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Research Article

Ultrasound biomicroscopic evaluation of traumatized eyes

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ABSTRACT

Background: High frequency ultrasound biomicroscopy (UBM) is a safe, non-invasive effective high-resolution technique used for *in vivo* imaging of the anterior ocular segment. It is of utmost use in the management of patients with ocular trauma when visualization is limited due to hazy media.
Methods: UBM was performed in 100 patients with close globe injury and 25 patients with open globe injury. Clinical and UBM findings were compared.
Results: Majority of the patients was males in the age group of 20-40 years. Workplace injuries were more common. More number of cases having angle recession, posterior capsular rupture, zonular dialysis and peripheral anterior synechiae were diagnosed by UBM.
Conclusion: UBM remains the choice of investigation for scanning the posterior chamber and posterior capsule with good axial resolution of 50 µ.

Keywords: Trauma, Eye, Ultrasound biomicroscopy

INTRODUCTION

Ultrasound biomicroscopy (UBM) is a high frequency, high-resolution technique developed by Pavlin, Sherar and Foster in Toronto in 1980's.[1] It allows non-invasive *in vivo* imaging of structural details of the anterior ocular segment at near-microscopic resolution and provides detailed two-dimensional grey scale images of the various anterior segment structures.[1]

Ocular trauma has now gained the attention as a major cause of visual morbidity.[2] It is an important preventable public health problem and an important cause of mono-ocular blindness worldwide. In most of the injuries to the eye, anterior segment bears the brunt of both the direct and indirect forces of injury. The clinical features of the anterior segment injury in trauma include hyphema, iridodialysis, rupture of the anterior lens capsule, zonular dialysis, cyclodialysis and angle recession (AR).[3]

Meticulous evaluation and appropriate treatment of the traumatized eye is crucial in preventing visual loss. However, media opacities and distorted anatomy may preclude adequate anterior segment examination.

High frequency UBM is a useful imaging tool of the anterior segment of the eye, providing high-resolution images with both qualitative and quantitative information about anatomical relationships of the anterior segment.[4,5] It may be used as a safe and effective adjunctive tool for clinical assessment and management of ocular trauma especially before planning any surgical procedures (cataract surgery, antiglaucoma surgery, keratoplasty, etc.) when visualization is limited.

The main aims of our study were:
- To know the status of anterior segment in the presence of traumatic dense corneal opacity
- To study the position of the lens, the status of the iris and ciliary body, the configuration of the angle, and cyclodialysis cleft in patients with trauma

- To determine the size, shape, site and nature of intraocular foreign body (IOFB)
- To study traumatic anterior uveitis
- To correlate clinical diagnosis with UBM diagnosis
- To explain about visual prognosis to the patient.

METHODS

Our study was carried out at C.H. Nagri Eye Hospital, Ahmedabad. UBM was performed on 125 eyes of 125 patients with OTI scan 3000 model: (Ophthalmic Technologies Incorporation, Toronto, Canada) between August 2010-September 2012.

Inclusion criteria

- 100 patients with close globe injury
- 25 patients with open globe injuries in which primary suturing was done (UBM was done for pre-operative assessment before going for specific intervention).

Exclusion criteria

- Eyelid eczema, skin allergy in which UBM is not possible
- Severely traumatized eye.

A detailed history of the patient about trauma was taken including:

Type of trauma, object of trauma and time interval between trauma and examination. A complete ophthalmic examination on a slit lamp including slit lamp biomicroscopy and indirect opthalmoscopy was carried out. Gonioscopy and UBM was done at the time of presentation in all the patients except for those with hyphema (done at the end of 4 weeks) in view of rebleed secondary to the procedure in close globe injury group.

After evaluating, the patients were treated medically or surgically.

Statistical analysis

First, UBM and clinical findings were tabulated. Frequency counts and percentage calculation was done. Chi-square test was used to test the correlation between the clinical and UBM findings. $p < 0.05$ was considered to be statistically significant. As there is no gold standard for UBM findings in eyes with ocular injury, sensitivity and specificity could not be calculated. Statistical analysis was performed using SPSS version 16 (Ophthalmic Technologies Incorporation, Toronta, Canada).

