ORIGINAL ARTICLE

EPIDEMIOLOGY, DEMOGRAPHIC CHARACTERISTICS AND FINAL VISUAL CONSEQUENCES OF OPEN GLOBE INJURIES IN GERIATRIC PATIENTS

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Abstract

Introduction: Eye trauma is an important preventable cause of blindness. Decreased visual acuity of geriatric patients due to diseases such as cataracts, diabetic retinopathy, glaucoma, and retinal vascular diseases also cause eye trauma.

Materials and Method: In this study, the files of 29 patients aged > 65 years who were treated for open-globe injuries at the eye diseases outpatient clinic of Akdeniz University (Antalya, Turkey) between January 2013 and November 2022 were retrospectively analyzed. Patient age, sex, location of injury, characteristics of injury, other accompanying findings, hospital admission time after injury (less than 12 h or > 12 h), and final visual acuity of the traumatized eye at admission and after treatment were recorded in addition to the visual acuity of the healthy eye at admission.

Results: The most common causes of injuries were tree branches (48.3%) and hard objects (31.0%). A total of 51.7% of eye injuries occurred at home and 48.3% occurred outdoors. Blunt and penetrating incisive injuries were observed in 65.5% and 34.5% of the patients, respectively. However, the most common injuries were penetration (75.9%) and perforations (20.7%). Injuries were mostly observed in zones I (58.6%) and III (31.0%). Visual acuity in the affected eye was less than 20/200 in 79.3% of the cases.

Conclusion: Precautions should be exercised to prevent eye trauma that reduces vision or results in legal blindness, especially in individuals over the age of 65 years. Furthermore, post-traumatic rehabilitation is very important.

Keywords: Geriatrics; Trauma; Blindness.

INTRODUCTION

Eye trauma is a major and preventable cause of blindness worldwide. Mechanical trauma of the eye is divided into open- and closed-globe injuries by the Birmingham Eye Trauma Terminology (BETT) and the Ocular Trauma Classification Group (1). An open-globe injury can be defined as a full-thickness injury to the sclera, cornea, or both. Several studies on the epidemiology and prognosis of the aforementioned two types of injuries are present (2–4). The epidemiology and prognosis of eye trauma may differ in geriatric populations aged >65 years (5). Decreased visual acuity of geriatric patients due to diseases such as cataracts, age-related macular degeneration, diabetic retinopathy, glaucoma, and retinal vascular diseases also contribute to eye trauma. Several studies have demonstrated that open- globe injuries are associated with more hospitalizations and worse visual prognoses than closed-eye injuries in geriatric patients (5–6).

The aging process naturally leads to restrictions in daily activities, and the decrease in vision with age also contributes to these limitations. A decrease in vision with age may be a cause of trauma, however, vision loss due to trauma may make daily life even more difficult for older patients with limited daily activities, which may lead to a vicious circle. According to a United Nations report, the geriatric population will constitute 21% of the world's population by 2050 (7). To improve the quality of life of geriatric patients and their participation in daily life, maintaining a certain level of vision, and preventing possible trauma, and related vision loss is important.

Studies on eye trauma in the geriatric population compared to the normal population are limited (5,6,8–10). In particular, if considered a public health problem, geriatric patients with ocular trauma should be further examined.

In this study, we retrospectively analyzed the causes of open globe injuries, the characteristics of injuries, and their effects on vision in geriatric patients and discussed possible measures to prevent the traumas.

