



STUDY OF ROLE OF B-SCAN ULTRASOUND IN OCULAR PATHOLOGY

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ABSTRACT

Background: B-scan ultrasonography (Brightness modulation scan) is a pivotal two-dimensional imaging modality for assessing abnormalities in the posterior segment of the eye, especially when direct or indirect ophthalmoscopy is hindered by opaque media. This study aims to evaluate the role of B-scan ultrasound in diagnosing various ocular conditions and its utility in treatment planning and follow-up. **Materials and Methods:** A cross-sectional study was conducted in the Radiology Department from June 2023 to December 2023, after obtaining Institutional Ethics Committee approval. A total of 110 patients, meeting the inclusion and exclusion criteria, were enrolled. All ultrasonography procedures were performed using a standard machine equipped with a 7.5–10 MHz high-frequency probe by an experienced radiologist. **Results:** The majority of patients (55.45%) were aged between 40 and 60 years, with a higher prevalence in males. Among the patients with dense cataracts (n=85), B-scan ultrasound revealed normal findings in 91.76% of cases, while 8.23% demonstrated posterior segment pathology. The most common intraocular pathology identified was vitreous hemorrhage (12.72%), followed by retinal detachment (4.54%) and vitreous degeneration & asteroid hyalosis (3.63% each). The sensitivity and specificity of B-scan ultrasonography in detecting posterior segment pathology were 95.24% and 98.91%, respectively. **Conclusion:** B-scan ultrasonography is a valuable tool for evaluating the posterior segment in the presence of opaque ocular media and plays a critical role in preoperative planning. It is particularly beneficial in cases of dense cataract and diabetic retinopathy, where it should be routinely employed to detect conditions like vitreous hemorrhage and asteroid hyalosis. B-scan ultrasonography should be the first-line screening modality for posterior segment lesions.

KEYWORDS : B-scan, Dense cataract, posterior segment pathology, Vitreous hemorrhage

INTRODUCTION

Diagnostic ultrasound (USG) was introduced to ophthalmology in the early 1950s and was initially applied before vitrectomy procedures in the 1970s.^{2,3} The superficial position of the eyeball, along with its fluid content, makes it particularly suitable for examination using USG. Ultrasonic sound waves (inaudible, >20 kHz) are generated through "piezoelectric lead-zirconate-titanate crystals," which create an electronic charge that produces these sound waves. These waves are transmitted into the tissues and reflected by echodense structures. The piezoelectric crystals detect the reflected waves and convert them into electrical signals, resulting in the echogram image.

USG has become a valuable tool in ophthalmology, as it is in other medical fields.⁴ While many eye conditions can be diagnosed through slit-lamp examination and fundoscopy, USG becomes particularly useful when opaque media obstructs the visualization of the posterior segment, enabling the evaluation of a variety of ocular diseases. A-scan USG is commonly used in cataract patients to measure axial length for personalized lens implantation and is considered a standard procedure in ophthalmology.^{5,6} B-scan USG, a two-dimensional imaging technique, is employed to assess abnormalities in the posterior segment of the eyes, especially when direct or indirect fundus examination is not possible due to opaque media like dense cataracts. In such cases, B-scan is routinely used as a preoperative tool to detect posterior segment abnormalities that may impact the visual outcome following surgery.^{7,8}

B-scan USG is an affordable, cost-effective, simple, non-invasive, reliable, safe, and rapid diagnostic method. It is widely accessible and provides reproducible results, making it especially valuable in rural healthcare settings.⁹ Due to its non-invasive nature, availability, and ability to deliver quick, reliable, and real-time information, USG is often the first imaging technique used for evaluating the eye and orbit.¹⁰

In recent decades, cataracts have become more prevalent in the fourth and fifth decades of life, with various causes,

including complications from other diseases. Additionally, the rise in diabetes has led to an increased incidence of diabetic retinopathy, which can result in neovascularization and vitreous hemorrhage. USG plays a crucial role in detecting vitreous hemorrhage (VH) and tractional retinal detachment (TRD) in patients with VH caused by diabetic retinopathy. USG also assists in treatment planning and is useful for follow-up when surgery is not the primary treatment option.⁴ B-scan is valuable for preoperative planning and serves as an effective screening tool for extraocular lesions. It is performed before vitrectomy and is used to assess conditions such as cataracts, vitreous degeneration, retinal detachment, ocular trauma, choroidal melanoma, and retinoblastoma.⁹

