**Determinants of Visual Outcomes in Open Globe Injuries: A 5-Year Retrospective Study from a Tertiary Hospital in Northern Tanzania**

**ABSTRACT**

**Objectives:** This study aimed to assess factors affecting visual outcomes among Open Globe Injury (OGI) patients attending the KCMC eye department from 2015 to 2020.

**Methodology:** A retrospective review of medical records was conducted for Open Globe Injury (OGI) patients aged three years and above, excluding those with missing data, prior trauma, or pre-existing ocular diseases. Data were analyzed using SPSS version 27 and STATA version 17. Categorical variables were summarized using frequencies and percentages, while numerical variables were analyzed using means and interquartile ranges. The chi-square test assessed differences in postoperative visual acuity (VA), and a modified Poisson regression model identified factors associated with poor VA (p<0.05 considered significant).

**Results:** A total of 184 open globe injury patients were included, with a majority being male (70.1%) and from rural areas (80.4%). Penetrating injuries were the most common (60.9%), and Zone I injuries predominated (59.3%). Only 29.9% achieved good postoperative best-corrected visual acuity (BCVA). Poor visual outcomes were associated with delayed surgery (>2 hours post-injury), larger ocular injuries, type of globe injury, anterior chamber status, and type of ocular surgery.

**Conclusion:** Poor visual outcomes following Open Globe Injuries remain a significant concern at KCMC, with less than one-third of patients achieving good postoperative visual acuity. Delayed surgical intervention, extent and type of injury, anterior chamber involvement, and the surgical approach were significant determinants of visual prognosis. These findings highlight the importance of early presentation and timely management to improve visual outcomes in affected patients. Furthermore, the results emphasize the need for increased public health efforts to raise awareness about eye protection, particularly among individuals in high-risk occupations, to reduce the incidence of preventable ocular trauma.

**Keywords:** Open-Globe Injury, Penetrating eye injury, Perforation eye injury, Intraocular foreign body (IOFB), Globe rupture, Visual Acuity

## **INTRODUCTION**

Ocular injuries are a major global cause of visual impairment and blindness, with about 55 million cases annually, 19 million of which lead to vision loss (Bian *et al.*, 2020) . These injuries result from trauma, chemical exposure, or foreign bodies and are classified into closed and open globe injuries (OGIs). Closed globe injuries do not breach the full thickness of the eye wall, while OGIs involve a full-thickness wound and are further classified into ruptures from blunt trauma and lacerations from sharp objects(Jeffery, Dobes and Chen, 2022)

The incidence of blindness from ocular injuries varies geographically, averaging approximately 9 per 100,000 in developed regions and soaring to around 75 per 100,000 in developing countries (World Health Organization, 1998). In Western nations, ocular trauma ranges from 14.4% to 21.1%, but in sub‑Saharan Africa, it accounts for about 27% of monthly eye emergency visits (Voon, See and Wong, 2001). In Tanzania, Sachedina et al. (2023) reported a 5.1% ocular injury rate, of which 85.9% were unilateral.(Sachedina *et al.*, 2023)

OGIs affect all age groups but are most common in young to middle-aged adults(Zungu *et al.*, 2021). Studies in Tunisia and Lithuania reported average ages of 31.9 and 41.9 years respectively, with a notable male predominance(Puodžiuvien, 2021). Major causes include domestic accidents, assaults, workplace injuries, and traffic incidents (Batur *et al.*, 2016; Jac-Okereke *et al.*, 2021)

Classification of OGIs is critical for predicting outcomes. Injuries are categorized by mechanism—rupture, IOFBs (Rice and Steffen, 2016)penetrating, or perforating injuries—and severity, based on initial visual acuity, from grade 1 (≥6/12) to grade 5 (no light perception) (Mayer *et al.*, 2021). Anatomically, injuries are divided into three zones: Zone I (cornea), Zone II (corneoscleral limbus), and Zone III (posterior segment), with Zone III injuries usually having the poorest outcomes. The Ocular Trauma Score (OTS) predicts prognosis using factors such as relative afferent pupillary defect, endophthalmitis, retinal detachment, and perforation, where lower scores indicate worse outcomes (Dutoit, Mustak and Cook, 2015; Mayer *et al.*, 2021). Evidence from Thailand, South Africa, and India shows that the Ocular Trauma Score (OTS) remains a useful tool for predicting visual outcomes, even in settings with limited resources. The score has shown good consistency with actual patient results, reinforcing its practical value in everyday clinical use(Pahor and Gracner, 2021; Watanachai *et al.*, 2023; Oughtkaew and Puangrab, 2024)