RESULTS

Demography

The age range of the study patients was 15-60 years. Most of the patients were in the age group of 20-30 years (42% close globe injury, 40% open globe injury). The majority of patients were younger than 40 years (84% close globe injury, 64% open globe injury) (Figure 1).

Majority of the cases were males accounting for 68%, whereas females are accounting for 32% in close globe injury. In open globe injury, male accounting for 80% and female accounting for 20% of total cases (Figure 2).

Workplace injuries (26%) was the commonest cause of close globe injury, which were followed by sports injuries (24%) and road traffic accidents (19%). In open globe injury group, blast injury (28%) and sports injury (28%) were more common (Figure 3).

Grading of visual loss

Visual acuity assessment was done at the time of presentation. Majority of the patient with close globe injury had moderate visual loss (45%) whereas severe visual loss was seen in 25%. In open globe injury group, 60% of patients had severe visual loss (Table 1).

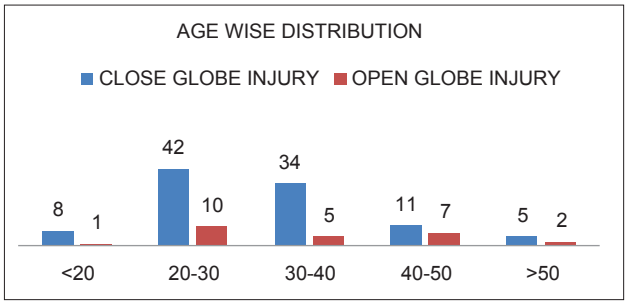

Figure 1: Age wise distribution.

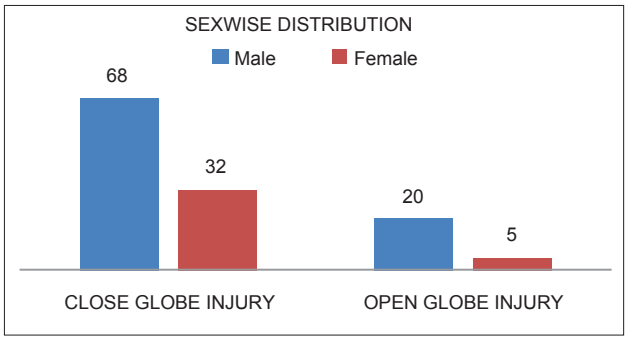

Figure 2: Sex wise distribution.

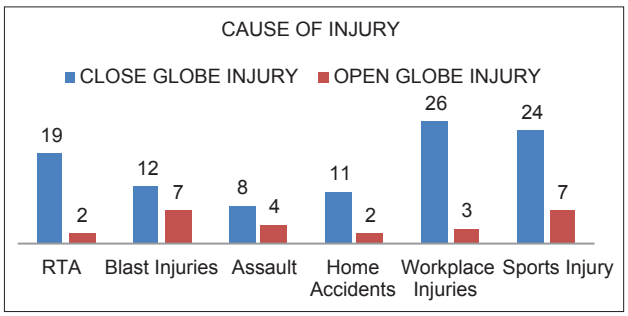

Figure 3: Cause of injury.

Hyphema in various grades of severity was present in 35% of patients. 20 (57%) out of 35 patients had moderate hyphema (Grade 2 to Grade 3). 10/35 (29%) had mild (Grade 1) hyphema and 5/35 (14%) had severe hyphema (Table 2).

The most common external ocular findings included lid ecchymosis (40%) and subconjunctival hemorrhage (45%). All the clinical findings were comparable with UBM findings except AR, zonular dialysis and posterior capsular rupture (PCR) (Table 3).

AR was noted in 12% patients by clinical examination (gonioscopy) and 30% patients by UBM examination.

Half of the patients had AR less than 3 clock h by UBM (Table 4). Chi-squared test = 9.7, $p < 0.01$.

Table 1: Grading of vision loss.

Grading of visual loss	Close globe injury	Open globe injury
Mild	30	2
Moderate	45	6
Severe	25	17

Table 2: Grading of hyphaema.

Grading of hyphaema	Number of cases (close globe injury)
Mild (Grade 1)	10
Moderate (Grade 2 and 3)	20
Severe (Grade 4)	5

Table 3: Clinical findings and UBM findings in patients with close globe injury.