B-scan is particularly useful in cases where direct clinical evaluation is difficult or has limited value, such as foreign bodies, trauma, intraocular hemorrhage, congenital or acquired structural anomalies, and tumors. It is also valuable in assessing retroocular orbital conditions like optic neuritis, abscesses, foreign bodies, or tumors. Doppler USG is used to diagnose orbital vascular irregularities or vascular tumors and to measure blood flow in major arteries and veins.¹⁰ The present study aimed to explore the role of B-scan USG in various ocular conditions.

MATERIAL AND METHODS

Following approval from the Institutional Ethics Committee, a prospective cross-sectional observational study was conducted in the Department of Radiology at Dr. Vithalrao Vikhe Patil Foundation's Medical College and Hospital, Ahmednagar, Maharashtra, India, from June 2023 to December 2023. In this study a total of n=110 patients who met the inclusion and exclusion criteria were recruited in the study. Patients with dense cataracts, those diagnosed or suspected of having posterior segment pathology with opaque or clear media, individuals with blunt eye trauma, those presenting with proptosis, and patients with presumed or diagnosed intraocular tumors were included in the study. Exclusion criteria encompassed patients with active painful ocular surface conditions, active infections on the ocular surface, ejection of intraocular contents, and those who had recently

undergone eye surgery.

The procedure involved positioning the patient supine, with the head slightly turned to the opposite side to prevent the gel from spilling, and applying a paper or drapery barrier around the orbit. Topical proparacaine hydrochloride drops were used for anesthesia. The USG was performed using a standard ultrasound machine (Logiq 400 Pro series, Wipro GE, Bangalore, India) with a 7.5–10 MHz real-time high-frequency probe. To reduce interobserver variability, all ultrasound examinations were conducted by the same experienced radiologist. During the examination, the patients' eyelids were kept closed, and carbomer gel was applied to enhance sound penetration. The transducer was gently pressed against the eyelid to obtain transverse and sagittal scans. Dynamic B-scanning, involving controlled eye movements, was performed to accurately assess vitreoretinal relationships, and Doppler settings were adjusted for low flow conditions to detect and visualize small blood vessels, including the central retinal vessels. The vitreous cavity was carefully examined for pathologies such as tractional retinal detachment (TRD), with scans performed in multiple planes. Both eyes were scanned sequentially, and excess gel was removed after the procedure. USG findings were documented with photographs, and the outcomes were correlated with the clinical history and final diagnosis.



Figure 1: Vitreous Detachment: There are linear echogenic membranes in the posterior compartment of the eye which are partially mobile. Some floating echoes noted in the vitreous chamber in keeping with vitreous haemorrhage.

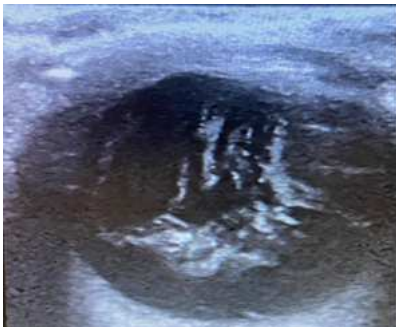


Figure 2: Vitreous Haemorrhage: Floating Echoes in posterior chamber.



Figure 3: Pthisis bulbi with Retinal Detachment: Axial US image shows a small, crenated, shrunken-looking ocular globe with retinal detachment.



Figure 4: Retinal Detachment: Continuous membrane noted within vitreous, with triangular shape, which inserted on optic disc. It is limited to ora serrata, unlike choroidal detachment.



Figure 5: Cataract – Heterogeneous Echogenicity noted within the lens in keeping with cataract.

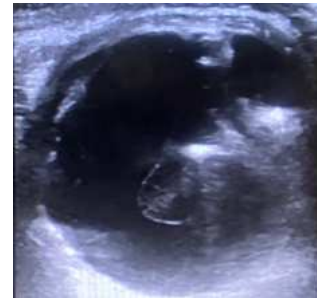


Figure 5: Lens Dislocation – There is dislocated intraocular lens with temporal side haptic possibly adherent to the capsule or iris.