OGIs are difficult to manage due to their complexity and potential complications. Early surgical repair is vital to preserve eye structure and improve visual prognosis (Rahman *et al.*, 2006).Even with severe trauma, primary surgery can lead to globe salvage and vision recovery. However, in many cases, delayed presentation hinders timely intervention, raising the risk of infection and poor visual outcomes (Shrestha *et al.*, 2021). Secondary procedures such as iris or strabismus repair and vitrectomy may also be necessary(Zhou *et al.*, 2022)

Several clinical predictors of poor visual outcomes include age, gender, injury type, initial vision, IOFBs, cataracts, hyphema, uveal prolapse, intraocular pressure, injury zone, vitreous hemorrhage, retinal detachment, and corneal scarring. Despite treating over 100 OGI cases annually, Kilimanjaro Christian Medical Centre (KCMC) in the northern part Tanzania lacks data on visual outcomes. This study aims to evaluate visual outcomes among OGI patients treated at KCMC from 2015–2020, focusing on how injury characteristics, treatment timing, and management influence postoperative best-corrected visual acuity (BCVA), with the hypothesis that delays and severe injuries predict poorer outcomes.

**METHODOLOGY**

**Study Design and Settings**

This study was a retrospective study of medical records of patients diagnosed with open globe injuries (OGI) at Kilimanjaro Christian Medical Centre (KCMC) between January 2015 and December 2020. Conducted in the Eye Department of KCMC, a major referral and teaching hospital, the study focused on patients from the Kilimanjaro region and neighboring areas, including Arusha, Manyara, and Tanga, as well as other parts of Tanzania and neighboring countries. The hospital's eye department handles approximately 30,000 consultations annually, with about 100 patients treated for open globe injuries each year, and also serves as a training center for ophthalmologists, ophthalmic nurses, optometrists, and medical students.

**Study Population**

The study included all patients aged three years and above who were diagnosed with open globe injury and received treatment at the KCMC Eye Department during the study period. Only patients who underwent surgery and attended follow-up for up to three months postoperatively were considered. Patients with missing key data related to visual outcomes or pre-existing anterior and posterior ocular diseases, such as corneal ulcers, corneal scars, retinal detachment, macular holes, age-related macular degeneration, proliferative diabetic retinopathy, and glaucoma, were excluded.

**Data Collection Methods and Tools**

Data collection was performed using a structured data extraction form, designed based on similar studies by (Fujikawa *et al.*, 2018; Abu *et al.*, 2020) The form included information on demographic characteristics, clinical features, risk factors for poor visual outcomes, and postoperative visual acuity at three months. The data collection process involved a systematic review of hospital files to obtain relevant clinical characteristics and risk factors affecting visual outcomes.

**Data Collection Procedures**

With the assistance of the theatre nurse in charge, all theatre registry books containing records of patients operated on during the study period were accessed. From these books, a list of patients aged three years and above who underwent globe repair surgery was compiled, along with their registration numbers and details of the procedures performed. This list was given to the hospital medical records team, who assisted in retrieving the physical files of the identified patients. The files were reviewed to determine eligibility, and only those meeting the study criteria were included. Data on socio-demographic information, clinical characteristics, and visual outcomes were recorded systematically using the structured extraction form.

**Study Variables**

The study analyzed both dependent and independent variables. The primary **dependent variable** was the visual outcome, measured as best-corrected visual acuity (BCVA) at three months post-surgery. **Independent variables** included demographic factors such as gender, age, occupation, and whether the patient was referred from a peripheral facility to KCMC. Injury characteristics included the type of injury (penetrating, perforating, foreign body, or rupture), injury location (Zone I, Zone II, or Zone III), time since injury before presentation, and injury size (≤ 5 mm, 5–10 mm, 10–15 mm, >15 mm). Ocular examination findings considered factors such as anterior chamber status (cells and flares, fibrin, hyphema, or hypopyon) and lens status (aphakia, phakia, pseudophakia, or dislocation). Surgical treatment variables included the type of primary operation performed, such as cornea repair, scleral cornea repair, VHCO, PPV, or RDS.

