CEOTI
Clinical and Experimental
Ocular Trauma and Infection

REVIEW

Received Date: 19 Februrary 2019 Accapted Date: 13 April 2019 Publication Date: 23 April 2019

Prognostic factors for traumatic visual impairment and blindness in special groups

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Abstract

Our purpose is to review the manuscripts worldwide and evaluate the prognostic factors that affect final visual acuity in different injury groups. Studies about ocular injuries of the children, worker, driver, and army personal were investigated. Injuries of those groups are more frequent in our region than some other regions. Prognostic factors of those studies were compared with each other. Globally prevention is critical and open glob injury is a bad prognostic factor, evaluation of visual acuity of the pediatric patients is important. Work related injuries and combat injuries mostly happen in productive young-aged and those have impact as global burden. Ocular traumas secondary to motor vehicle accident can cause central blindness secondary to optic neuropathy or intracranial pathology.

Keywords: ocular trauma, pediatric, combat, work related, blindness, visual impairment

1.Introduction

Approximately 4 million people are visually impaired or blind because of ocular trauma, and 18 million people have unilateral visual impairment (1). Ocular traumas are 2-6 % of all trauma admissions in United States (USA). The leading type of ocular traumas is contusions or superficial injuries, and the most frequent treatments are for eyelid or cornea (2). In Turkey 36 % of the all ophthalmic emergencies were ocular traumas. In male sex, 46 % of the ophthalmic emergencies were corneal foreign body; and in females, 30 % of ophthalmic emergencies were ocular traumas (3).

According to World Health Organization (WHO), trauma is not one of the leading causes of the blindness globally. The main cause of this statistic is because of the definition for the blindness and visual impairment that was made by WHO. Worldwide accepted criteria of the WHO (4) for blindness is:

•Visual acuity (VA) worse than 3/60 or a corresponding visual field loss of less than 10° in the better eye.

Visual impairment is:

•Moderate visual impairment: VA in the range from worse than 6/18 to 6/60

•Severe visual impairment: VA worse than 6/60 and equal to or better than 3/60.

As seen in the definition, WHO defined these terms according to both eyes. However most of the traumas occur unilaterally. If we make a definition about unilateral visual impairment/ blindness; trauma becomes the leading cause of the blindness both in developed and developing countries (4,5).

In developed countries the leading cause of the blindness is age related macular degeneration (AMD). In USA, the leading cause of monocular blindness is trauma; and the trauma is in the second place just after the cataract as a reason of the visual impairment (6). Also, it is true for developing countries; In developing countries the main

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cause of unilateral vision loss is trauma (5,7).

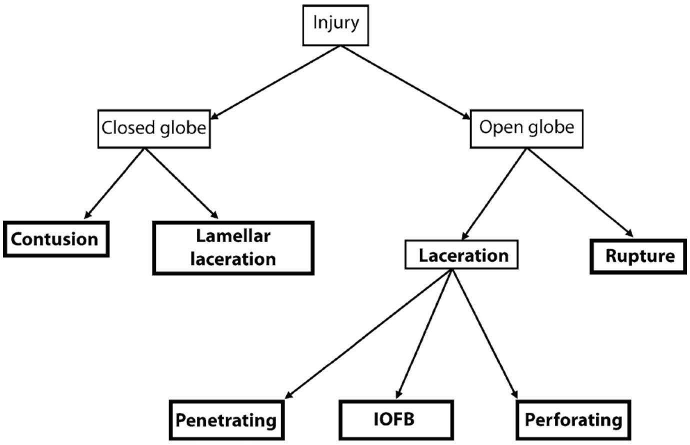

Figure 1: Birmingham Eye Trauma Terminology (BETT)(7).

