Open-globe-injury: A single center Spanish retrospective 5-year cohort study

Purpose: To review and analyze the epidemiological profile, clinical characteristics and visual outcomes in patients attended for traumatic open globe injury (OGI) at our hospital over a 5-year period.

Design: Retrospective chart review study.

Methods: Retrospective analysis of all patients attended at Fundación Jiménez Díaz University Hospital for OGI between 2011 and 2015. Data from 104 patients including demographics, ocular examination, medical and surgical treatment, visual outcomes, and complications were analyzed.

Results:

Most patients were male (79.8%) and the median age at the time of injury was 41 years (interquartile range 31.5-58 years). Work-related accidents represent more than half of the cases and their main mechanism was penetrating trauma or foreign body. This type of accident had good prognosis (median final visual acuity in decimal scale 0.8; interquartile range: 0.4-1). Falls were the second most common cause of OGI, predominantly affecting senior women (50%), with a high incidence of ocular rupture (50%) and associating a poor visual prognosis (median final visual acuity 0.01; interquartile range: 0-0.5). There was a strong correlation (0.75; $p<0.001$) between ocular trauma score (OTS) and final best corrected visual acuity.

Conclusions: Two different patterns of OGI were identified in our sample. Work-related trauma in young males was the most common form of OGI, and was associated

with good prognosis. However, falls in senior women were associated with poor prognosis.

Introduction

Ocular trauma is a major but preventable public health problem worldwide, causing significant visual morbidity, unilateral blindness and a great socio-economic burden[1, 2].Previous publications have described factors affecting visual prognosis after trauma [3-6]. Initial visual acuity seems to be the most important, although other factors such as age, wound length and type of surgery also influence the outcome. The Ocular Trauma Score (OTS) was developed to establish visual prognosis. This tool evaluates preoperative characteristics such as initial visual acuity, ocular rupture, endophthalmitis, perforating trauma, retinal detachment and relative afferent pupillary defect [3].

Open globe injury (OGI) is defined according to the Birmingham Eye Trauma Terminology system (BETTS) as a full-thickness wound of the eyewall and the mechanisms of injury include rupture, penetration, intraocular foreign body, perforation, and mixed injury [3].Despite efforts to prevent these injuries, the global incidence rate of OGI is between 2-6 per 100 000 people/year[7], making them a common reason for visiting emergency departments; in most cases they require emergency surgery[5]. Several studies have focused recently on ocular trauma, but few European series have been reporte[8]

Fundación Jimenez Díaz University Hospital is a tertiary referral center that serves an area of 815 000 inhabitants in Madrid, Spain. The number of ophthalmological emergencies that are evaluated in the hospital are about 13 000 per year. The aim of this study was to review the characteristics of patients with OGI who attended our center, a tertiary European urban hospital, over a 5-year period spanning from January 2011 to December 2015. The characteristics of ocular injuries, surgical management and subsequent complications were analyzed. These data were used to determine the relationship between these events and the final visual outcome.

Materials and Methods

A retrospective analysis of anonymized patient data obtained from the electronic medical records of the Fundación Jiménez Díaz was carried out following approval from the institutional review board and the ethics subcommittee of the Universidad Autónoma de Madrid Medical School.

The main inclusion criterion was the diagnosis of OGI, attended between 2011 and 2015. Selection was performed by diagnostic coding. Search codes used were: penetrating injury OR perforating injury OR intraocular foreign body OR full thickness rupture of the ocular wall.

The studied variables were:

-Age and gender.

-Injured eye (left/right).

-OGI type according to the BETT classification injure mechanism (i.e. penetrating injury, perforating injury, intraocular foreign body, ocular rupture).

-Cause of the injury (work-related accident, fall, assault, home accident, hunting accident, traffic accident, sport accident, do it yourself accident).

-Segment involved: anterior, posterior, both.

-Previous ocular morbidity.

-Best corrected visual acuity at presentation (BCVAP).

-OTS at presentation.

-Surgical procedures performed.

-Adjuvant medical treatment post-surgery.

-Postoperative complications.

-Follow-up period (in days).

-Final best corrected visual acuity (FBCVA).

To analyze the epidemiology of the different etiologies, we divided our sample into three groups (young, between 0-18 years; middle age, between 18 and 65 years-old; senior citizens, over 65 years-old). OGI was very rare in young subjects (only 4 cases).

