



## Evaluation of cataract patients by B-Scan ocular ultrasound in diagnosing posterior segment pathology

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### Abstract

The present study was planned to assess the prevalence and nature of posterior segment pathologies detected by B-scan ultrasound in pre-operative cataract patients and to study various patient risk factors that increase the likelihood of posterior segment pathology. The objective of this study is to help the ophthalmologic surgeon in predicting possible visual prognosis in addition to proper planning and execution of surgery and to decide postoperative management.

The present study was planned in the Department of Radiology, Government Medical College, Bettiah, Bihar from Jan 2018 to June 2018. Total 100 patients were enrolled in the present study. Diagnostic B-Scan Ultrasonography was performed in these patients preoperatively. Detailed history was taken and examination with Slit Lamp and Tonometry were done. A-Scan Biometry was performed in all the cases. Informed consent was taken. B-Scan ultrasonography using a standard USG machine (Sonomed B5500) equipped with a real-time high-frequency probe with the contact method was done.

B-scan is a good diagnostic modality for preoperative evaluation of posterior segment pathologies in the presence of cataract. B-Scan ultrasonography should be performed routinely in pre-operative assessment of cataract patients to diagnose pathologies of posterior segment that may influence the surgical strategy and visual prognosis of patients after cataract surgery. Diagnosing and characterizing the abnormalities with great accuracy by B-scan not only helps in preoperative cases but also changes the management of various other patients.

**Keywords:** B-scan ocular ultrasound, posterior segment pathology, cataract patients, etc

### Introduction

Because the eye is a superficial fluid filled structure, ultrasound is an easy to use modality for visualization of ocular pathology and anatomy [1]. The principles of ocular ultrasound are the same as other applications of this technology. Sound waves are generated at a frequency greater than 20,000 Hz (20 kHz), and reflected back to the transducer by tissue in its path. When the sound wave returns, a piezo-electric crystal in the transducer vibrates, resulting in electrical impulses that are translated into an image or other data [2].

Higher frequency waves penetrate less into tissue but have better resolution. In contrast, lower frequency waves penetrate more deeply but have worse resolution. Ultrasound waves, like other waves, have predictive behaviors based on properties of the medium they travel through. For instance, sound waves have higher velocity when travelling through solids than through liquids [3]. When sound waves travel between tissue interfaces with different acoustic impedance, or densities, they can either scatter, reflect, or refract. Some sound is absorbed by tissue as well. Sound waves that return to the transducer are called echoes, and ultrasound imaging zones can be hyperechoic, hypoechoic, or anechoic [4]. Shadowing can occur distal to a very dense lesion, resulting in an anechoic region.

There are two main types of ultrasound used in ophthalmologic practice currently, A-Scan and B-scan. In A-scan, or time-amplitude scan, sound waves are generated at 8 MHz and converted into spikes that correspond with

tissue interface zones. In B-scan, or brightness amplitude scan, sound waves are generated at 10 MHz. The data collected by the transducer produces a corresponding image. [2] The most prevalent use of ocular ultrasonography is to obtain globe length in order to calculate corrective lens power requirements. Other uses include the measurement of tumors including choroidal melanomas [2, 5], visualization of lens dislocation [5], and detection of retinal detachment. Ultrasonography is especially useful in cases in which the fundus is obscured from visualization by slit lamp and laser interferometry (IOL Master), as in patients with dense cataracts [2, 4]. In this population, the use of ocular ultrasonography may result in earlier detection of ocular melanoma [2].

The benefits of ultrasound include improved visualization of structures obscured by opaque substances, such as dense cataracts or vitreous hemorrhage. Second, real time information is available to the practitioner regarding conditions such as retinal detachment. Finally, ultrasound is safe, does not expose the patient to radiation, is widely accessible, and is low cost. Disadvantages include a high level of inter-operator variability [4], which does not plague other forms of imaging including optical coherence tomography, CT, and MRI.

B-scan, or brightness scan, is another method used for ocular assessment via ultrasound. It 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 include

visualization of the lesion, including anatomic location, shape, borders, and size. It can be used for a detection of a wide-range of pathological structures, including retinal or choroidal detachment, foreign bodies, calcium, and tumors [4, 2]. Echoes in B-scan are converted to dots with brightness intensity that is proportional to the echo amplitude. For example, high amplitude echoes appear as hyperechoic (white), and absent echoes appear black (anechoic). It is especially useful in imaging of tumors of the anterior orbit, myositis with associated EOM tendon thickening, and visualization of the superior ophthalmic vein in carotid cavernous fistulas [4, 2]. Similar to A-scan, high gain results in good sensitivity, but poor resolution. It is essential that lesions are centered in the image to obtain the best quality possible.