According to Birmingham Eye Trauma Terminology (BETT) System ocular traumas are divided into 2 groups based on the integrity of the eye wall (cornea and sclera). The first group is open globe injuries (OGI) and those are defined as full thickness injury of the eye wall. The other group is closed globe injuries (CGI) and those are defined as contusion or lamellar lacerations (Figure 1) (7). The rate of CGI is higher than OGI; but the impact

Step 1: Determining the raw points	Variable	Raw point value
Initial vision	NLP	60
	LP/HM	70
	1/200–19/200	80
	20/200–20/50	90
	≥20/40	100
	Rupture	–23
	Endophthalmitis	–17
	Perforating injury	–14
	Retinal detachment	–11
	APD	–10

Step 2: Conversion of the raw points into the OTS, and identifying the likely visual outcome (%)						
Sum of raw points	OTS	NLP	LP/HM	1/200–19/200	20/200–20/50	≥20/40
0–44	1	74	15	7	3	1
45–65	2	27	26	18	15	15
66–80	3	2	11	15	31	41
81–91	4	1	2	3	22	73
92–100	5	0	1	1	5	94

Figure 2: Ocular Trauma Score (7).

of the OGI on vision is greater than CGI. The form and type of injuries and their damages change according to this classification (3,8-11). To assess the damage and prognosis an ocular trauma score (OTS) was developed by United State Eye Injury Registry (USEIR) researchers. They used over 2500 patients from USEIR to develop the OTS. According to OTS, the most important prognostic factor is initial VA. Poor prognostic factors are rupture, endophthalmitis, perforating injury, retinal detachment (RD) and afferent pupillary defect (APD) (7) (Figure 2).

In this chapter, we searched the effects of injury zones, pediatric, occupational, combat and motor vehicle eye injuries on final VA from articles that reported all over the world and according to our experience from an industrialized region of a rapidly developing country.

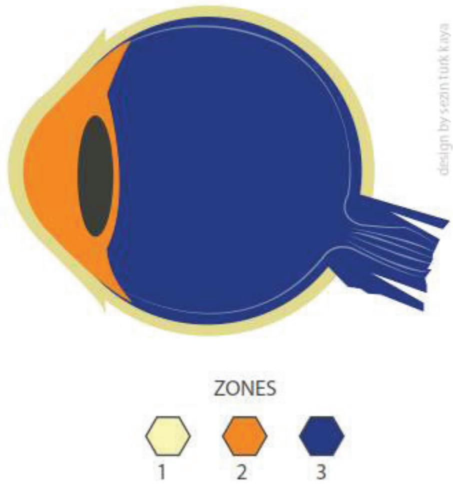

Figure 3: Injury zones in closed glob injuries (12).

2. Zone of Injury

2.1.Closed Globe Injuries

Closed globe injuries (CGI) are defined as contusion or lamellar laceration of the eye depending on the mechanism of injury (inflicting blunt object versus inflicting sharp object respectively).

According to affected site, CGIs are divided into 3 zones (Figure 3) (12).

Zone 1: Conjunctiva, cornea, sclera

Zone 2: Anterior chamber, lens, zonules, ciliary body

Zone 3: Retina, vitreous, optic nerve

On the one hand, the incidence of CGIs is higher than OGIs, on the other hand CGIs have better visual outcomes than OGIs (8-11). Contrary to this finding in Egypt, OGI rates was found higher than CGIs (13). The main causes of visual impairment in CGI are traumatic optic neuropathy, traumatic cataract, hyphema, retinal detachment, Bruch membrane rupture, macular scar. Retinal detachment secondary to CGIs was found very frequent and related with VA below 40/200 in Turkey. Macular scar, optic nerve damage and development of PVR were determined as other prognostic factors (14). It was mentioned that 90 % of the ocular traumas referred to emergency department in Turkey were CGIs (15). Another study

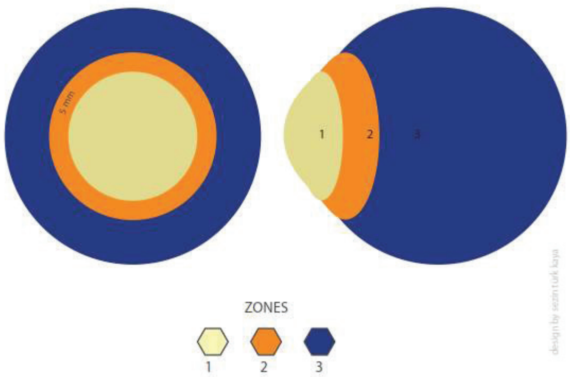

Figure 4: Injury zones in open glob injuries (12).

