Original Article

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Radiology Section

# Role of Ultrasonography in Evaluation of Pathologies of Posterior Segment of the Orbit

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## ABSTRACT

**Introduction:** B-mode ultrasonography provides a good anatomical background and helps to rule out various pathologic conditions that affect the posterior segment of the eye. It can guide the ophthalmologist in diagnosing disease and choosing treatment.

**Aim:** To study the role of B-scan ultrasound in posterior segment pathology of eye.

**Materials and Methods:** A total of 92 patients with complaints of diminution of vision, were subjected to clinical Ophthalmological examination and B scan USG to look for the presence of retinal, vitreous and choroidal pathologies. High resolution USG was done with machine (Hitachi Arietta S70) equipped with a 12-18 MHz real-time high-frequency probe and colour Doppler was used when required for further evaluation. The final diagnosis was made by correlating the USG findings with clinical diagnosis and statistical values were calculated accordingly.

**Results:** Most of the patients presented with retinal detachment, n=45 (48.91%), vitreous haemorrhage, n=43 (46.73%) followed by vitreous degeneration, n=12 (16.30%). Choroid detachment was seen in 6 patients (6.52%) followed by Melanoma in 2 patients (2.17%) and Panophthalmitis in 1 patient (1.09%). The sensitivity of USG was 97.7% and specificity was 80% among patients with statistical significance (p<0.001).

**Conclusion:** The present study shows that B- scan was useful for accurately diagnosing 92 patients, out of which 86 (93.47%) cases had some pathology while 6 (6.52%) patients were found normal. It also shows the utility of B-scan for evaluating the posterior segment in the presence of opaque ocular media.

**Keywords:** B scan ultrasonography, Ocular abnormalities

## INTRODUCTION

The slit-lamp examination and fundoscopy are the basis of diagnosis in most of the patients with eye disease. However, in cases where the media is opaque or cataractous change prevents the visualization of posterior segment, ultrasonography (US) helps in assessment of a variety of ocular diseases [1]. It can guide the radiologist and ophthalmologist in diagnosing disease and choosing method of treatment.

B-scan (Brightness modulation scan) is a two dimensional ultrasonography technique which uses high frequency sound waves. It can be safely performed in outdoor patient without any use of anaesthetics or sedative therapy [2]. It is useful for a better demonstration of the shape and topographic relationship of lesions in the posterior segment.

B-scan provides a good anatomical background and helps to rule out retinal, vitreous, choroidal detachments, tumours, and other pathologic conditions that affect the posterior segment of the eye [2,3]. The purpose of this study was to visualize the status of posterior segment of eye with B-scan ultrasound and to find out any posterior segment lesion in such cases.

## MATERIALS AND METHODS

The present prospective study was undertaken for a period of two years, from July 2016 to June 2018 and it included patients referred for high resolution ultrasonography from the Department of Ophthalmology. A total of 92 patients were subjected to clinical Ophthalmological examination and B-scan USG. Institutional ethical clearance was obtained (DMIMS(DU)/IEC/2016-17/5014). Patients who were diagnosed or suspected of posterior segment pathology with opaque or clear media, patients with blunt trauma to eye, patients presenting with proptosis and patients suspected or diagnosed intraocular tumours were included in this study. Patient who had active painful ocular surface infection with extrusion of intraocular contents, or patients who recently underwent surgery were excluded from the study.

The examinations were performed in B-mode USG with machine (Hitachi Arietta S70) equipped with a 12-18 MHz real-time high-frequency probe and colour Doppler was used when required for further evaluation.

Procedure was explained to the patients and they were placed in a supine position and asked to close both the eyes. The scan was performed after applying coupling gel. The patient was instructed to move the eye ball upwards, downwards, nasal side and temporal side for delineating better anatomy of the eye ball and mobility of intra-ocular lesions. Both eyes were scanned serially in transverse and sagittal planes. After examination, excessive gel was wiped out with sterile cotton. Images were obtained from the device and studied for evaluation. The final diagnosis was made by correlating the B-scan USG findings with that of clinical history and clinical diagnosis.