BCVAP and FBCVA were measured by means of a Snellen chart, using decimal equivalents to reflect results and establishing numerical values of 0.01 for "counting fingers", 0.001 for "hand movement," and 0.0001 for "light perception," thus making a statistical analysis of this variable possible. This conversion follows Holladay recommendations,[9] except for light perception.

Statistical analysis was performed using the **IBM SPSS** Statistics version **25** (**IBM**, Armonk, NY, USA). Normality was tested using Kolmogorov Smirnov test. Most of the studied variables did not follow a normal distribution, so quantitative variables were expressed as median and interquartile range. Spearman correlation coefficient was chosen to establish relations between the different variables and the Mann Whitney U test was used to compare them. Variables were represented using Boxplot graphs. P values <0.05 were considered statistically significant.

The predictive value of BCVAP and OTS was evaluated. OTS was calculated for all patients in the study. The formula used to calculate OTS can be consulted online (3). The distribution of visual acuities was not Gaussian because many patients have very low visual acuities at their initial visit. OTS followed a similar distribution. Therefore, median and interquartile range were preferred over mean and standard deviation to

express these variables and Boxplot graphs were chosen to reflect the influence of the type of accident on visual acuity and OTS.

Results

We identified 104 eyes from 104 patients who had been diagnosed with OGI at our hospital´s emergency department over the 5-year study period. This represents an incidence of 2.6 OGI/ 100 000 inhabitants/ year. OGI represented 1.6/ 1 000 emergencies seen during the study period. Surgical procedures were performed during the first 24-48 hours by the emergency staff, during the initial emergency visit.

The median **age** at the time of injury was 41 years, with a clear gender difference; 78 years in women and 38 years in men. The age and gender distribution of the sample is reported in **Figure 1.** The studied sample contained a broad majority of males, with 83 **men** (79.8%) and 21 **women** (20.2%). Median **follow up time** (from presentation to last visit) was 381 days (interquartile range: 132-879).

Figure 1. Age and gender distribution of the studied sample.

Both **eyes** were equally involved, with 49 right eyes (47.1%) and 55 left eyes (52.9%) affected. There were no cases with bilateral involvement.

Penetration, perforation and intraocular foreign body were the most common **mechanisms.** In the group of senior subjects, accidents were more common in women than in men and the main causes of OGI were home accidents and falls. This last type of accident explains why the most common mechanism of injury is ocular rupture in this group. *(Table 1).*

Table 1. Type of accident and mechanism according to age and gender.

A statistically significant relationship ((χ^2 test =0.001) was found between **cause** and OGI type *(Table 2)*, so that intraocular foreign body was the most common injury in patients who had been involved in a work-related accident.

Table 2. Causes and OGI type.

Likewise, intraocular foreign body represents 86% (36/42) of the work-related accidents attended at our center. Rupture was the most common OGI found after falls (50%). Indeed, a significant difference was found between the age of patients who had suffered a fall (median age 80.50 years) and the age of the remaining sample (median age 38.50 years), p=0.0000001, Mann-Whitney test .

Figure 2 shows the relationship between the type of accident and visual acuity and OTS values at presentation. 6 out of 104 patients were excluded from this relationship because their BCVAP was not registered. FBCVA was better when the trauma was caused by a work-related accident (0.8 (0.4-1)) than for other causes (0.01 (0-0.6)),p=0.00002, Mann-Whitney test.

Figure 2. Different causes of OGI: initial and final visual acuity.

Isolated anterior **chamber involvement** was present in 49.0% of OGI and was more common in penetrating injuries, while isolated posterior segment involvement was present only in 5.8% of cases. Both segments were affected in 45.2% of cases, including the majority of intraocular foreign bodies and ruptures. When taking patient gender into account, 50.6% of men had isolated involvement of the anterior segment, 7.2% isolated involvement of the posterior segment and 42.2% had injuries that affected both segments. On the other hand, 42.9% of women had involvement exclusively of the

anterior segment and 57.1% of both segments. No statistical association was found between segment involvement and gender (p=0.279, $\chi 2$ test).