Figure 5: Zone 1 and zone 2 open glob injury with choroid prolapse in a child.

from Turkey mentioned that most of the CGIs were corneal foreign bodies and none of the patients had final VA lower than 60/200 (11).

2.2.Open Globe injuries

Open globe injuries are defined as whole thickness damage of the cornea and/or sclera. It means that laceration or rupture of the globe is OGI caused by different mechanisms, outside-in versus inside-out respectively. Sharp objects such as knife, scissors, result in a laceration; and blunt trauma in rupture.

According to injury site open glob injuries are divided also into zones (Figure 4) (12).

Zone 1: Cornea and limbus

Zone 2: Sclera 5 mm from limbus

Zone 3: Sclera except Zone 2

Injury zone in OGIs are related with prognosis (8,16). In most of the OGIs Zone 2 and Zone 3 injuries have poor visual prognosis (8, 17) (Figure 5). According to ocular trauma score rupture is another bad prognostic factor (7). Most of OGIs injuries of are in zone 1 (18,19). It means that those injuries affect the cornea. According to bulletin of WHO ocular traumas are the main causes for corneal blindness besides corneal ulcerations. Most of these injuries remain underreported (20).

Lens damage may or may not go with full thickness corneal injuries (Figure 6). Blindness and visual impairment may occur as a result of corneal scar, corneal astigmatism, cataract, aphakia, secondary glaucoma, traumatic cataract, retinal detachment that are complications of this kind of injuries (8). In a study from Italy is mentioned that nearly 22 % of Zone 1 and 2 OGIs resulted on 20/200 or worse VA in a 5 years period; also it was mentioned that 40% of the injuries are corneal and 14% are limbal. Nearly 16% of the OGI needed lensectomy. They men

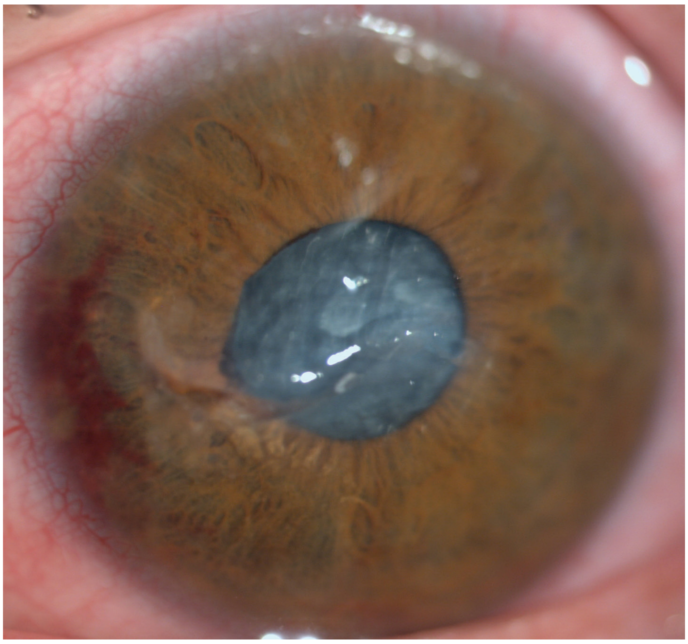

Figure 6: Lens damage in a patient with zone 1 open globe injury.

tioned that most of the Zone 3 injuries had VA worst than 20/200 (18).

