Ultrasound B-Scan for Posterior Segment Evaluation

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B-scan ultrasonography is an important non-invasive, reproducible investigation to aid in clinical assessment. This article aims to describe the principle, techniques and indications for echo graphic examination and also an understanding of echo graphic characteristics of various posterior segment pathologies.

**Principle**

Ophthalmic ultrasonography is based on the principle of pulse-echo system. The piezoelectric material in the probe transducer undergoes a mechanical vibration by the electrical signal. This vibration in turn causes a longitudinal ultrasound wave to be propagated through the ocular and orbital tissues. Some part of these waves is absorbed by the tissues and the other part is reflected back to the probe. This reflected wave is referred to as an echo. These reflected echoes create another mechanical vibration of the piezoelectric material. This vibration produces an electric signal that is transmitted to the receiver and display screen. These echoes are represented as multitude of dots that together form a two dimensional image on the screen.

**Instrumentation**

B-scan probe contains a transducer that oscillates back and forth near the tip of the probe. The probe has a marker, generally a dot or line. The probe is placed opposite to the area of interest eg, to assess pathology at 3 o’clock, the probe is placed at 9 o’clock position.

The probe face is the initial line on the left side of the echogram (P). The right side of the echogram represents the region located opposite the probe face. The upper part of the echogram corresponds to the region of globe where marker is directed. The centre of the screen represents the central portion of the probe face eg. if the area of interest is at 3-o’clock then the probe face is held on the globe at the 9-o’clock position with the marker aimed upward. The centre of the probe is aiming at 3-o’clock which appears in the centre of right side of the echogram which is the area of best resolution. The top of the right side of the echogram represents the 12-o’clock position since that is the orientation of the marker, and the bottom represents the 6-o’clock position. Therefore, the slice of tissue on the right side of the display is from the 12-o’clock position to the 6-o’clock position, with the 3-o’clock position in the centre.
Diagnostics: Ultrasound B-Scan for Posterior Segment Evaluation

B-Scan probe orientations
The macula is considered the centre of posterior fundus and it serves as a reference point for the three primary probe orientations - transverse (Table 1), longitudinal and axial (Figure 1).

Transverse: Demonstrates the lateral extent of the lesion and encompasses around 6 clock hours. It is done by placing the probe parallel to the limbus with the patient’s gaze towards the area of interest (Black line in Figure 2).

Longitudinal: Demonstrates the radial (antero-posterior) extent of the pathology, it is done by placing the probe perpendicular to the limbus (Red line in Figure 2).

Axial: Demonstrates the lesion in relation to lens, optic nerve and macula in a single scan. It is done with probe centred on corneal vertex and patient looking in primary gaze (Blue line in Figure 2).

<table>
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<th>Table 1: Orientation of the B-Scan probe marker</th>
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<td><strong>Probe Position</strong></td>
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<td>Transverse and Axial scans</td>
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<tr>
<td>Vertical</td>
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<tr>
<td>Oblique</td>
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<td>Longitudinal scans</td>
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<th>Table 2: Indications for Intraocular Examinations</th>
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<td><strong>Clear Ocular Media</strong></td>
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<tr>
<td><strong>Anterior Segment</strong></td>
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<tr>
<td>Iris Lesions</td>
</tr>
<tr>
<td>Ciliary Body Lesions</td>
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<tr>
<td>Miosis</td>
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<tr>
<td><strong>Posterior Segment</strong></td>
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<tr>
<td>Tumours</td>
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<tr>
<td>Choroidal Detachment</td>
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<tr>
<td>Retinal Detachment</td>
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<tr>
<td>Optic Disc Abnormalities</td>
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<tr>
<td>Intraocular Foreign Body</td>
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Basic Evaluation
There are various indications for doing an ultrasound B-Scan for the posterior segment evaluation (Table 2). Basic screening of the posterior segment of the eye is done by using transverse scans in 3, 6, 9, 12 o’clock positions and horizontal and vertical axial scans are performed. If any suspicious area is noted in these scans, further evaluation is done. The reflectivity of a lesion is classified into a particular category depending on the height of the lesion spikes compared with initial spikes in the echogram. This quantitative technique is performed with standardized A-scan using the Tissue Sensitivity setting (Table 3).

Echographic Characteristics of Various Pathologies

Vitreous
1. Normal vitreous: In young person it is echo lucent however due to liquefaction in ageing scattered low reflective opacities are noted (Figure 3).
2. Asteroid hyalosis: Calcium soaps produce bright, point like echoes. An area of clear vitreous is present between the opacities and the posterior hyaloid (Figure 4).
3. Posterior vitreous detachment (PVD): It may be focal, extensive or complete. PVD appears as a smooth, thin undulating membrane with good after movements (Figure 5).
Retina

Retinal detachment (R.D.)

a) Fresh Rhegmatogenous R.D. appears as a high reflective membrane with poor after movements attached to the optic nerve head posteriorly. As the R.D. becomes chronic it becomes stiffer and appear funnel shaped with or without intraretinal cysts (Figure 7a: blue arrow). A giant retinal tear may appear as a mobile, undulating membrane sometimes folded upon itself (Figure 7b: red arrow)

b) Exudative R.D.: membranous echo with a convex configuration and an evidence of shifting subretinal fluid (red arrow) in sitting and supine positions (Figure 8).

c) Tractional R.D. (TRD): It is represented by membranous echo with a concave configuration. In cases of TRD, the attachment of the PVD has to be noted carefully as to whether it is point, multiple or broad attachment for surgical planning (Figure 9).