Regarding **visual morbidity** prior to OGI, 38 patients (36.5%) presented ocular pathologies before sustaining ocular trauma, including amblyopia, herpes keratitis, cataract, glaucoma or prior retinal detachment. FBCVA was significantly associated with previous ocular morbidity. Median FBCVA was 0.8 (interquartile range: 0.1-1) in the group without previous pathology and 0.1 (interquartile range: 0-0.7), in the group with previous ocular pathology.

Only 6 patients did not have the best **BCVAP**, as a result, OTS could not be calculated, and they were not excluded from this analysis. Median BCVAP was significantly better in work-related accidents (0.2 (0.001-0.73)) than in falls (0.0001 (0.0001-0.01)).

The median value of **OTS** was 73.6±22.2 (range:16-100), and there were statistically significant gender differences (p<0.001).

The number and type of surgical procedures performed are recorded in *Table 3.* Corneal and scleral suture were the most common procedures. The prognostic value of the number of surgical procedures was studied using Spearman correlation coefficient. We did not find correlations between the number of surgical procedures and BCVAP (p=0.693), FBCVA (p=0.386) and OTS (0.785).

Table 3. Surgical procedures: number and distribution according to gender.

The use of topical and systemic **antibiotics** and topical and systemic **corticosteroids** after surgery was also analysed. Most patients received both topical and systemic antibiotics during the first days after trauma. Almost all patients, 103 patients (99.0%), were prescribed topical antibiotics, while 90 (86.5%) patients received antibiotics

systemically. Systemic antibiotics were not prescribed for small, clean wounds. Ninety-nine patients (95.2%) underwent therapy with corticosteroids.

Complications developing during follow-up are listed in *Table 4.*

Table 4. Complications during follow-up.

Retinal detachment developed in 10% of eyes. There was only one case of subacute endophthalmitis. Statistically significant differences in FBCVA were found between patients with initial retinal detachment (median 0.01,interquartile range: 0.001-0.1) and those who did not develop this complication (median 0.01,interquartile range: 0.001-0.1, p=0.017 Mann-Whitney U test.

FBCVA was better in men (median 0.75; interquartile range: 0.01-1), than in women (median 0.001; interquartile range: 0-0.48), p=0.00016, Mann-Whitney U test. FBCVA was also moderately correlated with BCVAP (Spearman correlation coefficient 0.66; p<0.001) and OTS (Spearman correlation coefficient 0.66; p<0.001).

Eyes with an intraocular foreign body had a better FBCVA (median 0.85) compared to those sustaining other type of lesions (median FBCVA 0.4), p=0.01, Mann-Whitney U test.

Discussion

To our knowledge this is the first study that analyzes the epidemiology of OGI in Spain. The incidence of 2.6 OGI/100 000 inhabitants/year is in the lower end of the range reported by other authors (incidences between 2-6/100 000 inhabitants/year have been reported)[7]. However, this incidence is just an estimation because our hospital works for insurance companies, so work-related accidents are probably over-represented in our series. On the other hand, some patients of our area could have sought attention at other hospitals.

At our center, any ophthalmological issue is attended directly by the ophthalmologist on call. No other medical specialties treat patients that consult ocular pathologies. The first exploration is performed in the slit lamp of the emergency department. Suspicion of ocular trauma is priorized the first in order of attendance. Fluorescein and anesthetic are used in monodose. Fast is compulsory since the perforation, penetration or the intraocular foreign body is diagnosed. The patient must sign an informed consent for exploration, surgical procedure and anesthesia. Blood analysis including coagulation and electrocardiogram were done before transferring the patient to the operating theatre. The systemic antibiotic in our OGI protocol was levofloxacin, intravenous during their hospitalization and orally after. The posology was 500mg/24hours for one week. If the patient was allergic to quinolones, amoxiciline was used instead.

In the last years logMar visual acuity is emerging as the standard form for reporting visual acuity. However in our series visual acuity was measured using a decimal scale in the emergency room. Visual acuity measured in this conditions is not very accurate. This limitation is common to most of the studies in this field. This limitation in the precision of visual acuity data and the non-normal distribution of this variable (clearly skewed towards low values), lean us towards a non-parametric approach. This conversion follows Holladay recommendations, except for light perception.[9] Holladay considers that light perception is not proper VA, and thereby it should have been translated into 0. However, doing so would have placed in the same group eyes with light perception and amaurotic eyes. Since the analysis have been made using non parametric tests, this variation of one thousandth in the group of light perception patients should not have significantly modified the results.