Injury zone was found as an independent risk factor in OGIs besides initial VA and RAPD in China (21). In Malaysia, final VA was found related with presenting VA, posterior injuries, size of the injury site, hyphaema and vitreous prolapse (22). A study from Egypt reported that ruptured eyes had bad prognoses. They noted that 77 % of the injuries had a vision below 1/60 at the time of discharge (13). There are several ocular trauma studies from

Turkey and many of them mentioned that Figure:Figure: 7 injury zones, wound size, and accompanying damages had prognostic influence on final VA. Kaplan et al noted that 62 % of the OGI were corneal, 20 % were scleral; and accompanying damages were iris/choroid prolapse (56 %), hyphema (28 %), traumatic cataract (23 %), vitreous hemorrhage (12 %), IOFB (8 %), RD (0.6%) (19). Gurlu et al. reported that posterior segment injuries, vitreous prolapse, hyphema, total anterior chamber volume loss, initial VA below 20/200 are prognostic factors for final VA that are probably below 20/400 in OGIs (17). Kargi et al. mentioned that one of the prognostic factors is the length of the wounds. Seventy four percent of the 1- 4 mm long wounds, 53 % of 5-8 mm long and 35 % of the 9-12 mm long wounds probably ended up with 6/60 and higher VA.[23] A recent study from Turkey reported that 35 % of the patients, who had VA below 3/60 after occupational OGI, had phythisis bulbi or had undergone enucleation or evisceration. All of these patients had at least zone 2 and 3 injuries (8). In our opinion hyphema, vitreous prolapse or wound length etc. are indicators of the power of the ocular trauma, and show excess injured tissue. For medicolegal issues those findings should be noted carefully.

3. Ocular trauma in pediatric age group

Open globe injuries have devastating complications for both adults and pediatric age groups. Complications are mostly similar, but due to the poor visual outcomes, a special focus on amblyopia management is needed in children (24). OGI is the leading cause of monocular blindness in the childhood (16,25-27). In small pediatric ages OGI mostly occur at home. In school aged children

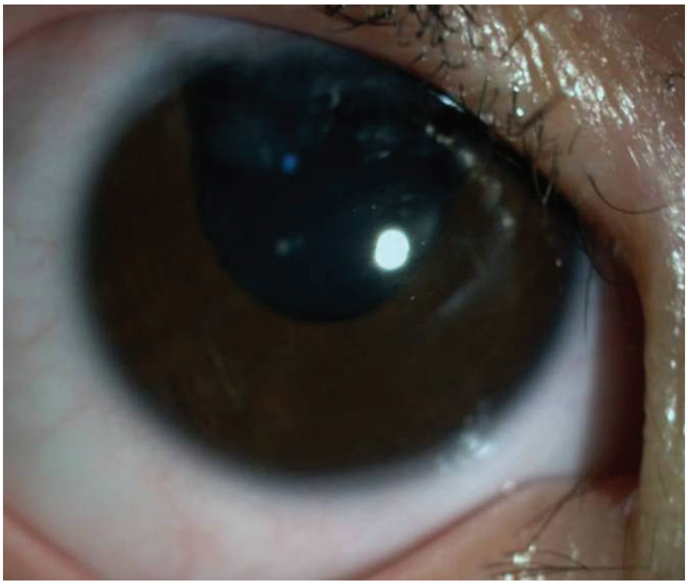

Figure 7: Postoperative photo of a child whose preoperative photo is shown in figure 5.

streets, playgrounds, sport and school areas are the places where OGIs occurred (16, 26,27).

