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Original Research Article

Clinical and ultrasound biomicroscopic (UBM) correlation in eyes with closed globe injury

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ABSTRACT

Purpose: To correlate UBM and clinical findings in patients with closed globe injury.
Materials and Methods: Prospective observational study of 75 patients, ≥ 12 years of age presenting to ophthalmic outpatient department within one week of sustaining closed globe injury. Patients with seriously ill polytrauma and open globe injuries were excluded from the study. Comprehensive ophthalmic examination including Visual acuity assessment, slit lamp examination, fundus examination and IOP measurement. Gonioscopy and UBM examination was done in all patients on presentation except for patients with hyphema (UBM and gonioscopy done at 4 weeks to prevent rebleed).
Results: Mean age of the patients was 31.4 ±8 years, most common external findings included lid ecchymosis (47%), subconjunctival hemorrhage (93%). The common anterior segment finding included traumatic iritis (87%), traumatic hyphema (61%) and traumatic cataract in 27% of patients. Clinical evidence of zonular dialysis was seen in 13% of patients. UBM was able to detect zonular defects in 62% patients (P=0.008). Most of the patients (57%) had zonular dialysis less than 3 clock hours on UBM examination. UBM confirmed the presence of other clinical findings like iridodialysis, cyclodialysis.
Conclusion: UBM is a safe and effective adjunctive tool for clinical assessment and management of ocular trauma. It can diagnose subtle zonular dialysis and other anterior segment changes following blunt trauma. UBM should be an integral part of ophthalmic examination especially in patients requiring surgical intervention after closed globe injury.

1. Introduction

Ocular trauma has now gained attention as a major cause of visual morbidity. It is a important preventable public health problem and an important cause of mono-ocular blindness worldwide.[1–3] However in developing countries the epidemiology and visual outcome of ocular trauma is not well established.[1] The "Aravind Comprehensive Eye survey" screened 5150 patients for ocular trauma, and reported an incidence of 4.5%. Blunt injury to the eye (54.9%) was the commonest form of ocular trauma. This study stressed that ocular trauma should be considered as a priority in Eye care programmes because visual disability caused by ocular trauma is higher than that reported for glaucoma, ARMD or diabetic retinopathy for this population.[4] In most of the blunt injuries to the eye, anterior segment bears the brunt of both the direct and indirect forces of injury. The clinical features of anterior segment injury in blunt trauma include hyphema, iridodialysis, rupture of the anterior lens capsule, lens displacement, cyclodialysis, angle recession, and intraocular foreign body.[5] Zonular dialysis caused by blunt ocular trauma may not always be clinically evident but is important for planning subsequent surgical procedure. A meticulous evaluation and appropriate treatment of the traumatized eye is crucial in preventing

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visual loss. However media opacities and distorted anatomy may preclude adequate anterior segment examination. High frequency ultrasound biomicroscopy (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.[6] It may be used as a safe and effective adjunctive tool for clinical assessment and management of ocular trauma especially planning surgical procedures like cataract surgery when visualization is limited.

2. Materials and Methods

Seventy five consecutive patients ≥12 years of age with the history of closed globe injury, presenting to Davangere Netralaya from August 2016 to July 2018 were included in the study. A written informed consent was taken from the all patients. Prior to starting the study the institutional ethical review board clearance was taken. All patients with seriously ill polytrauma and with previous history of intraocular surgeries like cataract surgery, glaucoma surgery, RD surgery were excluded from the study. A detailed history, demographic details and information regarding the nature of injury was noted. Ophthalmic examination including best corrected visual acuity using standard Snellen chart, slit lamp examination, intraocular pressure measurement using Perkins handheld Applanation tonometer, fundus examination using direct, indirect and 90 D examination was done in all patients. A detailed evaluation of the retinal periphery with indentation was done after one week of injury. Visual acuity was converted to its decimal equivalent for the purpose of analysis. Visual acuity was further graded as per the criteria described by the International Council of Ophthalmology meet Sydney 2002 as follows: - normal visual acuity 6/6, mild visual loss 6/9 to 6/18, moderate visual loss 6/24 to 6/60, severe visual loss >6/60.[7] Gonioscopy (using single mirror gonioscope) and UBM (using Sonomed VuMax II Model no. 203218) was done at the time of presentation for most of the patients except for those with hyphema (in view of rebleed secondary to the procedure) and patients with polytrauma who were not cooperative for these tests at presentation. In these patients UBM was done at 4 weeks following injury.