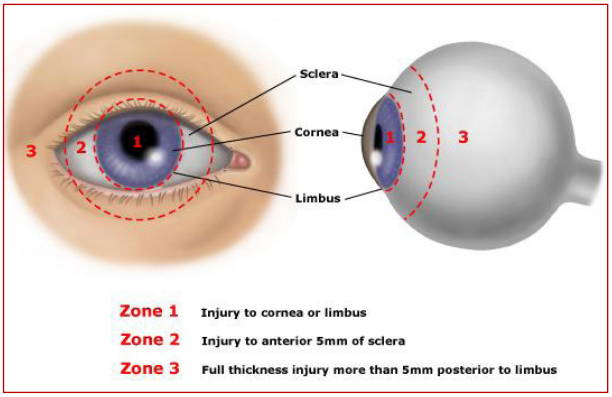

Figure 1. Open globe injury zones

MATERIALS AND METHOD

In this study, the files of patients over the age of 65 years with open globe injury who visited the eye disease outpatient clinic of Akdeniz University (Antalya, Turkey) between January 2013 and November 2022 were retrospectively analyzed. Patient age, sex, location of injury, characteristics of injury, other accompanying findings, hospital admission time after injury (less than 12 h or >12 h), and final visual acuity of the traumatized eye at admission and after treatment were recorded in addition to the visual acuity of the healthy eye at admission. We recorded whether the injuries were penetrating, punctured, or ruptured according to the BETT system (1).

Ocular trauma scores were calculated and classified for each patient. The ocular trauma score has a very important prognostic value in predicting the final visual outcome in patients presenting with open globe injury. The ocular trauma score was divided into five groups of 100 points as follows; grade 1:0–44 points, grade 2:45–65 points, grade 3:66– 80 points, grade 4:81–91 points, and grade

5:92–100 points. The higher the ocular trauma score, the better the final visual acuity.

Primary repair was performed in patients in whom anatomical integrity was achieved with primary suturing. Patients with traumatic cataracts underwent intraocular lens implantation with scleral fixation along with traumatic cataract extraction surgery. Patients with traumatic retinal pathology who had a surgical indication underwent pars plana vitrectomy. Best-corrected visual acuity 1 year after surgery was considered as final visual acuity.

We grouped our patients with a final visual acuity greater than 20/200 (the legal limit of blindness) as good or worse and examined the factors affecting this outcome (11).

Ethics Approval

This retrospective study was conducted by the ethical standards of the Declaration of Helsinki, with the approval of the Clinical Research Ethics Committee of Akdeniz University Hospital Medical Faculty.

RESULTS

The mean age of 29 patients included in the study was 68.8 ± 5.1 years (65–85 years). The male-to-female ratio was 2.2/1 and the injured eye was the left eye in 58.6% of cases. The most common causes of injury were tree branches (48.3%) and hard objects (31.0%). Moreover, a total of 51.7% of eye injuries occurred at home and 48.3% occurred outdoors. Blunt and penetrating incisive injuries were observed in 65.5% and 34.5% of the patients, respectively. However, the most common injuries were penetration (75.9%) and perforations (20.7%). Injuries were mostly observed in zones I (58.6%) and III (31.0%). The incision length was > 5 mm in 69% of the cases. Moreover, visual acuity in the affected eye was less than 20/200 in 79.3% of the cases, whereas visual acuity was >20/200 in 86.2% of the cases in the fellow eye. The mean ocular trauma score was

Table 1. Characteristics of patients and injuries

FEATURE	FREQUENCY N (%)
Age†	68,8 ± 5,1 (65-85)
Sex	
Female	9 (31,0)
Male	20 (69,0)
Side	
Right	12 (41,4)
Left	17 (58,6)
Injury-tool	
Wood-tree branch	14 (48,3)
Hard object	9 (31,0)
Other	6 (20,7)
Injury place	
House	15 (51,7)
Outdoor	14 (48,3)
Injury mechanism	
Blunt	19 (65,5)
Sharp	10 (34,5)
Injury type	
Penetrating	22 (75,9)
Perforating	6 (20,7)
Rupture	1 (3,4)
Injury zone	
Zone I	17 (58,6)
Zone II	3 (10,3)
Zone III	9 (31,0)
Size of injury	
≤5 mm	9 (31,0)
>5mm	20 (69,0)
Traumatic eye VA	
≤20/200	23 (79,3)
>20/200	6 (20,7)
Traumatic eye VA (logmar) †	2,36 ± 0,92
Fellow eye VA	
≤20/200	4 (13,8)
>20/200	25 (86,2)
Follow-up time (month) ††	16 (1-84)
Traumatic eye final VA	
≤20/200	18 (62,1)
>20/200	11 (37,9)
Traumatic eye final VA (logmar) †	2,03 ± 1,11
Ocular Trauma Score†	62,9 ± 19,0
Grade I	3 (10,3)
Grade II	12 (41,4)
Grade III	8 (27,6)
Grade IV	6 (20,7)
Grade V	0
Evisceration	2 (6,9)
First application time	
<12 hours	21 (72,4)
>12 hours	8 (27,6)