Hospitalization rate for children after eye injuries was 8.9 per 100 000 persons in USA. OGIs were 21 % of all eye injuries (28). A study from France reported that only 7 % of the pediatric ocular trauma patients needed surgical intervention. They mentioned that no blindness was occurred (27). A study from western Australia aimed to evaluate ocular injuries of pediatric patients. Mean duration of hospital stay was found 5 nights with OGIs and 2,5 nights with CGIs.[29]

In Eastern India OGIs are 19 % of all ocular traumas in pediatric age group. Nearly half of these patients had corneal injuries and one third of them had traumatic cataract. 37 % of the OGIs ended up with monocular blindness (30). A recent study from Turkey mentioned that children with zone 2 and 3 injuries, traumatic cataracts, hyphema, and retinal detachment had low final VA. In this study, the final VA was found under 3/60 in 61 % of the children, whose initial VA was below 3/60; and was found between 6/18 and 3/60 in 33 % of the patients who had initial VA between 6/18 and 3/60. Also it was reported that 35 % of the OGIs in childhood ended up with blindness (16). Another recent study from Surinam mentioned that 58 % of children with OGI had final VA below 6/60; and OGI was found related with bad visual outcome (31). A study from Qatar reported that only 37 % of the children with OGI had initial VA better than 6/60, and 63 % of the patients with OGI had final VA better than 6/18. Approximately 5 % of the OGI were blind and 11 % had severely visual impairment (32). In Colombia 53 % of the OGIs, in childhood period, had initial VA below 20/400. 55 % of the OGI were severely visual impaired or blind. [34] The rates were found higher in Nigeria. According to their results at the end of the follow up 80 % of the patients were visual impaired or blind (35). Those findings show that high rates of OGIs end up with blindness or visual impairment.

In United Kingdom lower age at the time of trauma, initial visual acuity, relative afferent pupillary defect, no red reflex, cataract, number of surgery were found as influencing factors on poor final VA (33). In a study from Australia globe ruptures, zone 3 injuries, bad presenting visual acuity, wound size longer than 10 mm and lens injury were related with poor visual outcome (9). Li et al. reviewed the literature and concluded that, small ages, bad initial VA, posterior segment injuries, wound size, globe rupture, lens damages, vitreous hemorrhage, retinal detachment, and endophthalmitis were found associated with low final VA (24). A study from Taiwan reported that RD secondary to OGIs in the childhood was found related with worse surgical results and poor visual outcomes (36). However controversially in a study from Israel mentioned that the type, extent, and severity of the RD were similar to each other in both open and closed globe injuries. They thought that RD is caused by secondary indirect impact of globe deformation in children (37).

In pediatric age groups low initial VA, posterior segment involvement, low scores from OTS evaluation, retinal detachment, afferent pupillary defect, vitreous and uveal tissue prolapse and hyphema affected prognosis (9,24,33,29). However, one of the challenging procedures is assessing initial VA in pediatric age groups. A study mentioned that initial VA could not be measured in 43 % of the pediatric OGI patients, and all of them were under 8 years old (16). It seems that posterior segment involvement has direct impact on prognosis, however lens and cornea involvement has impact on amblyopia.

In France, Mayouego Kouam et al. reported that most of the pediatric ocular traumas have affected cornea (27). A study from Suriname reported that of all ocular traumas 7 % were OGI, 85 % were CGI, 1 % orbital fracture, 7 % were eyelid injuries (31). In Qatar 60 % of the ocular traumas were CGI and 56 % of them had initial VA better than 6/60; and 83 % of CGI patients had final VA better than 6/18 (32). Visual outcomes were found significantly better in CGIs than OGIs in pediatric age group in Australia (9). In Colombia 80 % of the CGI had final VA better than 20 /60. Visual impairment occurred in 8 % of the CGI (34). Chakraborti et al reported that CGIs (62 %), were more common than OGIs (19 %) In pediatric age groups in eastern India. Twenty one percent of OGI and 79 % of CGI cases had more than 0.4 (Snellen) final VA. In total 10 % of all pediatric ocular trauma patients ended up with blindness (30).

It is critical to assess initial VA in children not only for prognostic aspect but also for medicolegal aspect; however, assessing VA is challenging in small age children. That's why ocular examination and imaging findings should be done and noted meticulously. OGIs should be distinguished from occult OGIs clearly, if it is not possible at biomicroscopic examination. Examination under general anesthesia should be performed in operating room (Figure 7).