Ultrasound examination was done with the patient in supine position. The UBM examination was first done in the eye with the history of blunt injury followed by the other eye to compare the anatomy of various structures to that of the injured eye. Probe frequency of 35 MHz or 50 MHz was selected. The 35 MHz probe was used for screening for the presence of abnormalities and specific abnormalities were evaluated using 50 MHz (E.g.:- Angle recession, Zonular abnormalities). “High resolution mode” was used for screening and “angle mode” for detecting angular and Zonular abnormalities. “Exponential gain and the base” were adjusted to obtain an artifact free image. Ultrasound biomicroscopy examination provided unique image characteristics for individual disorders. In the presence of angle recession, the normal V shaped configuration of the angle appeared as square edged and the acute angle configuration was lost in those clock hours having angle recession. Exact localization and extent of angle recession was made out with UBM. Iridodialysis and cyclodialysis cause change in their respective anatomical segments in the UBM image. Zonular dialysis was identified by direct or indirect evidence. Direct evidence was characterized by localizing the areas of missing zonules, whereas indirect evidence was characterized by identifying other associated changes in areas of Zonular dialysis like ciliary body flattening, increase in the curvature of lens equator, changes in the iris curvature. Intraocular foreign bodies appeared hyperechoeic or hypoechoeic based on the nature of the foreign body and usually caused back shadowing.

UBM and clinical findings were tabulated. Frequency counts and percentage calculation was done. Pearson’s Correlation was used to test the correlation between the clinical and UBM findings. P value of <0.05 was taken as statistically significant. As there is no gold standard for UBM findings in eyes with blunt ocular injury, sensitivity and specificity could not be calculated. Statistical analysis was done using SPSS version 16.

3. Results

Mean age of the patients was 31.4±8 years (range 12-60yrs), the majority of patients were younger than 40 years, 67/75 (89.4%). Majority of the patients were male(79%). Road traffic accidents and sports injury were the cause of blunt ocular injury in 36% and 29% respectively. Work place injury was noted in 15% of cases. Other injuries in the study group included assault (10%), home accidents (5%) and blast injuries (4%). Visual acuity assessment was done at the time of presentation. Majority of the patients had moderate visual loss (30 /75,40%). Severe visual loss was seen in 25/75 (33.3%). Mild visual loss was seen in 20/75 patients. Visual acuity was graded as per the criteria described by the International Council of Ophthalmologist in Sydney, 2003.[7]

The most common external ocular findings (Table 1) included lid ecchymosis 35/75(46.6%) and subconjunctival hemorrhage (70/75,93%). The most common anterior segment finding included traumatic iritis 65/75(86%), traumatic mydriasis 68/75(90%), traumatic hyphema (46/75,65%) (Table 1) Posterior segment findings (Table 2) included posterior vitreous detachment (25/75,33%), vitreous hemorrhage (9/75,12%), retinal detachment (3/75,4%), commotio retinae (55/75,73%), choroidal rupture (6/75, 6%), and traumatic optic neuropathy (3/75,4%). Commotio retinae was the most common posterior segment finding in 55/75 (73.3%) of the patients. The most common UBM findings (Table 3, Figure 2)

included Zonular dialysis (47/75, 61.8%), angle recession (22/75, 29.3%). The other findings included traumatic cataract (20/75, 26.6%), traumatic iridodialysis (17/75, 22.6%), traumatic cyclodialysis (3/75, 4%). Angle recession was noted in 18/75(24%) patients by clinical examination (gonioscopy) and 22/75(29%) patients by UBM examination. It was possible exactly localize the extent of angle recession by UBM. Most of the patients had angle recession less than 3 clock hours by UBM (19/22)(86%). Grading of Angle recession seen in our patients is shown in table 4.Iridodialysis was detected in 17/58 (29%) no of patients both by clinical examination and UBM examination. Detection and localization of iridodialysis was possible both by clinical and UBM examination. The findings included:-15/17(88%) patients had < than 3 clock hours of iridodialysis. 2 patients had iridodialysis >3 but <9 clock hours. No patient had iridodialysis more than 9 clock hours.