**Operational Definitions:**

**Visual Outcome of OGI:** Visual acuity taken 3 months after eye injury repair, is categorized into;

**-**Good visual outcome VA≥6/60

**-**Poor visual outcome VA<6/60

(Agrawal, Wei and Teoh, 2013)

**Delay presentation post OGI**- The time from injury to presentation at a healthcare facility exceeding 48 hours

**Data Management and Analysis**

Data was analyzed using STATA version 17 (Stata Corp LLC, College Station, Texas, USA). Encoding, labeling, defining variables, and generating new variables were performed before analysis. Descriptive statistics were conducted, with categorical variables summarized using frequencies and percentages, while numeric variables were summarized using the median and interquartile range (IQR). The chi-square (χ2) test was used to determine differences in postoperative visual acuity (VA) based on participant characteristics. A modified Poisson regression model was applied to identify factors associated with poor postoperative VA. Univariate analysis provided the crude prevalence ratio (CPR), while multivariable analysis generated the adjusted prevalence ratio (APR), both with corresponding 95% confidence intervals (CI). Variables with a p-value of <0.05 were considered statistically significant in association with poor postoperative VA.

**RESULTS**

Out of 475 OGI patients from 2015–2020, only 184 patients (184 eyes) were included in the study after excluding cases with missing files, incomplete data, or pre-existing ocular diseases**. Figure: 1**