4.Occupational Injuries

In USA occupational injuries are in the second place. However in a developing country such Turkey work related injuries are in the first position. This is because in developed countries most of the injuries occur at home as people make fixing activities at home by themselves. However in newly industrialized countries most of the OGI are occupational (7,38). Studies from USA suggest that occupational OGI have better outcome than other reasons that cause ocular rupture. They also mentioned that RD occurs to a lesser extend in occupational injuries. Kanoff et al reported that 6.5 % of the patients had no light perception, 26 % of the patients had 0,1 or less final VA in occupational eye injuries. Ten percent of them are between 0.1-0.4. They noted that protection is the best treatment (39). A study from Thailand noted that 56 % of injuries in the patients with OGI, who had undergone PPV, were work related (40). In a study from India the final VA was below 6/60 in 67 % of the patients with occupational OGI; 46 % of the poor vision were because of phytisis bulbi, 17 % macular scar, 11% RD (41). A recent study about occupational OGI from Turkey noted that wide injuries with posterior segment involvement especially (zone 2 and 3) were related with poor visual outcomes. In this study it was mentioned that 46 % of patients were blind both at initial and final visit. The mean number of surgeries is 1.8 ±1.0. There is a positive correlation between VA and the number of surgeries (8). In Malaysia it was noted that in adult 40 % of the OGIs was occupational (22). A study from Israel mentioned that 45% of the OGIs were work related. Interestingly in this study eyelid injuries were found as a prognostic factors besides initial VA and retinal detachment (42). Occupational or work related injuries are big issues in developing countries. Most of them are avoidable and affect working-aged men; as a result these injuries have an effect on whole community financially and socially. Therefore occupational eye injuries should be evaluated as public health issue(Figure 8).

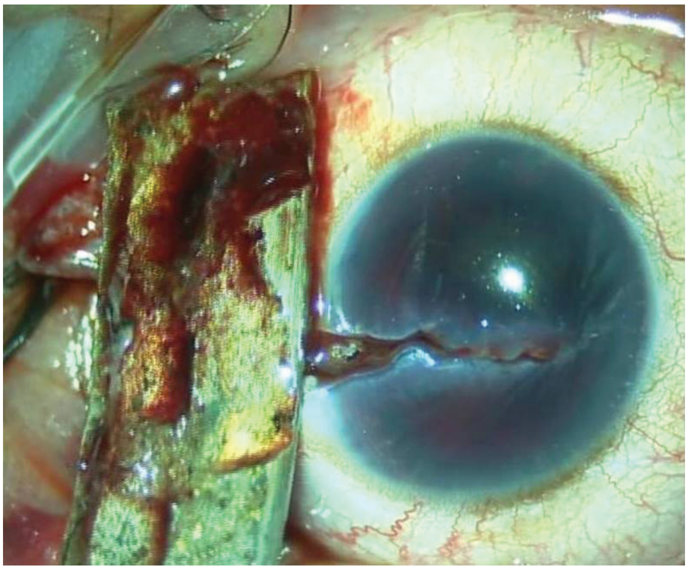

Figure 8: Occupational eye injury by metalic foreign body.