Hyphema in various grades of severity was present in 46/75(61%) patients. 36 (78%) out of 46 patients had moderate hyphema (grade2 to grade 3). 6/46 (13%) had mild (grade 1) hyphema and 4/46 (9%) had severe hyphema. Hyphema was not detected by UBM examination as this mode of examination was delayed in view to prevent rebleeds secondary to the procedure. UBM examination was done at 4 weeks in patients with Hyphema. Traumatic cataract was found in 20/75 (27%) cases. Rosette cataract was seen in 13/20 (65%). Ruptured anterior capsule was seen in 5/20 (25%) cases. Detection rate of traumatic cataract by clinical examination and UBM was the same. Clinical evidence of zonular dialysis as indicated by irregular anterior chamber depth and phacodonesis was present in only 10/75 cases (13.2%) when compared to UBM which was able to detect zonular dialysis in 47/75 (61.8%) of cases on correlating the parameters, there was a concordance of 50.3% between UBM and clinical evidence of zonular dialysis clinical examination underestimated the occurrence of zonular Z dialysis. However on statistical analysis using Pearson's correlation co-efficient, clinical evidence of zonular dialysis correlated significantly with UBM findings of zonular dialysis (P=0.008). UBM detected zonular dialysis in 47/75 cases (61.8%) of cases. 27/47(57%)detected cases had zonular dialysis only less than 3 clock hours.13/47 (28%) cases had Zonular dialysis between 3-6 clock hours. Only 2/47(4%) cases had zonular dialysis more than 9 clock hours(Figure 1). Direct evidence on UBM is characterized by localizing the areas of missing zonules. Indirect evidence is characterized by other associated changes like ciliary body changes, localized changes in the lens equator, localized changes in iris curvature. This method is useful when direct evidence is missing. Combination of direct and indirect evidence helped in detecting zonular dialysis in majority of cases.(27/47; (57%). 14/47(29%) of cases had direct evidence of missing zonules and 6/47 (12%) had indirect evidence of zonular dialysis on UBM examination (Table 5).

Traumatic iridocyclitis in its various grades of severity was seen in all the cases on clinical examination. Mild anterior uveitis was seen in 17%, severe anterior uveitis was seen in 8% of patients. Most of the patients had moderate amount of anterior uveitis (56%). Cyclodialysis was seen in 3/75(4%) no of patients. The detection rate of cyclodialysis was same in clinical examination and UBM examination. Most of these patients had cyclodialysis less than 3-6 clock hours. None of the patients had peripheral choroidal detachment either by clinical examination or by UBM Intraocular foreign body was seen in 6(8%) patients. One patient had foreign body floating in the vitreous, one patient had retinal foreign body, one patient had it in the anterior chamber angle and three patients had superficial corneal foreign body. UBM had no additional advantage in picking up foreign bodies but localization of it was more appropriate using this technique. Posterior chamber cysts were detected by UBM in 4 /75 (5%) patients.

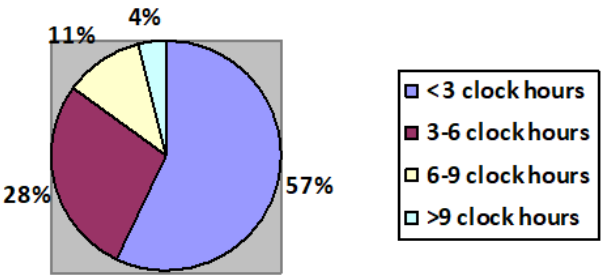

Fig. 1: Grading of Zonular dialysis on UBM

Table 1: Anterior segment findings

Clinical findings	Total number of cases n=75
Lid ecchymosis	35 (46.6%)
Lid laceration	28 (37.3%)
Subconjunctival hemorrhage	70 (93.3%)
Corneal contusions/lacerations	16 (21.3%)
Traumatic Iridocyclitis	65 (87%)
Traumatic Hyphema	46 (61.3%)
Traumatic Irididialysis	17 (22.6%)
Traumatic cyclodialysis	3 (4%)
Traumatic mydriasis	68 (90.6%)
Traumatic cataract	20 (26.6%)
Rupture of the anterior capsule	5 (6%)
Subluxated lens	2 (2%)
Phacodonesis	8 (11%)
Anterior chamber Intra ocular foreign body	1 (1%)
Angle recession	18 (24%)