When studying our series gender distribution, we found a 4 to 1 male to female ratio. This ratio is similar to previous reports on OGI from other countries[7, 10-14], as well as other traumatic ocular pathologies[15]. Similarly, the most common cause of OGI was work-related accidents in middle-aged men, in accordance with previous reports[6, 13, 16-18]. Thus, work-related trauma remains an important cause of avoidable visual morbidity, which may be lowered by implementing a culture of safety at the workplace.

The mean **age** of the women included in the study (69.8 years) was significantly higher than the age of the men (40.4 years), which is in agreement with other published studies[1, 5-7, 10, 13]. Median age in the group of patients who suffered a fall (80.5 years) was twice the median age of the patients of the other groups (38.5 years). Two different patterns of accidents with different prognosis were clearly identified: occupational trauma in young men versus falls in senior women. It follows from this that in developed countries, where the population is aging progressively, there is an increasing risk of falls among older individuals due to the fragility and instability of these patients, which could lead to an increased risk of OGI. The longer life expectancy of women probably explains why women represent the majority of patients in the fall group. This situation, therefore, creates a need for effective strategies to prevent falls, such as maintaining appropriate lighting in patients' homes and eliminating obstacles, such as rugs or objects left on the floor.

In one recently published Japanese series the right eye was more frequently involved than the left eye; the authors related this finding to handedness[5]. However, in most series, as in ours, both **eyes** were equally involved.

When studying the **OGI type**, penetrating injury and intraocular foreign body were the most common, with similar frequencies (43 and 42 out of 104 respectively). Rupture

was present in 18 cases and the least frequent type was perforating injury with only one case.

Regarding the **causes** of OGIS, in our series only one case of OGI took place during a car accident, and although hunting is a common activity in Spain, only two cases happened as a result of hunting accidents. This might be due to the improvements in car security, traffic and hunting legislation. In addition, the most frequent cause of OGI among women were falls, which are associated with older age.

Although gender differences are clearly linked to the sort of accident, the higher pre-existing **visual morbidity** among females (81% had a previous ocular condition) may have played a role and is associated with their older age. Liu et al, in their series of 374 intraocular foreign bodies, found that age over 50 years was an independent prognostic factor[11].

The **BVCAP** registered was very low. Assault, home accidents and falls had the same median (0.0001). Work-related accident had the highest median (0,2) and the rest of causes, 0.001.

The median value of **OTS** was 74, with statistically significant gender differences

We expected to find some correlation between the number of **surgical procedures** and visual prognosis (more procedures in more damaged eyes). Nevertheless, we did not find any correlation with BCVAP, FBCVA or OTS. Maybe some eyes that are damaged beyond reparation are not submitted to surgical procedures, whilstless damaged eyes that have a better prognosis do undergo surgery.

As regards **complications**, one surprising finding in our series is the very low incidence of endophthalmitis (only one case). The prevalence of endophthalmitis after open eye trauma has been reported to be between 4% and 8%, with a higher (6.9% to 30%) in the

presence of intraocular foreign bodies[19]. A study conducted in China on 1701 eyes with intraocular foreign bodies found an incidence of 16.4%[20]. Our low rate of endophthalmitis could be related to Madrid`s extended healthcare system, which provides easy access and allows prompt attention to OGI patients, as well as the systematic use of both topical and systemic prophylactic antibiotics. Furthermore, corneal wound closure took place at an early stage (<24–48 h). A study conducted in Massachusetts concluded that a protocol based on emergency surgery and 48 hours of intravenous antibiotic treatment was associated with a lower than 1% incidence of endophthalmitis, and as a result the authors recommended prophylactic administration of systemic antibiotics[21]. Other authors have also found very low incidences of endophthalmitis. The exact reason is still unclear. Some authors think that this reduction is due to early attention of OGI patients others relate this fact to age, intraocular foreign body location and type of lesion, or else to the expansion of fourth generation quinolones[4].