## RESULTS

[Table/Fig-1] shows that male patient were major in age group 41-50 years (24.56%) while female patients were maximum in age group 51-60 years (28.57%).

| Age Group | Male | % | Female | % | Total | % |
|---|---|---|---|---|---|---|
| ≤10 | 07 | 12.28 | 02 | 05.71 | 09 | 09.78 |
| 11-20 | 03 | 05.26 | 05 | 14.29 | 08 | 08.70 |
| 21-30 | 05 | 08.77 | 04 | 11.43 | 09 | 09.78 |
| 31-40 | 10 | 17.54 | 06 | 17.14 | 16 | 17.39 |
| 41-50 | 14 | 24.56 | 04 | 11.43 | 18 | 19.57 |
| 51-60 | 07 | 12.28 | 10 | 28.57 | 17 | 18.48 |
| 61-70 | 05 | 08.77 | 04 | 11.43 | 09 | 09.78 |
| >70 | 06 | 10.53 | 00 | 00 | 06 | 06.52 |
| **Total** | **57** | **61.95** | **35** | **38.04** | **92** | **100** |

**[Table/Fig-1]:** Age and Sex distribution with ocular abnormalities.

[Table/Fig-2] shows that majority of the patients had abnormal USG findings (93.47%) while 6 (6.53%) showed normal findings without any pathology. Most of the patients presented with vitreous haemorrhage (46.73%) followed by vitreous degeneration (16.30%). The other vitreous pathology included vitreous detachment (13.03%), dislocated lens in vitreous (7.61%), endophthalmitis (3.26%), PHPV (2.17%) and Asteriodhyalosis (2.17%).

| Vitreous pathology | No. of Patients* | Percentage |
|---|---|---|
| Vitreous Haemorrhage | 43 | 46.73 |
| Vitreous Detachment | 12 | 13.03 |
| Vitreous degeneration | 15 | 16.30 |
| Endophthalmitis | 03 | 03.26 |
| Dislocated lens in vitreous | 07 | 07.61 |
| PHPV | 02 | 02.17 |
| Asteriodhyalosis | 02 | 02.17 |

**[Table/Fig-2]:** USG findings of vitreous pathology among patients.

[Table/Fig-3] shows that majority of patients presented with retinal detachment (48.91%) followed by sub-retinal collection (8.69%) The other retinal pathology includes retinal cyst (3.26%), retinoblastoma (2.17%), diabetic retinopathy (1.09%) and retinoschisis (1.09%).

| Retinal pathology | No. of Patients* (n=92) | Percentage |
|---|---|---|
| Retinal detachment | 45 | 48.91 |
| Retinoblastoma | 02 | 02.17 |
| Sub-retinal collection | 08 | 08.69 |
| Retinal Cyst | 03 | 03.26 |
| Diabetic Retinopathy | 01 | 01.09 |
| Retinoschisis | 01 | 01.09 |

**[Table/Fig-3]:** USG findings of retinal pathology among patients. (* Multiple response present)

Subretinal collection was found in association with seven cases of traumatic retinal detachment and one case in association with diabetic retinopathy.

[Table/Fig-4] shows that majority of the patients presented with choroid detachment (6.52%) followed by Melanoma (2.17%) and Panophthalmitis (1.09%).

| Choroid pathology | No. of Patients* (n=92) | Percentage |
|---|---|---|
| Choroid detachment | 06 | 06.52 |
| Melanoma | 02 | 2.17 |
| Panophthalmitis | 01 | 1.09 |

**[Table/Fig-4]:** USG findings of choroid pathology among patients. (* Multiple response present)

[Table/Fig-5] shows various miscellaneous USG findings. Majority of patients presented with cataract (5.43%) followed by foreign body (4.35%), optic neuritis (3.26%), Pthysisbulbi (3.26%), globe rupture (1.09%).