Retinal detachment is an ophthalmologic emergency that can result in severe loss of vision. A variety of etiologies exist for this condition, including proliferative diabetic retinopathy, penetrating trauma, advancing age, serous fluid accumulation in inflammatory eye pathology, and a complication after cataract surgery [7, 8]. Direct observation of a detached retina can be impeded by a variety of factors, including an associated large vitreous hemorrhage, narrow anterior angle precluding mydriatic application, periorbital trauma, or lens opacification. In the aforementioned cases, and others, ocular ultrasonography can be used to delineate underlying pathology of visual symptoms [7].

Because ocular emergencies represent 3% of all ED encounters, existing constraints to CT/MRI of the orbit including time and cost [5], and variable availability of ophthalmologists, emergency practitioner comfort with ocular ultrasound is important. To use B-scan for evaluation of retinal detachment cases in the emergency room, Teismann *et al.* recommend the mnemonic CASE.

1. Close and cover the eye with gel
2. Axial plane: apply the transducer gently on the eye with your fourth and fifth fingers resting on the patient's nose.
3. Scan the retina for pathology. A normal appearing retina should be continuous. If detachment is present, fluid will begin to separate the retinal epithelium its attachment to the globe. This will create a thick, oscillating, hyperechoic structure in the case of retinal detachment.
4. Evaluate the entire eye: small retinal detachments can occur in the retina periphery. The patient may have to move his or her eyes while you are scanning to ensure visualization is complete.

Other forms of eye pathology can appear similar on ultrasonography, including posterior vitreous detachment and vitreous hemorrhage. If retinal detachment is suspected based on imaging or clinical history, referral should be made to ophthalmology within 24 hours, as noted above [7].

Research has shown that bedside ultrasound in the ED can be effectively used for the diagnosis of ocular pathology, as exemplified by Blaivas *et al.*, 2002. In this study, 61 patients presenting with ocular trauma or acute visual changes within 48 hours of symptom onset underwent B-scanning. Patients with binocular symptoms indicative of neurologic pathology were excluded. Bedside ultrasound images were analyzed for presence of vitreous hemorrhage or detachment, retinal detachment, central retinal artery and vein occlusion (by Doppler ultrasound), globe rupture,

intraocular foreign bodies, lens dislocation, and retrobulbar hematomas. Results were compared to a gold standard of CT of the orbit, ophthalmologist diagnosis, or both. In 60/61, nearly 100% of patients included in the study, the ED ultrasound results were confirmed by gold standard [5]. As such, ocular ultrasound modalities are likely to serve as useful adjuncts in cases where ophthalmology consults are delayed. Of course, care should be taken to avoid vitreous fluid leakage in cases of penetrating eye injury, and caution should be exercised when applying ultrasound equipment to the eye.

Eye is affected by spectrum of pathological conditions occurring in all age groups from new born to old age. Although clinical examination and ophthalmoscopy are the basis of diagnosis in most patients with eye disease, in many cases, especially when the clinical examination of the ocular fundus is difficult, other techniques will be required, ultrasound being one of them [8].

Ultrasound is a safe technique, cheaper and more affordable compared to other techniques that would also provide good data (such as OCT, CT, MRI) [9]. Although CT and MRI are invaluable in many orbital conditions, they lack the immediacy and simplicity of ultrasound, cannot produce real time images, and have considerable limitations when imaging the vitreous and the retina whereas ultrasound contributes more to tissue diagnosis. Dynamic examination is important and with B scan ultrasound it's possible to study characteristics of the motion and topography of pathological intra ocular conditions, enabling identification of detachment of vitreous membranes and vitreous retinal adhesions [10].

Both A (Amplitude) scan and B (Brightness) scan techniques are important for the diagnosis of posterior segment lesions. B scan (brightness) mode is useful for a better demonstration of the shape and topographic relationship of lesions in the posterior segment [9].

