnormalities were present on B-scan ultrasonographic examination in 17 (58.6%) eyes. In our study population retinal detachment was identified in total 3 patients of hyper-mature cataract on B-scan examination.

Thus, our results are consistent with those of other research projects. In patients with dense cataracts, preoperative assessment of the posterior segment with ultrasonography can be used to identify diseases that may impact the surgical approach and the visual prognosis following surgery. Before having cataract surgery, patients who have certain ocular characteristics that indicate a high risk for posterior segment pathology should have ultrasonography performed on them. The chance of finding anomalies on preoperative ultrasonography in eyes with advanced cataracts is extremely low in the absence of these risk factors. Retinal detachment did not appear to be associated with either hypertension or diabetes. When medial haziness prevents posterior segment evaluation, B-Scan ultrasonography can be helpful in determining the prognosis and examining the lesions in the posterior segment of mature cataract patients.

CONCLUSION

We find that fundus view may be impaired or not visible at all in patients with thick or advanced cataract. In these situations, preoperative B-scan ultrasonography can aid in surgical planning and help patients to set realistic expectations. It is a vital diagnostic instrument. It provides important details about the condition of the sclera, choroid, retina, and vitreous. Prior to cataract extraction, it is crucial to examine the fundus in order to evaluate and treat problems like diabetic retinopathy and retinal tears, among others, as well as to forecast the visual outcome. When medial haziness prevents the posterior segment from being evaluated, B-Scan ultrasonography can be helpful in determining the prognosis and examining the lesions in the posterior segment of mature and hyper mature cataract patients.

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