| Diagnosis | No. of Patients (n=92)* | Percentage |
|---|---|---|
| Cataract | 05 | 05.43 |
| Foreign body | 04 | 04.35 |
| Optic neuritis | 03 | 03.26 |
| Pthysisbulbi | 03 | 03.26 |
| Posterior staphyloma | 02 | 02.17 |
| Silicone infusion | 01 | 01.09 |
| Globe rupture | 01 | 01.09 |
| Coloboma | 01 | 01.09 |
| Drusen | 01 | 01.09 |
| Microophthalmia | 02 | 02.17 |
| High Myopia | 02 | 02.17 |
| Cysticercosis | 01 | 01.09 |
| Papilloedema | 01 | 01.09 |

**[Table/Fig-5]:** Miscellaneous ultrasonographic diagnosis among patients.
* Multiple response present

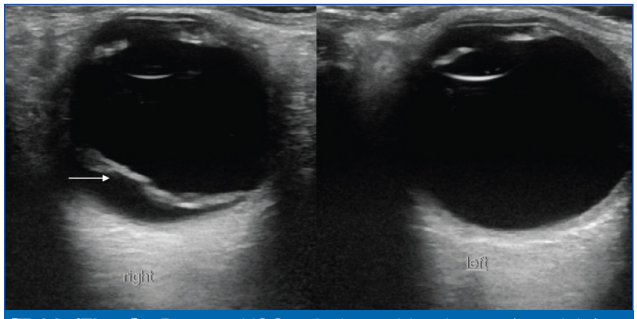
In the age group upto 10 years of age, 2 patients were diagnosed with retinoblastoma, 2 patients with a history of trauma, had retinal detachment and 1 another with trauma had vitreous haemorrhage, 1 patient had optic neuritis with micro-ophthalmia, 1 patient had coloboma with persistent hyperplastic primary vitreous and 2 were found to be normal.

[Table/Fig-6] shows that the sensitivity of USG was 97.7% and specificity was 80% among patients with statistical significance (p<0.001).

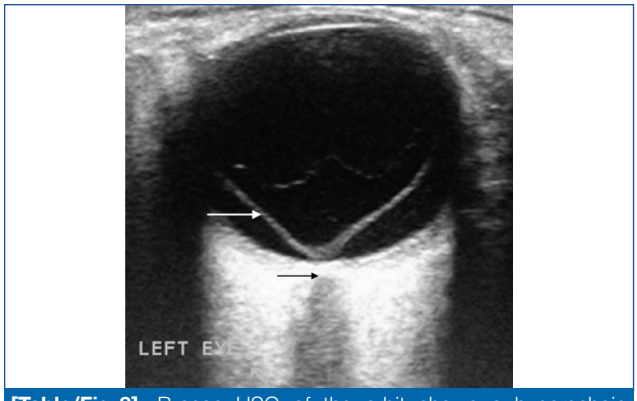
Few cases of the various pathologies of posterior segment of the orbit found in the present study were shown in [Table/Fig-7-14].

| USG diagnosis | Final Diagnosis | | Total |
|---|---|---|---|
| | Positive | Negative | |
| Positive | 85 | 01 | 86 |
| Negative | 02 | 04 | 06 |
| Total | 87 | 05 | 92 |

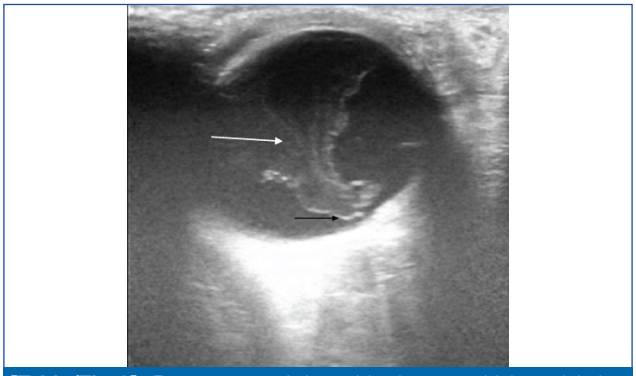
**[Table/Fig-6]:** Correlation of ultrasonographic and final diagnosis among patients.
$X^2$=34.95; p<0.0001; Statistically Significant