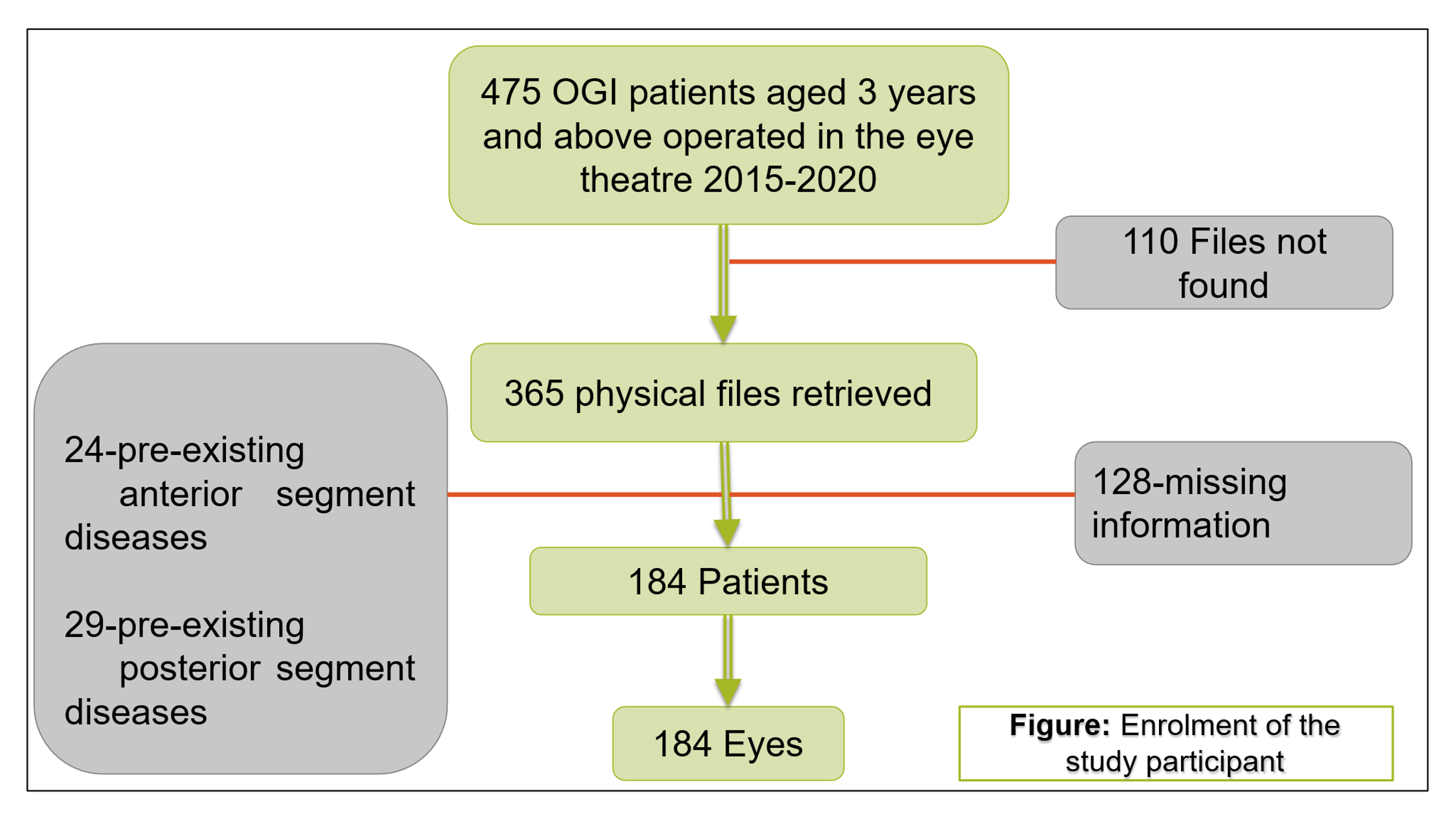


Figure: 1 Study protocol

Of the 184 patients included in the study, the majority were male (70.1%) and predominantly aged 16 years or younger (45.1%), with a median age of 19 years (IQR: 7–34.5). Most patients resided in rural areas (80.4%) and were primarily pupils or students (48.4%). Left eye involvement was slightly more common (54.9%) than right eye (45.1%). Additionally, a significant proportion of patients (76%) were referred to KCMC for further management. **Table 1**

Table 1 : Demographic characteristics among patients with Open globe injury (N=184)

|  |  |  |
| --- | --- | --- |
| **Variable** | **Frequency** | **Percentage** |
| **Patients Sex** |  |  |
| Male | 129 | 70.1 |
| Female | 55 | 29.9 |
| **Patient Age in Years** |  |  |
| ≤16 | 83 | 45.1 |
| 17-30 | 44 | 23.9 |
| 31-44 | 29 | 15.8 |
| ≥40 | 28 | 15.2 |
| *Median (IQR)* | *19(7-34.5)* |  |
| **Eye laterality** |  |  |
| Right Eye | 83 | 45.1 |
| Left Eye | 101 | 54.9 |
| **Patient residence** |  |  |
| Urban | 36 | 19.6 |
| Rural | 148 | 80.4 |
| **Patient occupation** |  |  |
| Pupils/students/pre-school | 89 | 48.4 |
| Farming/Livestock farming | 60 | 32.6 |
| Trading | 10 | 5.4 |
| Civil Public Servant | 8 | 4.3 |
| Retired | 5 | 2.7 |
| Others | 12 | 6.5 |
| **Patient referral** |  |  |
| Referral to KCMC | 139 | 76 |
| No Referral | 44 | 24 |

Most patients (91.9%) presented with severe visual impairment, and just over half (52.2%) underwent surgery more than two days after injury. The majority had clear anterior chambers (47.3%) and transparent lenses (63.0%), with wounds commonly between 5–10 mm (46.7%); vegetative material was the leading cause of injury (40.8%), and corneoscleral repair was the most frequent surgical procedure (42.4%). **Table 2**

Table 2: Clinical characteristics of patients with Open globe injury(N=184)

|  |  |  |
| --- | --- | --- |
| **Characteristics** | **Frequency** | **Percentage** |
| **Visual acuity before repair** | | |
| Mild impairment | 5 | 2.7 |
| Moderate impairment | 10 | 5.4 |
| Severe impairment | 169 | 91.9 |
| **Time Since Injury to Operation** | | |
| ≤2 Days | 88 | 47.8 |
| >2 Days | 96 | 52.2 |
| *Median (IQR)* | *3(1-4)* |  |
| **Anterior Chamber status** | | |
| Clear and Quiet | 87 | 47.3 |
| Cells, flare and fibrin | 8 | 26.6 |
| Hyphema | 49 | 4.4 |
| Hypopyon | 40 | 21.7 |
| **Lens Status** | | |
| Clear transparent lens | 116 | 63.0 |
| Lens Opacity | 14 | 7.6 |
| Lens dislocation | 1 | 0.5 |
| Aphakia | 8 | 4.4 |
| Mixed | 45 | 24.5 |
| **Size of injury** |  |  |
| ≤5mm | 39 | 21.2 |
| 5-10mm | 86 | 46.7 |
| 10-15 | 45 | 24.5 |
| >15 | 14 | 7.6 |
| **Cause of Injury** |  |  |
| Metal | 41 | 22.2 |
| Vegetative | 75 | 40.8 |
| Other | 68 | 37.0 |
| **Type of surgery** |  |  |
| Cornea repair | 68 | 37.0 |
| Cornea scleral repair | 78 | 42.4 |
| PPV + RDS | 38 | 20.6 |