Findings	On UBM	On slit lamp
Average AC depth (range)	2.36 mm (1.42-2.98 mm)	-
Posterior synechiae	15	15
Iridodialysis	2	2
Cyclodialysis	1	0
AR	30	12
Zonular dialysis	9	155
Focal rupture of anterior capsule	3	3
Displacement of PCIOL	2	2
PCR	16	2
Anterior vitreous herniation	3	2

AC: Anterior chamber, UBM: Ultrasound biomicroscopy, PCIOL: Posterior chamber intraocular lens, AR: Angle recession, PCR: Posterior capsular rupture

Clinical evidence of zonular dialysis as indicated by irregular anterior chamber (AC) depth and phacodonesis was present in only 15% when compared with UBM, which was able to detect zonular dialysis in 59% of cases (Table 5 and Figure 4). Chi-squared test = 41.52, $p < 0.001$.

UBM had detected traumatic PCR in 16% patients while clinically it was present in only 2% of patients (Tables 6 and 7). Chi-squared test = 11.94, $p < 0.001$.

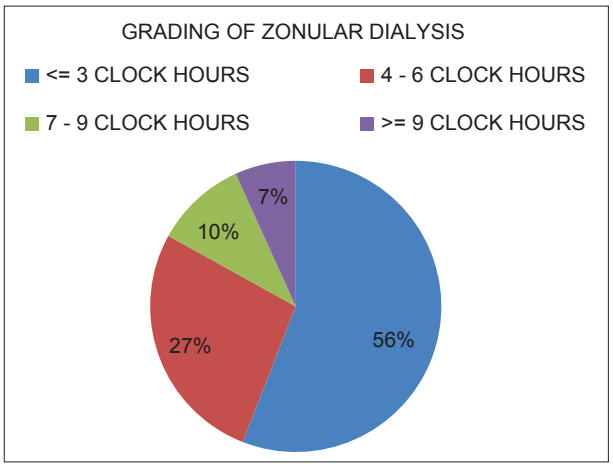

Figure 4: Grading of zomular dialysis.

Table 4: Grading of AR.

Grading of angle recession	Number of patients
Less than 3 clock h	15
4-6 clock h	9
≥6 clock h	6

AR: Angle recession

Table 5: Zonular diseases.

Zonular dialysis	Present	Absent
UBM	59	41
Clinically	15	85

UBM: Ultrasound biomicroscopy

Table 6: Evidence for zonular diseases.

Evidence for zonular dialysis	Number of cases (*n*=59) (%)
Direct	18 (31)
Indirect	10 (17)
Combined	31 (52)

Table 7: Traumatic PCR.

PCR	Present	Absent
UBM	16	84
Clinically	2	98

UBM: Ultrasound biomicroscopy, PCR: Posterior capsular rupture

Peripheral anterior synechia (PAS) were most commonly present in patients with open globe injury. 65% patients had PAS in >6 clock h of the angle of AC (Table 8 and Figure 5). Chi-squared test = 11.4, $p < 0.001$.

DISCUSSION

UBM, being a method that allows subsurface imaging of ocular structures at microscopic resolution, can be used for different purposes in the eyes exposed to trauma. UBM utilizes high frequency sound waves (35 MHz) with penetration of 5 mm into tissues, provides a tissue resolution of 50 µ.

In our study, UBM examination was able to identify zonular dialysis in 59% patients, whereas clinical examination was able to identify zonular dialysis in only 15% patients. UBM was far superior in identifying and localizing areas with zonular defects (in clock hours) than clinical examination. In cases having fewer clock hours of zonular dialysis, clinical examination may be equivocal, resulting in under-diagnosis of zonular dialysis. Studies carried out by Ozdall et al. have shown that zonular deficiency was the most frequent finding in blunt ocular injury and is far underestimated by clinical examination alone.[5] Prompt identification of the site and extent of zonular dialysis prior to the surgery helps the surgeon to plan and modify the surgical technique appropriately.

Table 8: Clinical findings and UBM findings in patients with open globe injury.