†Average±Standart Deviation, ††: Median (min-max),
N: Number, VA: Visual Acuity

62.9 ± 19.0 with evisceration required in two cases. In the first 12 hours after injury, 72.4% of the patients presented to the hospital emergency department (Table 1).

The most common findings accompanying ocular trauma were uveal tissue prolapse (58.6%), conjunctival incision (48.3%), hyphema (24.1%), and traumatic cataracts (17.2%) (Table 2)

Table 2. Findings accompanying ocular trauma

Finding	Frequency N (%)
Uveal tissue prolapse	17 (58,6)
Conjunctival laceration	14 (48,3)
Hyphema	7 (24,1)
Traumatic cataract	5 (17,2)
Fibrin membrane	4 (13,8)
Hemorrhagic coagulum	4 (13,8)
Lens dislocation	3 (10,3)
Vitreous at the wound	3 (10,3)
Lid laceration	2 (6,9)

N: Number

The demographic and clinical features of patients with a final visual acuity <20/200 and above were compared. Patients with a final visual acuity of <20/200 had a high initial visual acuity (p= 0.001) and a low ocular trauma score (p <0.001). However, no statistically significant differences were observed between the ages of the patients (Table 3).

The ocular trauma score was grade I in 16.7% of the cases, with a final visual acuity below 20/200; grade II in 66.7%; grade III in 11.1%; and grade IV in 5.6%. Of those with visual acuity greater than 20/200, 54.5% were grade III, and 45.5% were grade IV (p <0.001). The initial visual acuity value was low in patients with a final visual acuity of <20/200 (p= 0.001). However, no differences were observed between the final visual acuity groups in terms of age, sex, affected side, injury type, localization, injury size, or time of presentation (Table 4).

Of the 29 patients, 19 had diabetes, 13 had hypertension, and 11 had hyperlipidemia. Two of the patients had diabetic retinopathy, which caused a decrease in visual acuity in the non-traumatic eye. Among our patients, there is no known orthopedic, rheumatological or neurological disease that would reduce mobility.

The most common anterior segment findings in the unaffected eye were cataracts (79.3%) and pseudophakia (3.4%), while the most common fundus findings were diabetic retinopathy (6.9%), glaucoma-related optic atrophy (6.9%), and age-related macular degeneration (6.9%) (Table 5).

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows version 25. Categorical data are expressed as numbers and percentages, normally distributed continuous variables as mean and standard deviation and abnormally distributed median and minimum- maximum values. After distribution tests, normally distributed continuous

Table 3. Analysis of patient characteristics according to final visual acuity (quantitative variables)

Feature	Final VA ≤20/200 (N=18)		Final VA >20/200 (N=11)		p value
	Mean ± SD	Min-max	Mean ± SD	Min-max	
Age	69,1 ± 4,4	65-81	68,2 ± 6,2	65-85	0,657†
Inıtial VA (logmar)	2,90 ± 0,27	2,60-3,20	1,49 ± 0,96	0,40-2,60	0,001†
Ocular trauma score	51,9 ± 14,4	26-90	80,9 ± 9,4	70-90	<0,001†

†Student t test, VA: Visual Acuity, N: Number, SD: Standart Deviation

Table 4. Analysis of patient characteristics by final visual acuity (categorical variables)