With understanding of the indications for ultrasonography and proper examination technique, one can gather a vast amount of information not possible with clinical examination alone. Over the last 30 years, ultrasound has greatly advanced and now its most common use is in contact mode for evaluation of the posterior segment in eyes with media opacification. Situations that prevent normal examination of fundus include lid problems (eg, severe edema, partial or total tarsorrhaphy), corneal opacities (eg, scars, severe edema), hyphema, hypopyon, miosis, pupillary membranes, dense cataracts, or vitreous opacities (eg, hemorrhage, inflammatory debris). In such cases, diagnostic B-scan ultrasound can accurately image intraocular structures and give valuable information on the status of the lens, vitreous, retina, choroid, and sclera [9].

The present study was planned to assess the prevalence and nature of posterior segment pathologies detected by B-scan ultrasound in pre-operative cataract patients and to study various patient risk factors that increase the likelihood of posterior segment pathology. The objective of this study is to help the ophthalmologic surgeon in predicting possible visual prognosis in addition to proper planning and execution of surgery and to decide postoperative management.

### Methodology

The present study was planned in the Department of Radiology, Government Medical College, Betiah, Bihar

from Jan 2018 to June 2018. Total 100 patients were enrolled in the present study. Diagnostic B-Scan Ultrasonography was performed in these patients preoperatively. Detailed history was taken and examination with Slit Lamp and Tonometry were done. A-Scan Biometry was performed in all the cases. Informed consent was taken. B-Scan ultrasonography using a standard USG machine (Sonomed B5500) equipped with a real-time high-frequency probe with the contact method was done. Ultrasonic probe was placed over the globe with closed lid after application of the gel and then transverse, antero-posterior and longitudinal scans were taken. High Gain [80-90 db] and low gain [60-70 db] sensitivity were selected during Ultrasonography.

All the patients were informed consents. The aim and the objective of the present study were conveyed to them. Approval of the institutional ethical committee was taken prior to conduct of this study.

Following was the inclusion and exclusion criteria for the present study.

Inclusion criteria: (1) The patients with suspected posterior segment pathology having an opaque ocular media. (2) The patients with clear ocular media in whom the extent of posterior segment pathology needed to be assessed. (3) Hazy media (4) Unexplained visual loss.

Exclusion criteria: (1) The patients with badly ruptured globe and having active bleeding were excluded. (2) Unstable / poor general health

**Results & Discussion**

In developing countries like India, Cataract is an important cause of blindness and due to lack of proper awareness, many patients presents with advanced cataracts that precludes visualization of fundus prior to cataract surgery. Such visualization is considered important to provide accurate prognosis for vision after cataract surgery. Under such circumstances ultrasonographic examination can provide information regarding such abnormalities. Over the last 30 years, ultrasonography has greatly advanced which has enabled us to study posterior segment of the eye even in the presence of opaque media like dense cataract.

Traumatic cataract was more common in younger age group due to more involvement in outdoor games and activities and thus having more chances of trauma. Non traumatic cataract was most common in 41-60 years as this is the age group for senile cataract. The most common clinical symptom amongst patients included in the study was decreased vision followed by glare, colored halos and the least common was second sight. In case of traumatic cataract patients, trauma was documented in the past history.

**Table 1:** Age group of Patients

Age [yrs.]	No. of Patients
1-10	8
11-20	12
21-30	15
31-40	9
41-50	16
51-60	22
61-70	18
Total	100

**Table 2:** Type of Post.seg lesion

Type of Post. seg lesion	No of cases
Retinal detachment	3
Vitreous haemorrhage	2
Posterior vitreous detachment	1
Posterior Staphyloma	1
Vitreous opacities & Exudates	2
Asteroid hyalosis	1
IOFB	1
Coloboma choroid	1
Variation in Axial length	2
Total	14