5. Combat Injuries

In US Army 92 % of the combat eye injuries were OGI. Forty-three percent of them were corneal lacerations. Forty-eight of the all ocular injuries had intraocular foreign body (IOFB). Both cornea and retina were involved in 58 % of injuries with VA lower than 20/200 (43). A study from Turkey mentioned that terror related open globe injuries present with very poor VA and uncommon injuries. Nearly 1/5 of the patients underwent enucleation (44). One third of the patients, who have OGI, have also multisystem traumas. The rates are higher in terror attacks (44,45). Weichel et al. reported that 85 % of the patients who had ocular combat Injuries had also injuries in other parts of the body, 66 % had traumatic brain injuries, 58 % had facial injuries. Oculoplastic or neuro-ophthalmologic injuries that accompany to eye injuries had poor VA. 65 % of the CGIs had VA 20/40 or better; three quarter of the OGIs had VA 20/200 or below. Better VA was achieved after CGIs than OGIs in patients with combat ocular traumas (46). According to a study from Pakistan, vitreous haemorrhage 33 %, cataract 25%, retinal detachment 16 % and commotio retinae 16 % occurred after combat CGIs; and the functional and anatomical outcome was better in combat CGIs compared to OGIs (47). Erdurman et al investigated ocular injuries with improvised explosive devices (IEDs). They reported that 80 % of the eyes had OGIs 20 % of the eyes were CGIs; and 43 % of the patients had no light perception at the end of treatments. Main cause of poor outcomes was postoperative proliferative vitreoretinopathy (48). Hassan Naqvi et al. assessed the ocular war injuries and they mentioned that CGI had better visual outcomes than OGI. 80 % of the open globe war injuries resulted in blindness s whereas 25 % of closed globe war injuries (10). A study from Balkans mentioned that 53 % of the war injuries was constituted by OGIs. This study concluded that status of the ocular tissues after injury; wound site and size, IOFB and experience of the center for surgery were found as important prognostic factors (49).

On the one hand combat injuries mostly resulted with OGIs, on the other hand final VA is low with combat OGIs. Also periorbital and other organ injury rates are high with this type of injuries.

6. Motor Vehicle Related Eye İnjuries.

Motor vehicle accident (MVA) related eye injuries constituted 5 % of the all eye injuries that were referred to ophthalmic emergency in Israel (50). Twenty-three of all ocular traumas were result of MVA in Malaysia (51). Main risk factors for eye injuries were found as old age, female sex, seat position, vehicle weight, and collision severity (52). According to US emergency departments records, the commonest injury types of MVA eye injuries were contusion or abrasion (53).

On one hand, seatbelt usage decreases the risk of eye injuries at the moment of accident; on the other hand airbag deployment increases the risk (53). In another study the risks of airbag related ocular injuries were found as 2 % and severe eye injuries were 0.5 % when seat belts were used (54). Wearing glasses at the time of airbag deployment was found as a risk factor for OGIs, however some authors mentioned that it might decrease the risk of chemical ocular injuries, due to exposure to chemicals that are released into the car by the deployment of the airbag (54-56) (Figure9).

Kuhn et al. reported serious motor vehicle related ocular traumas. They mentioned that 47 % of the eyes had vision below 20/200 at initial examination; and 41 % of the eyes were blind at the end of the follow up. They suggest that ruptures after blunt traumas were associated with poor outcomes (57). Corneal injuries had more favorable results than scleral injuries. Scleral buckling prior to RD surgery was found useful to reduced post surgical retinal detachment rate (58).

Traumatic visual loss after motor vehicle accidents may occur by different mechanisms. Direct and indirect optic neuropathy, carotid cavernous fistula, optic pathway traumas are main mechanisms for vision loss (59). Traumatic chiasmal syndrome is also another cause for blindness after traffic accidents. It usually occurs after head traumas. Cranial nerve lesions, hypopituitarism, carotid-cavernous fistula may accompany to chiasmal syndrome (60,61). Main ocular finding is bitemporal hemianopia. Hassan et al. reported 19 patients with traumatic chiasmal syndrome, 75 % of patients had final VA 20/40 or better in at least one eye, however 10 patients had blindness because of optic neuropathy (60).

Motor vehicle injuries may affect many parts of the body, whole body examination and evaluation should be done at emergency department prior to admitting patients as ophthalmologic emergency. Intracranial injuries and optic neuropathies should be kept in mind while evaluating the patients (Figure 9).