Feature	Final VA ≤20/200 (N=18)	Final VA >20/200 (N=11)	p value
	N (%)	N (%)	
Age groups			0,671†
65-69	12 (66,7)	9 (81,8)	
70-85	6 (33,3)	2 (18,2)	
Sex			0,534†
Female	6 (33,3)	3 (27,3)	
Male	12 (66,7)	8 (72,7)	
Side			0,514†
Right	7 (38,9)	5 (45,5)	
Left	11 (61,1)	6 (54,5)	
Type of injury			0,060††
Penetrating	11 (61,1)	11 (100)	
Ruptur	6 (33,3)	0	
Perforating	1 (5,6)	0	
Location			0,111††
Zone I	8 (44,4)	9 (81,8)	
Zone II	2 (11,1)	1 (9,1)	
Zone III	8 (44,4)	1 (9,1)	
Size of injury			0,237†
≤5 mm	4 (22,2)	5 (45,5)	
>5 mm	14 (77,8)	6 (54,5)	
Ocular trauma score			<0,001††
Grade I	3 (16,7)	0	
Grade II	12 (66,7)	0	
Grade III	2 (11,1)	6 (54,5)	
Grade IV	1 (5,6)	5 (45,5)	
Grade V	0	0	
Initial VA			0,001†
≤20/200	18 (100)	5 (45,5)	
>20/200	0	6 (54,5)	
Time to presentation			0,110†
<12 hours	11 (61,1)	10 (90,9)	
>12 hours	7 (38,9)	1 (9,1)	

†: Fisher's Exact test, ††: Chi-square test, VA: Visual Acuity, N: Number

variables were analyzed between groups using Student's t-test, and abnormally distributed variables were analyzed using the Mann-Whitney U test. Categorical variables were compared using Fisher's exact and chi- square tests. Statistical significance was set at $p < 0.05$.

Tablo 5. Examination findings of the healthy eye

Feature	Frequency N (%)
Anterior segment	
Normal	5 (17,2)
Cataract	23 (79,3)
Pseudophakia	1 (3,4)
Fundus	
Normal	23 (79,3)
Diabetic Retinopathy	2 (6,9)

N: Number

DISCUSSION

Ocular trauma, particularly open-eye injury, is an important but largely preventable cause of unilateral blindness. According to the World Health Organization, an estimated 285 million people of all ages have visual impairment or blindness globally, and approximately 60 percent of these people are aged 50 years and above (12,13). In 2020, the leading cause of blindness in people aged 50 years and above was cataracts, followed by glaucoma, incompletely corrected refractive error, age-related macular degeneration, and diabetic retinopathy. The leading causes of visual impairment are incomplete correction of refractive errors and cataracts (13). Ocular trauma is the leading cause of monocular blindness worldwide. More than 55 million cases are reported each year, of which 1.6 million result in vision loss. Approximately 200,000 cases of ocular trauma involve open-globe injuries (14).

Age-related vision changes in geriatric patients are potential risk factors for serious eye injuries, and open-eye injuries are an important cause of blindness in the older population (15). In a study that analyzed 11,320 traumatized eyes, 51 percent of patients over the age of 60 years had a final visual acuity below 20/200 (legal level of blindness), and many of the traumas were preventable (16). In our study, the final visual acuity was 20/200 in 18 (62%) of the 29 patients who presented with open-globe injuries.

For all ages, men are more likely to be affected by eye trauma than women, which can be explained by the fact that men engage in more active work, sports, and dangerous activities. However, at 60 years and above, the ratio of affected women to men was almost equal. Studies have reported that women are more affected than men. This is because both sexes engage in similar activities after the age of 60 years (such as agricultural activities in the farm or garden) and are affected by factors such as retirement (5,17–19). In our study, the mean age was 68.8 ± 5.1 years and the men/women ratio was 2.2/1.

The main causes of ocular trauma in geriatric patients are falls, accidents in agricultural activities, and traffic accidents. Injuries mostly occur at home, on farms, and in gardens. (5,17,20,21). Some comorbidities (neurological, orthopedic, and psychiatric) in the geriatric population play an important role in the higher incidence of falls compared to young people.