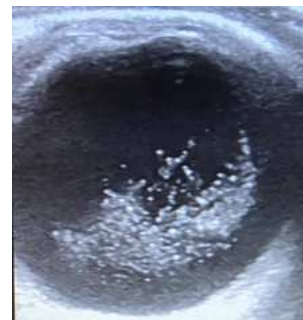


Figure 6: Asteroid Hyalosis: Small Hyperechoic echoes noted floating in the vitreous chamber.

Statistical Analysis:

The data was recorded and assessed using Microsoft excel. Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were expressed as percentages. Continuous variables were expressed as mean ± standard deviation, and categorical variables as percentages. Intraoperative findings were compared with preoperative A- and B-scan results. Cases were classified as false-positive if USG results indicated a condition not confirmed during surgery, and false-negative if USG failed to detect a condition confirmed surgically. Sensitivity and specificity were calculated using the method outlined by

Total	42	92	134
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RESULT

The study included a total of 110 patients, whose ages ranged across various groups. The majority of the cases, 61 patients (55.45%), were in the 40 to 60-year age group, making this the most prevalent age group in the study. This was followed by 36 patients (32.72%) who were aged 60 years and above. The 20 to 40-year age group accounted for 12 patients (10.9%), while the 0 to 20-year age group was the least represented, with only 1 patient (0.9%). Among study subjects, 58 (52.72%) patients were male.

In this study, the most common diagnosis was dense cataract with a normal B-scan, accounting for 78 cases (70.90%) involving 93 eyes. This indicates that the majority of patients with dense cataracts had no detectable posterior segment pathology on B-scan ultrasonography. Vitreous hemorrhage was diagnosed in 8 cases (7.27%), affecting 10 eyes, making it the second most common finding. Diabetic retinopathy with associated vitreous hemorrhage, retinal detachment, or asteroid hyalosis was found in 5 cases (4.54%), involving 10 eyes. Retinal detachment alone was observed in 4 cases (3.63%) and 4 eyes. Other conditions included dense cataract with vitreous hemorrhage in 3 cases (2.72%) and 3 eyes, dense cataract with retinal detachment in 2 cases (1.81%) and 2 eyes, dense cataract with vitreous degeneration in 2 cases (1.81%) and 2 eyes, vitreous degeneration in 2 cases (1.81%) and 4 eyes, asteroid hyalosis in 2 cases (1.81%) and 2 eyes, and choroidal detachment in 2 cases (1.81%) and 2 eyes. Less common diagnoses included pthisis bulbi and choroidal melanoma, each observed in 1 case (0.90%) affecting 1 eye (Table 1).

Table 1: Distribution of patients according to diagnosis on B-scan

Sr No.	Diagnosis	Number of cases N (%)	Number of eyes
1	Dense Cataract with normal B-scan	78 (70.90%)	93 eyes
2	Dense Cataract with Vitreous Hemorrhage	3 (2.72%)	3 eyes
3	Dense Cataract with Retinal Detachment	2 (1.81%)	2 eyes
4	Dense Cataract with Vitreous degeneration	2 (1.81%)	2 eyes
5	Vitreous Hemorrhage	8 (7.27%)	10 eyes
6	Diabetic Retinopathy with VH / RD / AH	5 (4.54%)	10 eyes
7	Retinal Detachment	4 (3.63%)	4 eyes
8	Vitreous degeneration	2 (1.81%)	4 eyes
9	Asteroid Halosis	2 (1.81%)	2 eyes
10	Choroidal Detachment	2 (1.81%)	2 eyes
11	Pthisis Bulbi	1 (0.90%)	1 eyes
12	Choroidal Melanoma	1 (0.90%)	1 eyes
Total		110 (100%)	134 eyes

Among the 42 eyes with a positive final diagnosis, USG correctly identified 40 of these cases (true positives), while 2 cases were missed (false negatives). For the 92 eyes with a negative final diagnosis, USG correctly identified 91 of these cases as negative (true negatives) and incorrectly diagnosed 1 case as positive (false positive). The sensitivity and specificity of B-scan USG was found to be 95.24% and 98.91% respectively.

