Ultrasound imaging can be employed to characterize accurately the internal ocular anatomy. In the hands of an experienced echographer, ultrasound is reliable in detecting retinal detachment, posterior vitreous separation, vitreous hemorrhage and opacities, choroidal detachment (can differentiate between serous and hemorrhagic), areas of vitreoretinal adhesion, choroidal and scleral ruptures, vitreous incarceration, and intraocular foreign bodies.

**Advantages**

- Unlike MRI and CT, ultrasound provides real-time images of the eye and orbit.
- The relatively high frequency of the sound waves (10 MHz) affords outstanding resolution (0.1 to 0.01 mm), an ideal choice to image intraocular structures.
- Multiple cross-sectional and radial cuts of the eye can be rapidly obtained at the bedside or in the operating room.
- Serial echography permits following the clinical course of various conditions (e.g., choroidal detachment resolution, membrane and retinal detachment development).
- Ultrasonography is less expensive than radiological studies.

**Disadvantages**

- Because ultrasound requires direct contact with the eyelids and/or globe, it should not be used in eyes with a high risk of extrusion of intraocular contents (e.g., large wound, uncooperative patient). In these cases, echography can be performed in the operating room after the globe has been closed and the patient is under general anesthesia.
- Training and skill are required.
- It is not useful in diagnosing orbital fractures.

**Pitfalls**

- False-negative results are possible on echography if the IOFB is small, wooden, or of vegetable matter.
- False-positive result may be found in the presence of gas bubbles.
- B scan tends to overestimate the size of the IOFB and should not be used for measuring purposes.
- For finding and localizing small, nonmetallic IOFBs in the anterior segment, ultrasound biomicroscopy is superior to CT, MRI, and contact B-scan ultrasonography.
- It is limited in its ability, however, to distinguish between different materials and cannot be used if the globe has an open wound.

**Timing of USG Scan**

- In close globe injury— If no view of the fundus is afforded, gentle B scan at presentation may be done.
- If occult globe rupture is suspected— Gentle B scan at presentation may be done over closed eye lid without applying pressure.
- In perforating/penetrating trauma— Only after primary repair has been done, never before that.

**Parameters to be noted in a B scan**

- Topography- location, extent and shape (borders and contour). Echoes can be point like, membrane like, band like, or mass like.
- Quantitative — reflectivity estimate and measurement (spike height on A-scan and signal brightness on B-scan), internal structure, sound attenuation, absorption and shadowing.
- Kinetic- mobility, after movements and vascularity.

**Basic probe positions include**

- Transverse (Lateral. Here circumferential slice of opposite fundus is seen)
- Longitudinal (Anteroposterior. To see membrane insertion, mass borders etc)
- Axial (To find relation to landmarks)

**Gain**

- High gain is used to see vitreous opacities and gross lesions.
- Low gain is used to see flat fundus elevations.

**Ultrasound in Trauma**

**What to look for?**

- IOFB
- To assess the posterior segment in closed globe injury with mediahaze (Dislocated lens, vitreous haemorrhage, RD, CD)
- In open globe injuries to detect occult perforation and to rule out IOFB, RD, CD, Vitreous track, Vitreous haemorrhage
- Iatrogenic globe injuries. e.g. needle perforation

**Note**

- Should be done over the closed eyelid.
- Probe should be cleaned before use.
- Gentle.

Blunt trauma to the eye can produce marked distortion of the globe resulting in more severe damage than maybe clinically apparent.
Sequelae of Blunt Trauma

<table>
<thead>
<tr>
<th>Anterior Segment</th>
<th>Posterior Segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyphema</td>
<td>Vitreous Hemorrhage</td>
</tr>
<tr>
<td>Cataract</td>
<td>PVD</td>
</tr>
<tr>
<td>Subluxation of lens/ICL</td>
<td>Retinal tear</td>
</tr>
<tr>
<td>ALC/PC rupture</td>
<td>Retinal detachment</td>
</tr>
<tr>
<td>Corneoscleral rupture</td>
<td>Edema of retinochoroid layer</td>
</tr>
<tr>
<td>Cyclodialysis cleft</td>
<td>Hemorrhagic Choroidal Detachment</td>
</tr>
<tr>
<td>Iridodialysis</td>
<td>Posterior Scleral Rupture</td>
</tr>
</tbody>
</table>