Examination of the intra ocular contents by ophthalmoscopy is dependent upon transparent light conducting media: the cornea, the aqueous humour, the lens and vitreous gel. After trauma, the media are frequently opacified by hemorrhage, laceration, scarring, or cataract. Internal injury is often serious than is immediately apparent, and contusional damage to posterior segment structures carries an unfavourable visual prognosis. The aim of surgery is to intervene at an early stage, so that vitrectomy and other microsurgical techniques are carried out before chronic, irreversible changes develop which threaten the patient's sight. Before surgery it is helpful to have knowledge of the degree of internal derangement, and in the presence of opaque media, ultrasound has proved to be the ideal tool [10]. In the study done by Manzoor A Qureshi and Khalida Laghari, B scan ultrasound was performed on 750 patients with dense cataract. Out of 750 patients, 90 patients had posterior segment lesions. Out of 90 positive cases, 25 had retinal detachment, 14 had posterior vitreal detachment, 24 had vitreous hemorrhage, 12 were asteroid hyalosis, while posterior staphyloma and intraocular foreign body were found with the frequency of 9 and 6 respectively. The study concluded that B scan ultrasound can be one of the diagnostic tool for the detection of hidden posterior segment lesion and can be performed routinely in pre-op cataract patients as this would help in surgical planning [9].

A retrospective and observational study done by Ejaz Ahmed Javed, Aamir Ali Ch., Iftikhar Ahmad, Mehmood hussain on 463 cases having opaque media, it was found that, 20 had only corneal pathology, 90 had mature cataract, 60 had only vitreous hemorrhage, 68 had only retinal detachment, 51 had tractional retinal detachment, 4 had retinoblastoma, 2 had optic nerve anomaly, 2 had choroidal pathology, 2 had persistent hyperplastic primary vitreous, and 1 had asteroid hyalosis. The study concluded that B scan proved to be a valuable diagnostic modality in opaque media and had remarkable prognostic importance [11].

There was diffuse vitreous opacification with vitreous echoes and membranes and thickened and ill defined retinochoroido-scleral complex on B-scan. In endophthalmitis, opacities are similar to opacities of dispersed vitreous hemorrhage. Follow up was necessary as organization and membrane formation is faster than seen in vitreous hemorrhage. Ultrasound is useful to determine the severity and extent of inflammation in clinically suspected cases of endophthalmitis. Similar findings were reported by Maresova *et al*, who conducted a retrospective study in 7 eyes of 7 patients to evaluate the ultrasound findings in eyes with endophthalmitis following penetrating injury and found

that membranes were present in the vitreous in 5 eyes <sup>[12]</sup>.

Ocular trauma can lead to scleral folds, which are diagnosed by ultrasound and appear as irregularities in globe contour, which may mimic small dome-shaped elevations, highly reflective at their top and shadowing the orbital tissues. Because of the shadow, they mimic a foreign body and may also resemble choroidal detachment. This is one reason for US evaluation prior to primary closure. Foreign Bodies US is a complementary modality to radiology in the detection and localization of foreign bodies. It can give additional information regarding the exact location within the eye and the extent of damage to surrounding tissues. B-scan offers advantages in determining the foreign body's position and distance from ocular structures. A-scan ultrasonography displays the relative echo amplitude of foreign body and other tissues. The major value of US in detecting foreign bodies is its independence from radio-opacity. Another advantage of this diagnostic modality is the ability to differentiate between intraocular and extra ocular foreign bodies when they are located near the sclera. In addition, the mobility, magnetic properties and shift in position of the foreign body between the time of initial study and the time of surgery can be accurately evaluated. However, this modality does have some limitations. Softer materials, which are only intermediately reflective (wood and vegetative materials) are more difficult to detect. Small particles particularly located at the orbital apex and those lodged in highly reflective tissues can be missed. Metal or glass foreign bodies deflect or absorb sound so that they produce an anechoic area posterior to the body <sup>[13]</sup>.

Now since there was no means to visualise the fundus by any optical method or to determine the refractive error because of dense cataractous lens, we clinically assumed that it was a case of complicated cataract and in that case postoperative prognosis was not good. But on ultrasonographic scanning, we could actually visualise that the antero-postero diameter of the cataractous eye was much smaller than the other myopic eye (showing posterior staphyloma, apart from increased A-P diameter). So we could profess good visual results after operation and indeed, after lensectomy, the corrected visual acuity was 6/9.

### Conclusion

B-scan is a good diagnostic modality for preoperative evaluation of posterior segment pathologies in the presence of cataract. B-Scan ultrasonography should be performed routinely in pre-operative assessment of cataract patients to diagnose pathologies of posterior segment that may influence the surgical strategy and visual prognosis of patients after cataract surgery. Diagnosing and characterizing the abnormalities with great accuracy by B-scan not only helps in preoperative cases but also changes the management of various other patients.

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