Table 2: Correlation of B-scan diagnosis and final diagnosis among patients

USG diagnosis (n=134 eyes)	Final Diagnosis (n=134 eyes)		Total
	Positive	Negative	
Positive	40	1	41
Negative	2	91	93

DISCUSSION

USG is a valuable tool for assessing eyes with dense cataracts, diabetic retinopathy, and vitreous hemorrhage, particularly when direct visualization of the fundus is not feasible. It provides critical information that aids in diagnosing, predicting outcomes, and planning treatment for these and other ocular conditions. In dense cataracts patient's posterior segment pathology cannot be evaluated by slit-lamp examination and fundoscopy, and treatment plan, prognosis will be changed if there is posterior segment pathology. In current years with increasing co-morbidities cataract may be associated with undiagnosed posterior segment pathology because the clinical presentation of posterior segment pathology may be masked by symptoms of cataract and hence it may go unnoticed. But posterior segment pathology will significantly affect the postsurgical outcome. Also, prevalence of diabetes is on rise and the incidence of micro-vascular complications of diabetes is also on rise due to late diagnosis of diabetes, poor control of blood sugar, lack of awareness regarding the regular eye checkup among diabetes.

Looking at the above scenario the present study was planned to study the role of B-scan USG in different ocular conditions. Following approval from the Institutional Ethics Committee, a cross-sectional study was carried out in the Department of Radiology from June 2023 to December 2023. A total of 110 subjects satisfying the inclusion and exclusion criteria were involve in the study. All of the USG procedures were carried out with the standard USG machine (Logiq 400 Pro series, Wipro GE, Bangalore, India) equipped with a 7.5–10 MHz real time high-frequency probe with the contact method. by the same experienced vitreo-retinal surgeon ⁴. B-scan USG findings were correlated with clinical history and clinical diagnosis and final diagnosis was obtained.

The present study, suggests that the incidence of ocular conditions requiring B-scan ultrasonography is significantly higher in middle-aged and older adults, particularly those aged 40 to 60 years. This could be attributed to age-related changes in the eye, such as cataracts and other degenerative conditions, which are more common in these age groups. The relatively lower number of cases in younger age groups indicates that such ocular conditions are less prevalent among them, possibly due to fewer age-related ocular pathologies in younger individuals. These findings are comparable with the study conducted by Rajimwale G et al, and OP Sharma et al. ^{12,13}.

In present study, there were 58 (52.72%) male cases and 52 (47.27%) female cases. Similar findings were observed in study by Chaudhari H et al., they found that out of 100 subjects 58 patients were male and 42 were female ¹⁴. As per Rajimwale G et al, ocular anomalies were more common in male subjects (61.95%) than female subjects (38.04%) ¹². AS per OP Sharma et al., the male to female ratio was 2:1 ¹³.

In present study, dense cataract with normal B-scan was seen in 93 eyes of 78 (70.90%) patients. In dense cataract cases, posterior segment pathology was seen in B-scan of 7 eyes of 7 patients. Dense Cataract with Vitreous Hemorrhage was seen in 3 eyes of 3 (2.72%) patients. Dense Cataract with Retinal Detachment was seen in 2 eyes of 2 (1.81%) patients. Dense Cataract with Vitreous degeneration was seen in 2 eyes of 2 (1.81%) patients. Among dense cataract patients (n=85), B-scan illustrates that a maximum number of the subjects had normal USG findings (91.76%) whereas 7 (8.23%) presented posterior segment pathology. In a study by Anteby II et al., in 19.6% of the patients with dense cataracts, "posterior segment pathology" was seen on B-scan. The most commonly seen anomalies were "posterior staphyloma" (7.2%), retinal

detachment (4.5%), and vitreous hemorrhage (2.5%)¹⁵.