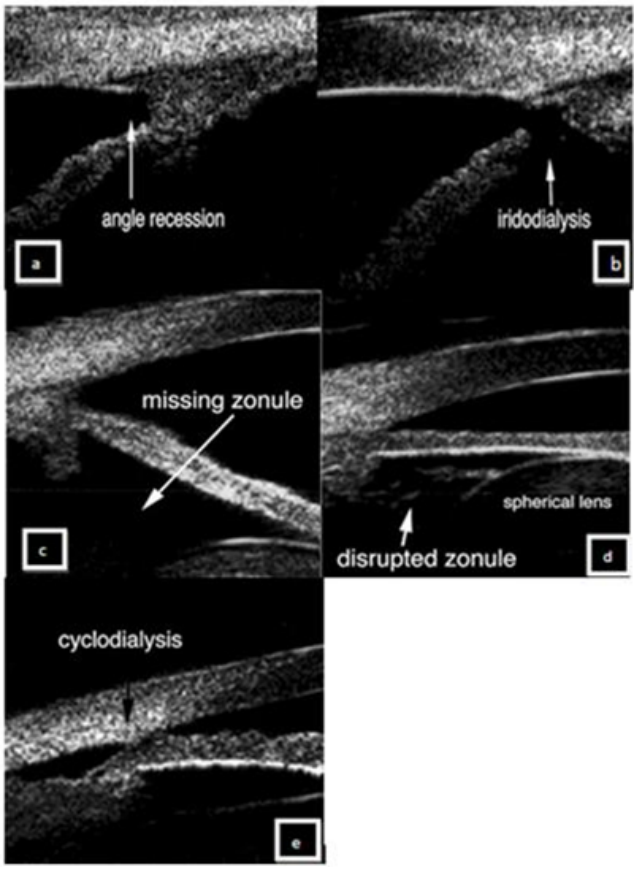

Fig. 2: UBM findings- **a)** Angle recession **b)** Iridodialysis **c)** Missing zonules **d)** Disrupted zonules **e)** Cyclodialysis

Table 2: Posterior segment findings

Posterior segment findings	No of cases n=75
Posterior vitreous detachment	25 (33.3%)
Vitreous hemorrhage	9 (12%)
Retinal detachment	3 (4%)
Commotio retinae	55 (73.3%)
Choroidal rupture	6 (8%)
Traumatic optic neuropathy	3 (4%)

Table 3: UBM findings

UBM Finding	No of cases, N=75
Zonular Dialysis	47 (61.8%)
Iridodialysis	17(22.6%)
Cyclodialysis	3(4%)
Traumatic Cataract	20(26.6%)
Posterior Chamber Cysts	4(5%)
Intraocular Foreign body	3(4%)
Angle recession	22(29.3%)

Table 4: Grading of angle recession by UBM

Grading of angle recession	No of cases N=22
Less than 3 Clock hours	19(86.3%)
3-6 clock hours	3(14%)
Total	22(100%)

Table 5: Evidences of zonular dialysis on UBM

Evidence for Zonular Dialysis	No of cases (total = 47)
Direct	14(36%)
Indirect	6(13%)
Combined	27(57%)

4. Discussion

In the present study, most of the patients were in the age group of 20-40 years which accounted for 75% of the patients. Most of the patients were male patients accounting for 79% of the study group. Prior studies done by Danenberg et al[8] consisting of 635 patients, reported that 75% of patients with ocular trauma were younger than 40 years of age, with 97% of the patients being male. Studies done by Ozdal et al. also concur that young males are more prone for ocular injuries.[6] These findings are consistent with the present study and show predominant involvement of the younger age group and more involvement of males in cases of blunt ocular trauma. In our study, road traffic accidents (36%) and sports injury (29%) were the main cause for blunt ocular injury, with occupational injury in 15% of the patients. Motor vehicle accidents has been described as the major cause of blunt ocular injury in a retrospective study done by Kearns P et al., while Punnonen et al have reported that 40% of the patients of blunt ocular trauma were due to sporting activites and 36% were related to occupation.[9,10]

In our study most of the patients had moderate visual loss (40%) according to the classification based on International Council of Ophthalmology meet at Sydney 2002.[7] This is in consistent with the study done by Ozdall et al.[6]They reported 45% moderate visual loss in their patients with blunt ocular injury. Most of the anterior segment lesions included subconjunctival hemorrhage (93%), corneal abrasions (20%), lamellar corneal lacerations (21%). This was consistent with the study done by Zagelman et al[11] who found that common injuries to the anterior segment following blunt ocular injury include abrasion of the lids, traumatic ecchymosis and subconjunctival hemorrhage. The iris because of its mobility and lack of support is susceptible to blunt ocular trauma. The pupillary margin of iris is the region most susceptible to trauma. Traumatic mydriasis was seen in 68/75(90%) patients. Sphincter tears was noted in 25/75 (33.3%) patients. Traumatic iridocyclitis in its various grades of severity was seen in nearly all the patients included in the study (86%). Zagelman et al in their study also showed that traumatic iritis (75%) was very common in eyes with blunt ocular injury which is consistent with our study.[11]