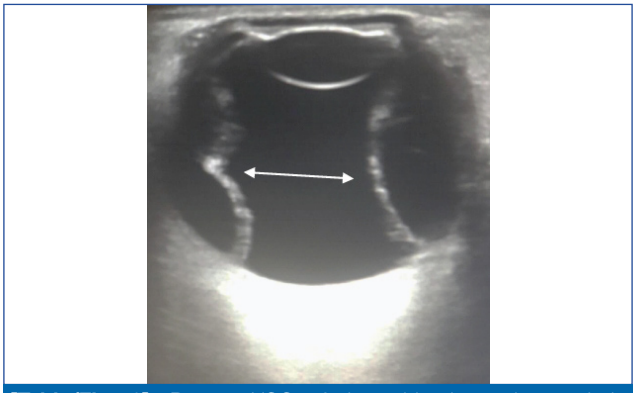

**[Table/Fig-7]:** B-scan USG of the orbit shows (on right) a hyperechoic membrane (arrow), attached to the orraserrata on one side anteriorly suggesting unilateral retinal detachment. (On left) the posterior segment appears anechoic and normal.



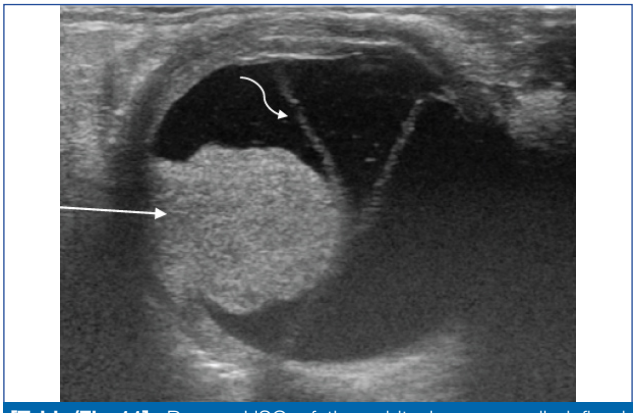

**[Table/Fig-8]:** B-scan USG of the orbit shows a hyperechoic V-shaped membrane (arrow), attached to the orraserrata anteriorly and to the optic nerve head posteriorly (black arrow), suggestive of retinal detachment.



**[Table/Fig-9]:** B-scan usg of the orbit shows a thick undulating membrane (black arrow), which is free in its posterior end suggesting vitreous detachment associated with echoes which suggest vitreous haemorrhage (white arrow).



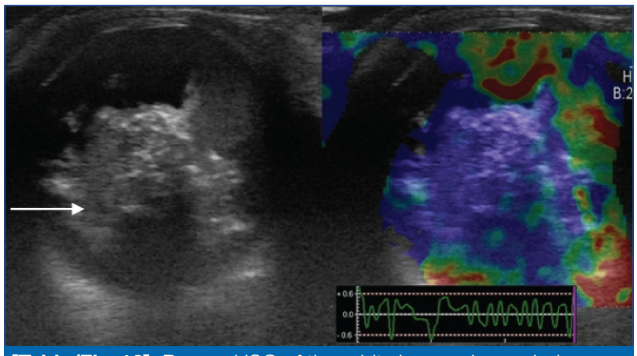
**[Table/Fig-10]:** B-scan USG of the orbit shows hyperechoic biconvex membranes (arrow) on both walls suggesting choroidal detachment. The anterior and posterior attachments cannot be determined, which differentiates this from retinal detachment.



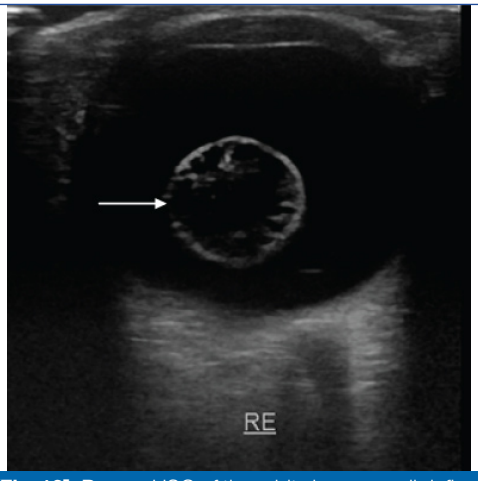
**[Table/Fig-11]:** B-scan USG of the orbit shows a well defined hyperechoic mushroom shaped mass (arrow) originating from the posterior membranes suggesting choroidal melanoma. There is thin V- shaped hyperechoic membrane suggesting retinal detachment (curved arrow).