In the present study, on B-scan 2 (1.81%) patients had Choroid Detachment, and 1 (0.90%) patients had Choroid Melanoma in one eye. Analogous outcomes were noted in a study by Rajimwale G et al, they found that among Choroidal deviations maximum cases were of "choroid detachment (6.52%) followed by Melanoma (2.17%) and Panophthalmitis (1.09%)"¹². Agrawal R et al., reported that among choroidal deviations maximum cases were of choroidal detachment (80%), while rest 20% cases were of choroidal haemorrhage¹⁶.

In present study, on B-scan 14 (12.72%) patients were having vitreous hemorrhage, of which 5 patients were having bilateral vitreous hemorrhage. On B-scan 4 (3.63%) patients were having vitreous degeneration, of which 2 patients were having bilateral vitreous degeneration. On B-scan 4 (3.63%) patients were having Asteroid Halosis, of which of which 2 patients were having bilateral Asteroid Halosis. In this study, the majority of patients were found to have vitreous hemorrhage (12.72%), with vitreous degeneration following at 3.63%. This contrasts with the findings of Rajimwale G et al., who reported that most patients had "vitreous hemorrhage" (46.73%), followed by vitreous degeneration (16.30%)¹².

In present study, on B-scan 4 (3.63%) patients were having unilateral Retinal Detachment, 5 patients were having changes of Diabetic Retinopathy in both the eyes. Three patients (2.72%) were having Diabetic Retinopathy with bilateral vitreous hemorrhage, 1 (0.90%) patient was having Diabetic Retinopathy with bilateral retinal detachment & 2 (1.81%) patients were having Diabetic Retinopathy with bilateral AH. Comparable outcomes are observed in study by Rajimwale G et al, they in their study found retinal detachment in 45 (48.91%) patients¹².

In present study, total 22 (20%) patients were having Vitreous pathology on B- scan, total 9 (8.18%) patients were having Retinal pathology & Total 3 (2.72%) patients were having Choroid pathology. Pthisis Bulbi was seen in one eye of 1 (0.90%) patient.

In present study, most common intraocular pathology was vitreous hemorrhage (12.72%), followed by retinal detachment in 5 cases (4.54%) followed by Vitreous degeneration & Asteroid Halosis each in 4 (3.63%) patients. Similar to present study Sharma OP et al., in their study on 122 cases found that vitreous haemorrhage was the most common intraocular pathology (41.17%) followed by retinal detachment (26.4%)¹³. Ahmed J et al., in their study that most cases were of Vitreous Haemorrhage (29%) followed by Retinal Detachment (25%)¹⁷. But Haile M et al., in their study found that the most common abnormality was retinal detachment (39%) followed by vitreous opacities (31%)¹⁸ and Coleman DJ in their study found 25% incidence of RD¹⁹. The difference in percentage in present study was because, out of 110 patients, 85 patients were with dense cataract, having normal posterior segment in 78 (91.76%) patients with only 7 (8.23%) patients having posterior segment pathology.

On correlation of B-scan diagnosis with final diagnosis among patients, sensitivity of B-scan USG was 95.24% and specificity was 98.91% in detecting posterior segment pathology. Rajimwale G et al. found that the sensitivity of ultrasound (USG) was 97.7% and the specificity was 80%, with these results showing statistical significance (p<0.001).

However, B-scan USG has some limitations: 1) Gas bubbles and subretinal hemorrhages may lead to false positives. 2) Small lesions and fibrotic tissue can result in false negatives. 3) B-scan may not distinguish between different pathologies, such as thick vitreous and retinal detachment. 4) It is not applicable in cases of open globe injury. 5) For tumors, it is less

effective at detecting bony involvement and extension to adjacent structures and the brain. 6) B-scan is not useful for diagnosing orbital fractures.

CONCLUSION

B-scan is essential for assessing the posterior segment when the ocular media are opaque. It is particularly useful for preoperative planning and should be routinely performed in patients with dense cataracts. For individuals with diabetic retinopathy, B-scan is crucial for accurately evaluating posterior segment pathology, as common issues include cataracts and vitreous degeneration. B-mode USG is the preferred initial screening tool for posterior segment lesions, offering high-quality real-time imaging of various ocular conditions. It is widely applicable in diagnosing retinal disorders, such as retinal detachment and masses, especially in patients with opaque ocular media.

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