Findings	On UBM	On slit lamp
Retrocorneal membrane	5	5
PAS	20	8
Iridocorneal adhesion	10	10
Zonular dialysis	6	4
IOFB	1	1
Anterior capsule rupture	8	8
Anterior vitreous herniation	8	8
Staphyloma	3	3

All the slit lamp findings were comparable with the UBM findings except PAS. IOFB: Intraocular foreign body, UBM: Ultrasound biomicroscopy, PAS: Peripheral anterior synechia

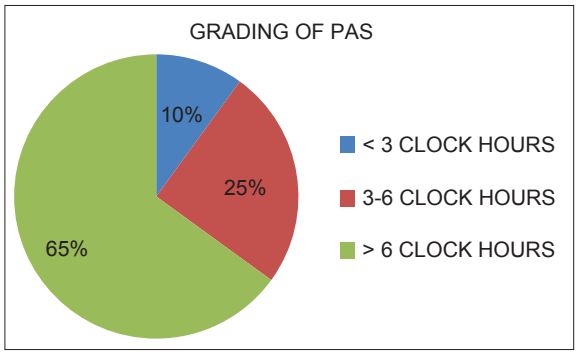

Figure 5: Grading of peripheral anterior synechia.

UBM, a device primarily designed to assess the AC angle anatomy, has an important role in assessing the damage to the angle structures following close globe injury. In the present study, AR was identified in 30%, with half of the cases (50%) having <3 clock hours AR. Clinical examination tended to underestimate AR with 12% cases. Though clinical examination is equally good in the diagnosis of AR and cyclodialysis, it cannot be applied in traumatized eyes because of hazy media, anatomic distortion, and excessive hypotony. UBM probe attached with nose cone piece causes minimum pressure on the globe and can be used for accurate assessment of angle pathology that occurs due to trauma. Ozdall et al. compared the angle pathology between open and closed globe injuries and found that they are more common in patients with close globe injury.[5]

Traumatic PCR has not been studied extensively. In our study, we have studied the effect of trauma on posterior capsule. It was present in 16% of patients and when preoperatively diagnosed can help the surgeon to anticipate the complication during surgery. Isolated rupture is caused by acute stretching forces by blunt injury. If the PCR is large, lens hydration progresses rapidly, and intumescent cataract develops shortly after trauma that is why PCR is more detected in traumatic mature cataract (87% in our study).

In close globe injury, clinical examination has underestimated the occurrence of AR, zonular dialysis, and PCR. On statistical analysis with Chi-squared test, UBM findings of Above 3 were highly significant than clinical evidence of above 3.

In Open globe injury, PAS were present in 80% of patients. More than half of the patients (65%) had PAS in >6 clock h of angle of AC. PAS can give post-operative surprises in terms of raised IOP. So, pre-operative diagnosis of PAS is helpful in determining the surgery and pre-operative management. In open globe injury, PAS on UBM was highly significant than clinical findings. Open globe trauma has caused deformation of the anterior segment of the eye. UBM has given important clues for anterior segment reconstruction.

Retained foreign bodies may lead to ocular morbidity, including inflammation and infection, and their detection is very important for the prognosis of the traumatized eye. Identification and localization of intraocular foreign bodies in eyes with opacified media or a distorted anatomy require a radiographic or ultrasonographic evaluation. IOFB made of wood or plastic can be confused with air on computed tomography (CT) scan. Magnetic resonance imaging is contraindicated in cases with suspected metallic IOFB. UBM has been reported to be helpful in detecting small and non-metallic foreign bodies. Deramo et al. reported that UBM could detect small foreign bodies of various compositions, including those missed by CT scan or ultra sonography.[6]

UBM was a contact investigation requiring a skillful operator. There was a risk of corneal injury and ocular contamination.

Taken care by prescribing antibiotic drops post-examination. Use of the eye cup during UBM examination was very discomforting for the patient, and it could not be done in younger children and uncooperative patients. UBM took a long time to scan entire circumference of the angle and only one part of the angle had been imaged at a time. UBM was done cautiously in patients with open globe injury.

Though anterior segment optical coherence tomography is easy to perform, gives good image quality and has good patient compliance, it cannot image behind iris - i.e. posterior chamber (zonules, ciliary body) as posterior pigment epithelial layer of the iris is not transparent for infrared light.

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