## DISCUSSION

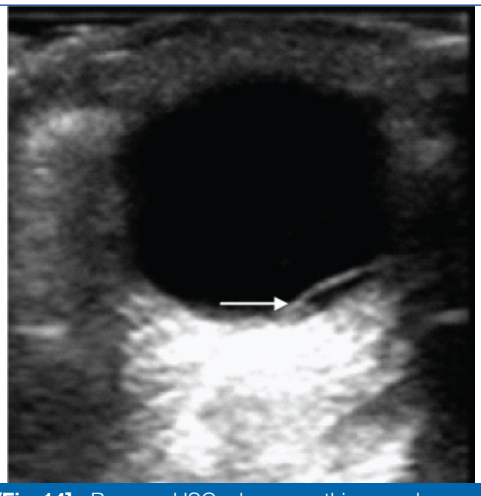
In present study, ocular abnormalities were common in male (61.95%) patients than female patients (38.04%). Ocular abnormalities are believed to be more common in males than



**[Table/Fig-12]:** B-scan USG of the orbit shows a hyperchoic mass (arrow) occupying most of the vitreous chamber and arising from the retinal membrane with mutiplehyperchoic specks of calcifications within, suggesting retinoblatoma. On elatstography, predominantly blue colors are seen in the lesion which is suggestive of a hard mass.




**[Table/Fig-13]:** B-scan USG of the orbit shows a well defined lesion (arrow) in the vitreous chamber with a hyperchoic margin suggesting lens drop.
Vertically-placed dislodged lens should not be mistaken as a mass.



**[Table/Fig-14]:** B scan USG shows a thin membrane (arrow), splitting focally from the posterior layers with anechoic fluid between the layers. However, the membrane is not fully separated.

in females. In a study done by OP Sharma et al., the sex ratio was 2:1 [3]. Chaudhari H et al., studied role of ultrasonography in evaluation of orbital lesions and observed that out of 100 patients 58 patients were male and 42 were female [4]. Ocular abnormalities were observed commonly among 41-60 years age group. In a study done by OP Sharma et al., ocular abnormalities were observed maximum in 4th to 5th decades [3].

In the present study, most of the patients presented with vitreous haemorrhage (46.73%) followed by vitreous degeneration (16.30%). Retinal detachment was seen in 45 (48.91%) patients. Study by Sharma OP et al., on 122 cases revealed vitreous haemorrhage as the most common intraocular pathology (41.17%) followed by retinal detachment (26.4%) [3]. However, in the study by Ahmed J et al., most cases were of Vitreous Haemorrhage (29%) followed by Retinal Detachment (25%) [5]. In a study by Haile M et al., the most common abnormality was retinal detachment (39%) followed by vitreous opacities (31%) [6] whereas, in another study Coleman DJ showed 25% incidence of RD [7].

In one of the patients, we found retinoschisis, which is considered to be a different entity from retinal detachment, in the form that retinoschisis is characterized by splitting of the neurosensory retina, at the outer plexiform layer. B-scan echography can be used to differentiate between retinal detachment and retinoschisis. A rhegmatogenous retinal detachment is flattened by scleral indentation as the subretinal fluid is forced into the vitreous cavity through the retinal break, while in retinoschisis, flattening occurs because there is no direct communication between the retinoschisis cavity and the vitreous space [8].

Choroidal abnormalities included maximum cases of choroid detachment (6.52%) followed by Melanoma (2.17%) and Panophthalmitis (1.09%). In a study by Agrawal R et al., choroidal abnormalities included maximum cases of choroidal detachment (80%), while rest 20% cases were of choroidal haemorrhage [9].