The incidence of angle recession in our study was 29.3%. Most of the patients had angle recession less than 3 clock hours (86%). This result closely agrees with that found by Blantton et al[12] who noted an incidence of 33%

in a series of 182 eyes. Longer follow up is required to identify the incidence of glaucoma in such patients. Hyphema is one of the commonest associations with blunt ocular injury and it was found to be the commonest ocular finding in our study also. Hyphema is often associated with other anterior segment injuries like iridodialysis, traumatic cataract etc. Tonjum et al have found a higher association of angle recession in patients with hyphema (46%).[13] In our study, hyphema in various grades of severity was present in 46/75(61%) no of patients. 36 (78%) out of 46 patients had moderate hyphema (grade2 to grade 3). This is consistent with results from other studies by MPC Ozdall et al.[6]In our study, majority of the contusion cataracts remained localized to anterior and posterior subcapsular regions. Total cataract was seen in 20/75 (26.6%) /patients. Anterior capsular rupture was noted in 5/75(6%) patients. These findings are similar to those of Davidson et al, who emphasized that cataract formation is common with blunt ocular injury (30%). They also described a precise anatomical relationship between lens opacities and iris injury.[14] The site of impact determines the nature of ensuing damage; where this is over some part of anterior segment, damage to the iris, ciliary body and lens may result. When the impact is scleral, the anterior segment is often not involved, but peripheral retinal damage over the site of impact may result. Contracoup macular damage is also common after localized impact, and is often associated with anterior segment damage. In our study commotio retinae was the commonest posterior segment finding (73%). Vitreous hemorrhage was noted in 9/75 (12%) patients, choroidal tear was noted in 6/75(8%) patients. Dislocated lens was noted in one patient. Retinal detachment though not a common finding in other reported series, was noted in 3/75 (4%) patients.

In our study, UBM was most important in evaluating zonular integrity following blunt ocular injury. UBM examination was able to identify zonular dialysis in 47/75(62%) patients, whereas clinical examination was able to identify Zonular dialysis in only 10/75 (13.3%) patients. UBM was far superior in identifying and localizing areas with zonular defects than clinical examination. Overt zonular dialysis detected by clinical examination was also confirmed by UBM. zonular status is an important issue in planning the surgical technique for cataract removal. Clinical signs like phacodonesis, iridodonesis, and irregular anterior chamber depth can imply zonular defect, but the nature and extent of it cannot be correctly visualized. In cases having fewer clock hours of zonular dialysis, clinical examination maybe equivocal, resulting in under diagnosis of zonular dialysis. UBM is a very sensitive tool in identifying the areas of zonular dialysis and properly defining those areas in clock hours so that surgical technique can be modified accordingly. Most of the earlier studies have taken clinical examination as the only criteria to identify zonular dialysis and this evidence is dependent on indirect features like phacodonesis, iridodonesis, irregular anterior chamber depth. However, UBM can not only be used to identify the areas with zonular defects, but with higher frequency probe it can also localize the cut end of the zonular fiber with precision. Studies done by Ozdal et al[6] have shown that Zonular deficiency was the most frequent finding in blunt ocular injury and is far underestimated by clinical examination alone. The author has also suggested that UBM examination should be an integral part of cataract surgery work up in any patient with past history of blunt ocular injury to the eye.[6]