Sequelae of Acute Penetrating Trauma

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<tr>
<td>Corneoscleral rupture</td>
<td>Hemorrhagic track through the vitreous</td>
</tr>
<tr>
<td>Cyclic membrane</td>
<td>Hemorrhagic Choroidal Detachment</td>
</tr>
<tr>
<td>Shallow AC</td>
<td>Posterior Scleral Rupture</td>
</tr>
<tr>
<td>Iridodialysis</td>
<td>Scleral fold</td>
</tr>
</tbody>
</table>

Intraocular foreign body (IOFB)

IOFB following trauma are readily picked up by USG. Even if a FB has been detected by the CT it maybe unable to indicate whether it lies just within or outside the globe. Metallic FBs produce a very echo-dense signal that persists even at low gain settings. In addition, there is usually marked shadowing of the ocular and orbital structures just posterior to the foreign body (although FB < 0.5mm in diameter or like a metallic wire may not produce obvious shadowing even if they are very echo dense). The FB shows a very high reflectivity on A scan regardless of sound beam direction. The echographic detection of a FB can also be facilitated if it has produced a hemorrhagic track within the eye. For foreign bodies in the anterior chamber an immersion technique maybe necessary. This can only be done after the entrance wound has been sutured or has healed. Examination through the lids with a soft stand off technique may also be necessary if the immersion technique cannot be performed. Now ultrasound biomicroscopy is used for imaging anterior segment in a better way.

Case examples:

Case 1 Vitreous hemorrhage

A transverse scan of the eye showing multiple point like echoes in the vitreous cavity suggestive of a vitreous hemorrhage and a membrane like lesion which shows a moderate spike on corresponding A scan suggestive of partial PVD

Case 2 Posteriorly Dislocated Lens

A transverse B scan of the eye showing a lanceolate lesion in the mid to posterior vitreous cavity suggestive of a posteriorly dislocated natural lens. The corresponding A scan shows a highly intense signal at the interface of the surfaces of the lens.

Case 3 Vitreous Hemorrhage with Hemorrhagic Choroidal Detachment

A transverse scan of the eye showing multiple pin point echoes in the vitreous cavity suggestive of vitreous hemorrhage. Another dome shaped lesion inferiorly with echoes within the substance of the lesion suggestive of hemorrhagic choroidal detachment.

Case 4 Vitreous Incarceration with vitreous hemorrhage
A transverse scan of the eye showing a broad membrane like lesion extending across the mid vitreous cavity attaching to the ocular wall at one end suggestive of vitreous incarceration. In addition it also shows vitreous hemorrhage.

**Case 5: Vitreous haemorrhage with Serous Choroidal Detachment**

Dome shaped echo with clear central area suggestive of serous choroidal detachment inferiorly with point like areas in vitreous cavity suggestive of vitreous haemorrhage.

**Case 6: Reverberation echoes due to air bubble**

**Case 7: Retinal detachment with PVD**

There is a high reflective membranous echo with not much after movements attached to disc. This is a retinal detachment. Inside that there is another low reflective membranous echo with good after movements which is a complete PVD.

**Case 8: Occult scleral rupture**

Longitudinal section through the superior rectus insertion showing discontinuity of ocular coats suggestive of rupture.

**Case 9: Occult Scleral rupture**

There is distortion of ocular coats with discontinuity at the upper part suggestive of rupture. Hyper echoic areas outside the globe is haemorrhage. Also there is point like echoes inside the eye suggestive of vitreous haemorrhage.

**Case 10: Retained metallic intraocular foreign body**

High reflective (100%) echo with shadowing behind.
Case 11 IOFB with RD

High reflective (100%) echo with shadowing behind suggestive of metallic foreign body. Also there is a high reflective membranous foreign body with no after movements. This is RD

Role of serial ultrasound in trauma

Case 12

Left- Point like echoes in vitreous cavity suggestive of vitreous haemorrhage. Also there is membranous echo going towards primary repair site. This is vitreous incarceration. After 2 weeks (right) new high reflective membranes have appeared. This is RD

Case 13

Left – Dome shaped lesion with some echoes inside (Kissing choroidals or scalloped appearance). After 2 weeks there is reduction in choroidal detachment

Ocular ultrasound has more than 90% sensitivity and specificity in the diagnosis of ocular trauma cases

References