FBCVA following OGI was better when the trauma was caused by a work-related accident (median VA 0.8), than for other causes (median VA 0.01). A similar finding was reported in a study carried out in Japan[5]. We also observed better FBCVA in patients who presented with intraocular foreign body (median VA 0.85) than in the rest of the sample (median VA 0.4). Since the most common OGI type in work-related accidents was intraocular foreign bodies, which are more frequent in men, this probably explains that the final visual outcome was better in men (median FBCVA 0.75), than in women (median FBCVA 0.001).

As in other studies[6, 13, 14, 19, 22] a positive correlation was found between BCVAP, OTS, and FBCVA, leading us to the assumption that both visual acuity prior to surgery as well as OTS are useful indicators in predicting final visual outcome.

We acknowledge several limitations in our study, such as the fact that it is a single center case series and the retrospective nature of the study. As mentioned, we might see a higher rate of work-related accidents. The type of foreign body was not always reported. Visual acuity was registered using decimal scale. LogMar scale is not usually used in the emergency department.

Conclusions

Most of the patients who sustained an OGI were men, and the primary cause was a work-related accident. Women with OGI were older than men. The most common cause of OGI among senior subjects was falls. Both BCVAP and OTS were predictive of FBCVA. Efforts should be made to prevent these often devastating injuries, both by promoting eye safety and protection in the workplace and also by taking measures to prevent falls in the elderly.

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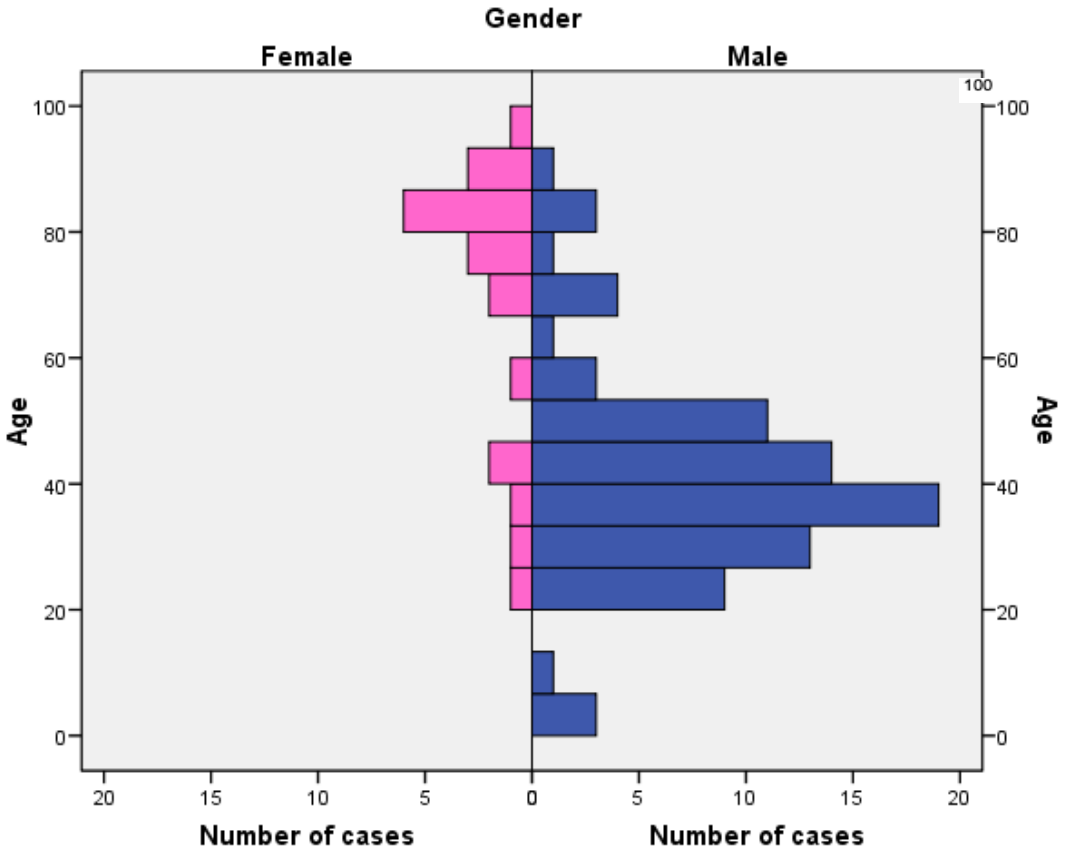

Figure 1. Age and gender distribution of open globe injuries in our series.