UBM, a device primarily designed to assess the anterior chamber angle anatomy, has an important role in assessing the damage to the angle structures following blunt ocular injury. In the present study, angle recession was identified in 22/75 cases (29.3%), with most of the cases (86%) having <3 clock hours angle recession. Clinical examination tended to marginally under estimate angle recession with 24% cases having clinical evidence of angle recession. Though clinical examination (gonioscopy) is equally good in the diagnosis of angle recession and cyclodialysis, it cannot be applied in recent postoperative and 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. Ozdal et al[6] compared the angle pathology between open and closed globe injuries and found that they are more common in patients with closed globe injury. Ir*i*dodialysis, which is a disinsertion of the iris root from its insertion to the ciliary body, can also be identified with UBM. Cyclodialysis is disinsertion of ciliary body from the scleral attachment. This is can be promptly identified by clinical and UBM examination and supraciliary fluid can be demonstrated and measured by UBM. Iridodialysis was seen in 17/75 (22.6%) patients in our study. Cyclodialysis was seen in 3/75(4%) patients. Most of the patients had iridodialysis /cyclodialysis in less than 3 clock hours. Detection of iridodialysis /cyclodialysis by UBM and clinical examination was the same. Defining the iridodialysis /cyclodialysis in clock hours and identifying associated abnormalities is possible with UBM particularly when media clarity precludes anterior segment examination. Though intraocular foreign body is not a feature of blunt ocular injury, we found 3/75 (4%) superficial foreign and 3/75 (4%) intraocular foreign bodies. These foreign bodies were even detected by clinical examination. In all these cases, it was high velocity injury (eg:- mine blast). Retained foreign bodies lead to significant ocular morbidity by causing inflammation and infection, and their detection is very important for the prognosis of the traumatized eye. UBM is not only helpful in detecting and localizing the foreign body, but also in distinguishing the composition as

reported by Deramo et al. It is complimentary to CT scan in detecting small non metallic foreign body.[15]

5. Conclusion

UBM images a cross section of the angle and Zonular structures without complication; it allows diagnosis of the minute hidden subtle pathologies in closed globe injury such as angle recession, cyclodialysis, iridodialysis, and traumatic zonular abnormalities. UBM should be an integral part of ophthalmic examination especially in patients requiring surgical intervention after closed globe injury.

6. Source of Funding

None.

7. Conflict of Interest

None.

References

1. Koval MD, Teller, Belkin M, Romem M, Yanko L, Savir H. The Israeli ocular injuries. *Arch Ophthalmol*. 1988;106(6):776–80.
2. Jackson H. Bilateral blindness due to trauma in Cambodia. *Eye (Lond)*. 1996;10(Pt 4):517–20.
3. Maurya RP, Srivastava T, Singh VP, Al-Mujaini A, Mishra CP. The epidemiology of ocular trauma in Northern India: A teaching hospital study. *Oman J Ophthalmol*. 2019;12(2):78–83.
4. Nirmalan PK, Katz J, Teilsh JM, Robin AL, Thulasiraj RD, Krishnadas R. Ocular Trauma in the rural south Indian population The Aravind comprehensive eye care Survey. *Ophthalmology*. 2004;111(9):1778–81.
5. Mieler WF, Hariprasad SM. Overview of ocular Trauma. In: Albert DM, Miller JW, Azar DT, Blodi BA, editors. Albert and Jakobiec's Principles and Practice of Ophthalmology. United States: Saunders; 2008.
6. Ozdal MPC, Mansour M, Deschênes J. Ultrasound biomicroscopic evaluation of the traumatized eyes. *Eye (Lond)*. 2003;17(4):467–72.
7. WHO Bulletin PBL 03.91. International Council of Ophthalmology (ICO) and adopted at the 29th International Congress in Sydney, in April 2002.
8. Dannenberg A. Penetrating Eye Injuries Related to Assault. *Arch Ophthalmol*. 1992;110(6):849–52.
9. Kearns P. Traumatic hyphema, Retrospective study of 314 cases. *Br J Ophthalmol*. 1991;75(3):137–41.
10. Punnonen E. Epidemological And social aspects of eye injuries. *Acta Ophthalmol (Copenh)*. 1989;67(5):492–8.
11. Zagelbaum BM, Donenfeld ED, Chad S, Donnenfeld ED, Perry HD, Jeffers JB. National basketball association eye injury study. *Arch Ophthalmol*. 1995;113(6):749–52.
12. Blanton FM. Anterior chamber angle recession and secondary glaucoma. A study and after effects of Traumatic hyphema. *Arch Ophthalmol*. 1964;72:39–43. doi:10.1001/archopht.1964.00970020041010.
13. Shingleton BJ, Hersh PS. Traumatic hyphema. In: Shingleton BJ, Kenyon KR, editors. Eye Trauma. St. Louis: Mosby; 1991. p. 206–10.
14. Irvine JA, Smith R. Lens injuries. In: Shingleton BJ, Hersch PS, Kenyon KR, editors. Eye Trauma. St. Louis: Mosby; 1991. p. 126–35.
15. Derama VA, Gaurav KS, Baumal CR, Fineman MS, Corrêa ZM, Benson WE, et al. UBM as a tool for Detecting and localizing occult foreign bodies after ocular trauma. *Ophthalmology*. 1999;106(2):301–5.

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