When all age groups were included, open-eye injuries were mostly penetrating injuries. However, rupture-type injuries increased significantly in patients aged 60 years (9,11,20,22).

In our study, injuries were caused by accidents at home in 51.7% of patients. Penetrating injuries occurred in 22 of 29 patients. 24% of the patients stated that they were exposed to trauma because they were careless while doing housework, and 22% suffered trauma due to a fall caused by low vision. The majority of patients with outdoor trauma were injured by wood branch while cutting wood to light a stove or working in the garden.

To predict the anatomical and functional state of the affected eye in patients presenting with open-globe injury is important. Furthermore, to be able to talk to the patient in the above-mentioned direction, especially geriatric patients and those with low vision in the nonaffected eye is also significant. Certain parameters are used to predict prognosis. Factors such as wound location, wound size, affected area, ocular trauma score, and visual acuity at first admission can provide important clues for the prognosis and final visual outcome. Several studies have investigated these parameters.

Wounds larger than 5 mm, wounds involving zones II and III (sclera- retinal involvement, accompanying retinal detachment, optic nerve damage, and vitreous hemorrhage), low ocular trauma score, and low visual acuity at the first examination (hand motion, light perception, and no light perception) are associated with poor prognosis (23).

In this study, 23 of the 29 patients had a visual acuity of 20/200 or less at the time of first admission. Eighteen patients had a final visual acuity of 20/200 or less, and 11 had a final visual acuity greater than 20/200. The mean ocular trauma score of patients with a final visual acuity of 20/200 or less was lower than that of the other groups. Low visual acuity and ocular trauma scores were also important indicators for predicting prognosis, especially at first admission.

When previous studies are scanned, the average time for first application is between 0-6 hours. In this study 21(%72.4) of 29 patients were admitted to the emergency department or our ophthalmology clinic on the day of the trauma(between 0-12 hours after trauma). 7 patients were admitted between 12-24 hours and one of our patients was brought to us 28 hours after the trauma by a estranged relative who noticed that he was traumatized. Patients living alone and away from their families presented to the emergency department later than patients living with or close to their families.However, no findings such as infection or lower final visual acuity compared to other patients were detected related to late presentation.

Endophthalmitis is an important complication in patients presenting with open-globe injuries, and various studies have reported the prevalence of the condition (ranging from 1–10%). Additionally, endophthalmitis is a complication that may result in blindness and eye loss, hence the management

of the condition is important. Factors that increase the risk of developing endophthalmitis include intraocular foreign bodies, traumatic lens dislocation drop, intraocular tissue prolapse, and diabetes (24).

None of our patients had an intraocular foreign body, and 17 patients had accompanying uveal tissue prolapse, but no endophthalmitis was observed in any of our patients.

Evisceration was performed, and the prosthetic eye was used for aesthetic concerns, reducing the risk of sympathetic ophthalmia and increasing life expectancy in young patients with a final visual acuity of no light perception. However, geriatric patients have a shorter life expectancy and fewer aesthetic concerns compared to young patients, so the evisceration rate is lower. In our study, the final visual acuity was determined to be no light perception in seven patients, and evisceration was applied to two of these seven patients to prepare the ground for the prosthetic eye.

When we examined the eyes of patients in our study who were not affected by trauma, we observed pathologies such as cataracts, age-related macular degeneration, glaucoma, and diabetic retinopathy that reversibly and irreversibly reduced vision. Treatment and follow-up are extremely important in patients with diabetes mellitus, which may result in the paradox of falling and cause repetitive trauma due to low vision. Diabetes may also limit the patient's daily activities and independence. Low vision may also psychologically affect patients (25).

We believe that trauma in elderly patients may be caused by lower energy traumas unlike young patients. Simple home accidents may result in serious penetrating or perforating injuries. Most falls in the geriatric population occurred while walking (20). The rate of open-globe injuries because of falls in the geriatric population is extremely high at 65% compared with only 4% in persons younger than 65 years (20). Surgical incisions due to previous surgical history and age-related decreases in corneal and scleral collagen cross-links responsible for the integrity of the cornea and sclera are thought to be the reasons for this.