7. Treatment and Rehabilitation

Best treatment modality was described as protection by many authors (39). Early referral to the hospital after ocular traumas is crucial; especially after OGIs. The risk for endophthalmitis, which is the one of the bad prognostic factors according to OTS, increases 24-36 hours after the

OGIs (7). To do a full ophthalmic examination is valuable for making treatment plan and medico-legal and prognostic aspects. Primary repair should be done immediately. Secondary operations such as lens aspiration, IOL implantation, vitrectomy should be postponed according to degree of inflammation (7,12). Other important issues are complications of the traumas and surgeries. Besides the direct influence of the trauma, complications such as aphakia, sympathic ophthalmia or phytisis bulbi may lead to blindness. Phythisis bulbi is described as the second most common monocular blindness in patients under 18 years old, just after the hereditary maculopathies (62). If it is not possible to distinguish a OGI from CGI (an occult OGI) patient should be examined under general anesthesia in the operating room. Tetanous shot should be performed in emergency room if needed; and prophylactic antibiotics should be started intravenously. In our practice we order urgent computed tomography for all ocular trauma patients.

In rehabilitation period it is important to keep a good communication with patients and their families especially in childhood traumas to influence the implementation of the treatment positively and overcome amblyopia. Contact lenses and glasses can be used for aphakia treatment. Gas permeable rigid contact lenses can be used for corneal scars. Low vision rehabilitation is an option for visual impaired patients.

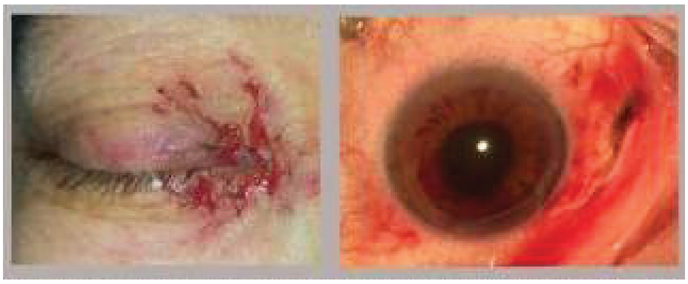

Figure 9: Open globe and eyelid injury after airbag deployment in a motor vehicle injury.

8. Prevention

Ocular traumas are one of the main reasons of disabilities. Disabilities especially preventable ones cause a socioeconomic burden both for patients and public. Almost all eye injuries are preventable. And nearly all articles globally conclude that prevention and education are very important.

Posterior segment involvement, both in OGIs and CGIs were associated with visual impairment or blindness. Almost all studies mentioned that injury zone is one of the important prognostic factors such as initial VA. The best way for protection is to wear a protective eyewear. Blackburn et al. noted that wearing protective glasses had statistical significant effects (63).

In pediatric age groups the leading cause of monocular blindness is OGI. Most of them occur at home. Younger age is one of the poor prognostic factors (26). Main treatment modality is prevention. Education of the parents is important to make them aware about ocular traumas and visual impairment. Protective eyewear can be advised to children who are engaged with sports (26).

In developed countries occupational injury rates are lower than in developing countries. The main reason for this finding is the educated employers and employees and the safety workplace rules that can easily be put in practice. However in newly industrialized countries both employers and employees are not aware of the importance of prevention. Kivanc et al reported that 78 % of the patients with occupational OGI had not worn protective eyewear; and 40 % of them mentioned that their work place had protective eyewear (8), also this study mentioned about the accident hours and this shows us most of the injuries occur when workers are hungry or tired (8).

Most of the motor vehicle eye injuries are not serious. However they may cause visual impairment or blindness. Also they may cause blindness without direct injury of the eyes. Best protection is using seatbelt and driving slow and safe by obeying the rules (53,54). Other system traumas should be evaluated.

Combat injuries are the most complicated, and usually with multi-system traumas. War injuries commonly affect human in young ages. Protection from this type of injuries is not easy. The best protection is make peace not war as told by Mustafa Kemal Ataturk (a leader and soldier) ¨Peace at home peace in the world¨ (64).

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