In the present study, the sensitivity of USG was 97.7% and specificity was 80% among patients with statistical significance ($p<0.001$). Coleman DJ et al., in his review of 100 cases also showed 100% specificity and sensitivity of B mode ultrasonography in detecting and characterizing intra-ocular lesions. In his review of 18 cases, 17 cases were immediately diagnosed, and one suspected case was diagnosed after a long term surveillance which proved it to be an intra-ocular tumour true to the suspicion made with B mode ultrasonography [10].

**Vitreous Haemorrhage:** Vitreous haemorrhage is a major cause of diminution of vision and may also lead to blindness. On USG, it presents as echogenic material in the posterior chamber. This appearance depends on the age and severity

of the haemorrhage. Fresh haemorrhages are seen as small dots or linear areas of low reflective mobile opacities in the vitreous, whereas in older haemorrhages, blood organizes to form membranes of low to medium level reflectivity [11].

**Endopthalmitis and Panopthalmitis:** Endopthalmitis appeared as free mobile dots, associated with thickening of the ocular coat (>3 mm). In panopthalmitis there is oedematous fluid in tenon space, seen as a black ring surrounding the highly echogenic sclera along with thickening of optic nerve void. This is called as the "T" sign; the arm of the "T" is formed by oedema in the tenons space and the stem by the optic nerve void [12].

| | PVD | VD | CD |
|---|---|---|---|
| Membrane | Thin | Thick | Very thick |
| Reflectivity/ echoes | Low, nonuniform | High, uniform | High, uniform |
| Attachment | Attachment to disc± | Attached to disc except tractional RD | No attachment to disc, extend anteriorly to ora. |
| Shape | U shaped parallel to the globe | If complete – T/V/Y shaped<br>If partial/ tractional – linear membrane | Dome shaped with vortex vein extending upto the dome |
| After movement | Marked | Fresh – moderate<br>Old - restricted | No after movement |
| Vascularity | Avascular | Vascular | Vascular |

**[Table/Fig-15]:** Differentiating features of PVD, RD and CD.
**PVD-Posterior Vitreous Detachment; RD-Retinal Detachment and CD-Choroidal Detachment.

**Detachments [13]:** The various detachments can be Posterior Vitreous Detachment (PVD), Retinal Detachment (RD) and Choroidal Detachment (CD). The differentiating features are summarized in [Table/Fig-15].

**Intraocular Tumours Retinoblastoma:** This is one of the commonest tumours of childhood. A pineal tumour (pineoblastoma) with bilateral retinoblastoma is called trilateral retinoblastoma. They can be endophytic or exophytic. Clinically the child has leukokoria. On ultrasound the tumour has variable echogenicity with posterior acoustic enhancement and smooth, dome or irregular shape. Calcification within the tumour is characteristic. This differentiates it from other causes of leukokoria in childhood like PHPV [14].

**Choroidal Melanoma:** This is one of the most common intraocular tumours of adults. The imaging findings are characteristic and diagnostic. On ultrasound, it appears as a homogenous low to medium echogenicity tumour having a dome shaped or collar button shape with base over choroid. The collar button shape indicates break in Bruch's membrane. It is pathognomic of melanoma. Internal vascularity is a very important differentiating feature which is absent in most melanoma mimics, like choroidal haemangiomas or choroidal nevi [13].

## LIMITATION

B-scan was not useful in diagnosing orbital fractures. False positive results may be found in the presence of gas bubbles and sub retinal haemorrhages. False negative results may be observed in cases of fibrotic tissue and small lesions. It is a less sensitive modality for identification of bony involvement of a tumour, its extension to adjacent structures and brain. B scan does play a major role in diagnosis specifically the pathologies of posterior segment of eye however in few of the situations, B scan fails to differentiate between various pathologies e.g., between thick vitreous and retinal detachment. B scan cannot be used in open globe injury.

## CONCLUSION

The B-mode ultrasonography should be the first screening modality in evaluation of posterior segment lesions. It provides excellent quality real time imaging of various ocular pathologies.

It can be extensively used in evaluation of retinal disorders, like retinal detachment, retinal masses and also diagnostic in patients with opaque ocular media and diminution of vision, where a preoperative fundoscopic evaluation is virtually impossible, for assessment of the posterior segment.

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