CONCLUSION

Rehabilitation and follow-up processes, especially in individuals over 65 years of age, are needed to prevent eye trauma that reduces vision or results in legal blindness, to maintain the independence of participation in daily activities that may occur after trauma, and to overcome the psychological effects that result, especially due to low vision. Therefore, increasing public awareness is important.

Conflicts of interest: No conflict of interest.

REFERENCES

1. Kuhn F, Morris R, Witherspoon CD, Heimann K, Jeffers JB, Treister G. A standardized classification of ocular trauma. Ophthalmology. 1996 Feb;103(2):240-3. PMID: 8594508. (DOI: 10.1016/s0161-6420(96)30710-0)
2. El-Sebaity DM, Soliman W, Soliman AM, Fathalla AM. Pediatric eye injuries in upper Egypt. Clin Ophthalmol. 2011;5:1417–23. (DOI: 10.2147/OPTH.S24679)
3. Khatry SK, Lewis AE, Schein OD, Thapa MD, Pradhan EK, Katz J. The epidemiology of ocular trauma in rural Nepal. Br J Ophthalmol. 2004;88(4):456–60. (DOI: 10.1136/bjo.2003.030700)
4. Soylu M, Sizmaz S, Cayli S. Eye injury (ocular trauma) in southern Turkey: epidemiology, ocular survival, and visual outcome. Int Ophthalmol. 2010;30(2):143–8. (DOI: 10.1007/s10792-009-9300-4)
5. Onakpoya OH, Adeoye A, Adeoti CO, Ajite K. Epidemiology of ocular trauma among the elderly in a developing country. Ophthalmic Epidemiol. 2010 Oct;17(5):315-20. PMID: 20868258. (DOI: 10.3109/09286586.2010.508352)
6. Aghadoost D, Fazel MR, Aghadoost H, Aghadoost N. Pattern of ocular trauma among the elderly in Kashan, Iran. Chin J Traumatol. 2013;16(6):347-50. PMID: 24295581. (DOI: 10.4103/JETS.JETS_90_16)
7. United Nations DoE, Social Affairs PD. World Population Ageing [e-book] (ST/ ESA/SER. A/348). 2013. [Internet] Available from: https://digitallibrary.un-.org/record/826632 Accessed: 01.09.2023.

8. Sahraravand A, Haavisto AK, Holopainen JM, Leivo T. Ocular trauma in the Finnish elderly - Helsinki Ocular Trauma Study. Acta Ophthalmol. 2018 Sep;96(6):616-622. Epub 2018 Apr 16. PMID: 29659145. (DOI: 10.1111/aos.13714)

9. Zamani M, Tabatabaei SA, Fotouhi A, Naderan M, Soleimani M. Open globe injuries in geriatric population in Iran: characteristics and outcomes. Int J Ophthalmol. 2021 Aug 18;14(8):1237-1240. PMID: 34414090; PMCID: PMC8342302. (DOI: 10.18240/ijo.2021.08.16)

10. Kaneko H, Asami T, Sugita T et al. Better Visual Outcome by Intraocular Lens Ejection in Geriatric Patients with Ruptured Ocular Injuries. PLoS One. 2017 Jan 20;12(1): e0170094. PMID: 28107485; PMCID: PMC5249204. (DOI: 10.1371/journal.pone.0170094)

11. Tök L, Yalçın Tök Ö, Özkaya D et al. Characteristics of open globe injuries in geriatric patients. National Journal of Trauma and Emergency Surgery. (in Turkish) 2011 Sep;17(5):413-8. PMID: 22090326.