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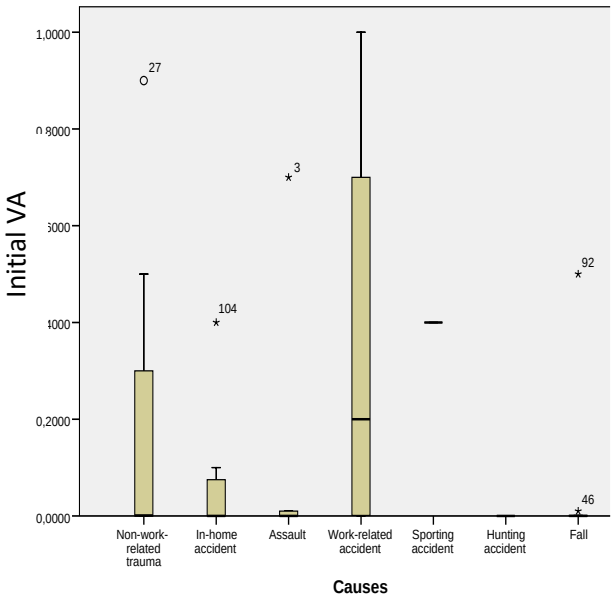

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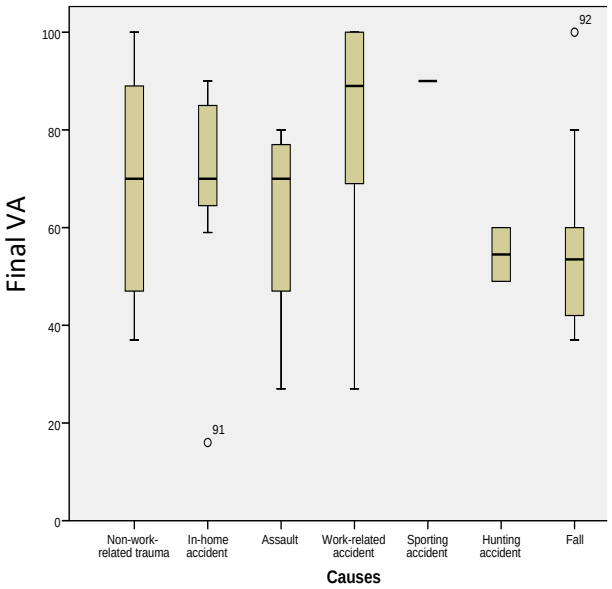

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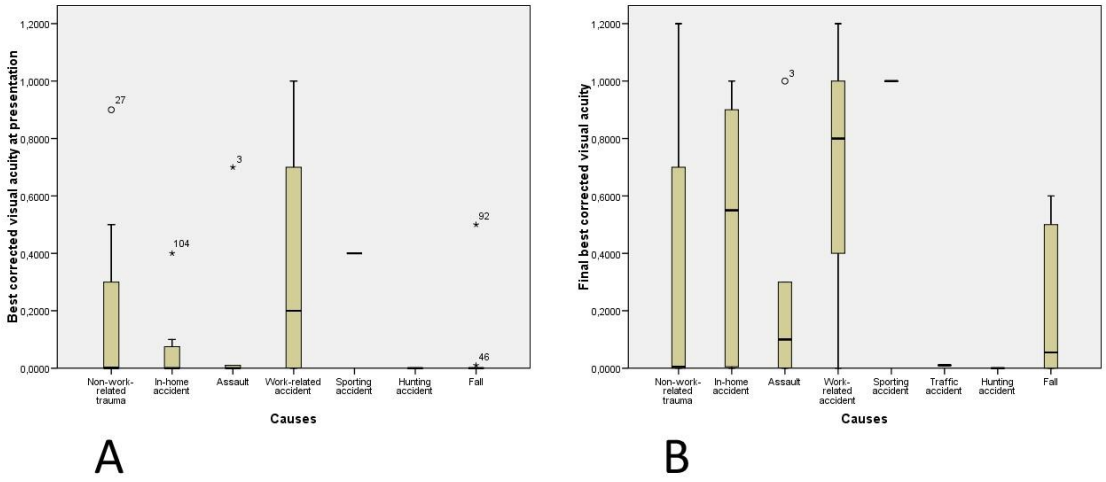

Figure 2. Different causes of OGI: initial and final visual acuity.