Choroid

Choroidal Detachment: A membranous echo which is smooth, dome-shaped, and thick with no after movement. It can be serous in which the subchoroidal space is echo lucent (Figure 10a) whereas in haemorrhagic the space shows multiple dot echoes (Figure 10b).

Intraocular Tumors

Ultrasound is commonly used for the initial and follow-up evaluation of intraocular tumours.

Choroidal Melanoma: The classic configuration of a melanoma is that of a collar button though some may

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**Table 3: Reflectivity Categories**

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<tr>
<th>Category</th>
<th>Spike Height %</th>
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<tbody>
<tr>
<td>Extremely Low</td>
<td>0-5</td>
</tr>
<tr>
<td>Low</td>
<td>5-40</td>
</tr>
<tr>
<td>Medium</td>
<td>40-60</td>
</tr>
<tr>
<td>Medium-High</td>
<td>60-80</td>
</tr>
<tr>
<td>High</td>
<td>80-100</td>
</tr>
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</table>

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**Figure 4:** Vitreous showing multiple high reflective dot echoes (red arrow) with clear space (blue arrow) suggestive of Asteroid Hyalosis.

**Figure 5:** Membranous echo with point attachment at ONH (red arrow) suggestive of Incomplete PVD

**Figure 6:** Echogram showing complete PVD (red arrow) with low reflective dot echoes below (blue arrow) suggestive of subhyaloid haemorrhage and few above the PVD suggestive of VH (Green arrow)

4. **Vitreous Hemorrhage (VH):** The echo graphic pattern of a vitreous hemorrhage depends on its age and severity. Fresh mild VH appears as small mobile dots of low reflectivity. In old severe VH the blood organizes and forms membranes. Blood lined PVD becomes moderate to high reflective. It is differentiated from retinal detachment by good after movements. Sub
Melanomas have homogenous, cellular architecture therefore these tumours typically have low to medium reflectivity. Large melanomas produce significant internal sound attenuation causing reduced reflectivity at tumour base (acoustic hollowing). This attenuation also gives a characteristic angle kappa on corresponding A-scan. Choroidal excavation may also be noted (Figure 11).

**Choroidal Hemangioma:** It appears as a dome shaped lesion with high internal reflectivity with regular structure. It may be associated with exudative retinal detachment (Figure 12).

**Retinoblastoma:** Shows irregular configuration and internal reflectivity varies according to the degree of calcification. When calcium deposits are numerous or large they cause high reflectivity with shadowing of adjacent sclera or orbit (Figure 13).

**Trauma**

Ultrasound is of great value in assessment and planning the management in cases of ocular trauma. The following features are to be noted in trauma:

1. Status of the lens/IOL - dislocation/subluxation (Figure 14 a & b)
2. Status of posterior capsule - intact/disrupted
3. Vitreous hemorrhage/vitreous incarcerarion
4. Intraocular foreign body (IOFB)- present/absent (Figure 15)
5. Posterior globe dehiscence-present/absent (Figure 16).
6. Exudates in the vitreous – present/absent (Figure 17)
7. Status of the retina- attached/detached
9) Status of the ONH – avulsion present/absent.

**Endophthalmitis**

Multiple dot and membranous echoes of low to moderate reflectivity are present in the vitreous cavity with or without thickening of the ocular coats (Figure 17a). Panophthalmitis, in addition can present with the ‘T’ sign which is an echo lucent space found behind the sclera. Tsign can also be found in scleritis (Figure 17b).

**Miscellaneous**

*Posterior staphyloma:* appears as a smooth bulge in the posterior aspect of the globe associated with an increased axial length (Figure 18).

*Retinochoroidal coloboma:* it is a sharp edged excavation in the posterior aspect of the globe sometimes associated with retinal detachment (Figure 19).
**Figure 14a:** High reflective globular echo s/o dislocated lens (red arrow) & **Figure 14b:** Dislocated IOL in posterior vitreous (blue arrow).

**Figure 15:** High reflective echo (white arrow) with reverberation (red arrow) also with acoustic shadowing (blue arrow) suggestive of IOFB.

**Figure 16:** Open globe injury showing vitreous haemorrhage (red arrow) and posterior globe dehiscence (blue arrow).

**Figure 17a:** Echogram shows diffuse dot and clump echoes of low to moderate reflectivity (red arrow) in vitreous with increased choroidal thickness (blue arrow) s/o of Endophthalmitis. **Figure 17b:** Echogram showing T sign s/o panophthalmitis.
Silicone filled eye: The axial length appears to be increased due to the reduction of speed of ultrasonic waves through silicone oil. The silicone oil meniscus is seen as a high reflective echo (Figure 20).

Pthisis bulbi: The ultrasound shows disorganised globe structures with reduced axial length. Ocular coat calcification may be noted in some cases (Figure 21).

Tips for a beginner: when we start doing an ultrasound B-Scan

- Always read the complete history of the patient before doing the ultrasound as you need to correlate with the clinical presentation of the patient
- Make the patient lie in supine position
- If your right hand is the dominant hand place the patient couch on your right side with the height of the couch till the examiner’s waist
- Understand the probe positions well and keep a track of your probe marker
- Save the images while doing the ultrasound
- Interpret the findings while doing the ultrasound and not on frozen images as don’t forget it is a dynamic procedure
- With a combination of various probe positions which give 2 dimensional images, a 3 dimensional image is to be constructed mentally.

“one can master the technique of ultrasonography by perseverance and a systematic approach”

References