12. Pascolini D, Mariotti SP. Global estimates of visual impairment: 2010. Br J Ophthalmol. 2012 May;96(5):614-8. Epub 2011 Dec 1. PMID: 22133988. (DOI: 10.1136/bjophthalmol-2011-300539)

13. GBD 2019 Blindness and Vision Impairment Collaborators; Vision Loss Expert Group of the Global Burden of Disease Study. Causes of blindness and vision impairment in 2020 and trends over 30 years, and prevalence of avoidable blindness in relation to VISION 2020: the Right to Sight: an analysis for the Global Burden of Disease Study. Lancet Glob Health. 2021 Feb;9(2):e144-e160. doi: 10.1016/S2214-109X(20)30489-7. (DOI: 10.1016/S2214-109X(20)30489-7)

14. Négrel AD, Thylefors B. The global impact of eye injuries. Ophthalmic Epidemiol. 1998 Sep;5(3):143-69. PMID: 9805347. (DOI: 10.1076/opep.5.3.143.8364)

15. Namazova IK. [To the analysis of outcomes and severity of eye trauma in elderly patients]. Vestn Oftalmol. 2014 Jul-Aug;130(4):34-8. Russian. PMID: 25306721.

16. Kuhn F, Morris R, Witherspoon CD, Mann L. Epidemiology of blinding trauma in the United States Eye Injury Registry. Ophthalmic Epidemiol. 2006 Jun;13(3):209-16. PMID: 16854775. (DOI: 10.1080/09286580600665886)

17. Andreoli MT, Andreoli CM. Geriatric traumatic open globe injuries. Ophthalmology. 2011 Jan;118(1):156-9. Epub 2010 Aug 14. PMID: 20709403. (DOI: 10.1016/j.ophtha.2010.04.034)

18. Chocron IM, Goduni L, Poulsen DM, MbekeanI JN. Patterns of ocular trauma in elderly patients in an urban population-the Bronx experience. Arq Bras Oftalmol. 2020 Mar-Apr;83(2):113-119. PMID: 32159593. (DOI: 10.5935/0004-2749.20200025)

19. Cillino S, Casuccio A, Di Pace F, Pillitteri F, Cillino G. A five-year retrospective study of the epidemiological characteristics and visual outcomes of patients hospitalized for ocular trauma in a Mediterranean area. BMC Ophthalmol. 2008 Apr 22;8:6. PMID: 18430231; PMCID: PMC2387139. (DOI: 10.1186/1471-2415-8-6)

20. Sheng I, Bauza A, Langer P, Zarbin M, Bhagat N. A 10-year review of open-globe trauma in elderly patients at an urban hospital. Retina. 2015 Jan;35(1):105-10. PMID: 25127048 (DOI: 10.1097/IAE.0000000000000261)

21. Beshay N, Keay L, Dunn H, Kamalden TA, Hoskin AK, Watson SL. The epidemiology of Open Globe Injuries presenting to a tertiary referral eye hospital in Australia. Injury. 2017 Jul;48(7):1348-1354. Epub 2017 Apr 18. PMID: 28438416.(DOI: 10.1016/j.injury.2017.04.035)

22. Supreeyathitikul P, Chokesuwattanaskul S, Choovuthayakorn J et al. Epidemiology and Outcomes Following Open Globe Injury in Agricultural Region, an 11-Year Experience. Ophthalmic Epidemiol. 2020 Aug;27(4):246-251. Epub 2020 Jan 29. PMID: 31994961. (DOI:10.1080/09286586.2020.1716381)

23. Fujikawa A, Mohamed YH, Kinoshita H et al. outcomes and prognostic factors in open-globe injuries. BMC Ophthalmol. 2018 Jun 8;18(1):138. PMID: 29884145; PMCID: PMC5994054. (DOI: 10.1186/s12886-018-0804-4)

24. Faghihi H, Hajizadeh F, Esfahani MR et al. Posttraumatic endophthalmitis: report No. 2. Retina. 2012 Jan;32(1):146-51. PMID: 21775927. (DOI: 10.1097/IAE.0b013e3182180087)

25. Guo X, Arsiwala LT, Dong Y, Mihailovic A et al. Visual Function, Physical Function, and Activities of Daily Living in Two Aging Communities. Transl Vis Sci Technol. 2021 Dec 1;10(14):15. PMID: 34913953; PMCID: PMC8684303. (DOI: 10.1167/tvst.10.14.15)