	Young (<18)		Working age (18-65)		Senior(>65)		Total
	Female	**Male**	**Female**	**Male**	**Female**	**Male**	
Type of accident:							
Street violence	-	1	1	3	-	-	5
Hunting accident	-	-	-	1	-	1	2
Sport accident	-	-	1	-	-	-	1
Traffic accident	-	-	1	-	-	-	1
Work-related accident	-	-	**1**	**58**	-	-	59
In home accident	-	1	-	2	4	1	8
Fall	-	-	-	2	**8**	**4**	14
Other	-	2	2	4	3	3	16
Total	-	4	6	70	15	9	104
Type of mechanism:							
Perforating injury	-	-	-	1	-	-	1
Penetrating injury	-	2	5	28	8	-	43
Intraocular foreign body	-	1	-	38	-	3	42
Rupture	-	1	1	3	7	6	18
Total	-	4	6	70	15	9	104

Table 1. Type of accident and mechanism according to age and gender.

	Intraocular foreign body	Penetrating injury	Perforating injury	Rupture	Total
Street violence	-	2	-	3	5
Hunting accident	2	-	-	-	2
Sport accident	-	1	-	-	1
Traffic accident	-	1	-	-	1
Work-related accident	36	20	1	2	59
In home accident	-	5	-	3	8
Fall	1	6	-	7	14
Other	3	8	-	3	14
Total	42	43	1	18	104

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394 **Table 2.** Causes and mechanisms of open-globe injury.

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Surgical procedures	Total number (%) of surgeries	Men (%) /women (%)
Scleral suture	48 (46.2)	37(44.6) /11(52.4)
Corneal suture	52 (50.0)	41(49.4) /11(52.4)
Eyelid suture	6 (5.8)	4(4.8) /2(9.5)
Anterior chamber washout	27 (26.0)	16(19.3) /11(52.4)
Iridectomy	12 (11.5)	6(7.2) /6(28.6)
Lensectomy	22 (21.2)	21(25.3) /1(4.8)
Intraocular lens removal	5 (4.8)	2(2.4) /3(14.3)
Intraocular lens implantation	9 (8.7)	8(9.6) /1(4.8)
Intraocular foreign body removal	34 (32.7)	34(41.0) /0(0.0)
Anterior vitrectomy	13 (12.5)	5(6.0) /8(38.1)
Posterior vitrectomy	26 (25.0)	26(31.3) /0(0.0)
Endolaser	12 (11.5)	12(14.5) /0(0.0)
Cryotherapy	7 (6.7)	7(8.4) /0(0.0)
Buckling	2 (1.9)	2(2.4) /0(0.0)
Intracameral antibiotic injection	21 (20.2)	14(16.9) /7(33.3)
Intravitreal injection of antibiotics	2 (1.9)	2(2.4) /0(0.0)
Gas tamponade	11 (10.6)	11(13.3) /0(0.0)
Silicone oil tamponade	4 (3.8)	4(4.8) /0(0.0)
Evisceration	5 (4.8)	3(3.6) /2(9.5)

Table 3. Surgical procedures: number and distribution by gender.

Complications during follow-up	Total number (%)	Men (%)/ women (%)
Retinal detachment	11(10.6)	9(10.8) /2(9.5)
Endophthalmitis	1(1.0)	0(0.0) /1(4.8)
Post-traumatic aphakia	9(8.7)	9(10.8) /0(0.0)
Traumatic cataract	13(12.5)	11(13.3) /2(9.5)
Microbian keratitis	2 (1.9)	2(2.4) /0(0.0)
Corneal leukoma	4(3.8)	4(4.8) /0(0.0)
Ocular hypertension	4(3.8)	3(3.6) /1(4.8)
Wound leakage requiring suture	6(5.8)	6(7.2) /0(0.0)
Amniotic membrane transplantation	1(1.0)	1(1.2) /0(0.0)
Phthisis bulbi requiring evisceration	7(6.7)	4(4.8) 3(14.3)

Table 4. Complications during follow-up