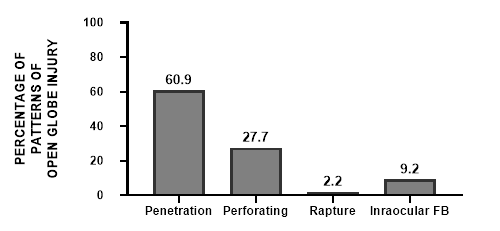
The majority of participants sustained penetrating open globe injuries (60.9%), while globe ruptures were rare (2.2%) **(Figure 2).** Regarding the zone of injury, most eyes were classified as zone I (59.2%), followed by zone II (27.7%), with zone III injuries being the least common (13.1%).

Figure 2: Classification of OGI based on type (mechanism) of injury

Proportion of Post OP VA

The overall proportion of good visual acuity post-operative BCVA was 29.9% (55/184). Figure 3 displays the comparison of initial and post-op VA.



Figure 3: Proportion of initial and Post OP VA

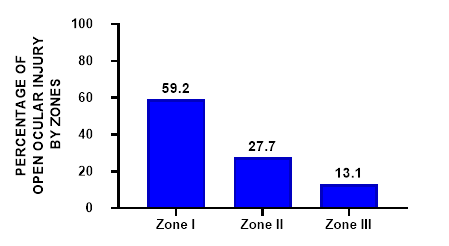
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## **Factors associated with post-OP VA**

Factors significantly associated with poor postoperative visual acuity included delayed surgery (>2 days), presence of hypopyon, larger wound size (>10 mm), and undergoing secondary surgery (PPV and RDS). Patients operated on after more than two days were 21% more likely to have poor visual outcomes. Those with hypopyon had a 51% higher likelihood of poor vision compared to those with a clear anterior chamber, while injuries larger than 10 mm increased the risk by 51%. Additionally, patients requiring secondary surgery were 25% more likely to experience poor postoperative visual acuity **Table 3**

Table 3: Factors associated with poor visual outcome

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable** | **CPR (95% CI)** | **P-value** | **APR (95%CI)** | **P-value** |
| **Patients Sex** |  |  |  |  |
| Male | Ref |  |  |  |
| Female | 0.90(0.72-1.13) | 0.391 |  |  |
| **Patient Age in Years** |  |  |  |  |
| <18 | Ref |  |  |  |
| ≥18 | 1.2(0.99-1.46) | 0.06 |  |  |
| **Patient occupation** |  |  |  |  |
| Non-farmers | Ref |  |  |  |
| Famers | 1.03(0.84-1.25) | 0.746 |  |  |
| **Time Since Injury to Operation (Days)** |  |  |  |  |
| ≤2 | Ref |  | Ref |  |
| >2 | 1.27(1.04-1.55) | 0.016 | 1.21(1.02-1.44) | 0.017 |
| **Anterior chamber status** |  |  |  |  |
| Clear and Quiet | Ref |  | Ref |  |
| Cells flare and fibrin | 1.39(0.89-2.17) | 0.102 | 1.40(0.90-2.19) | 0.137 |
| Hyphema | 1.39(1.09-1.80) | 0.009 | 1.25(0.99-1.57) | 0.054 |
| Hypopyon | 1.80(1.48-2.21) | <0.001 | 1.51(1.28-1.77) | <0.001 |
| **Lens status** |  |  |  |  |
| Clear transparency lens | Ref |  |  |  |
| Abnormal lens (Lens Opacity, lens dislocation, Mixed) | 1.19(0.99-1.42) | 0.063 |  |  |
| **Ocular Location of Injury** |  |  |  |  |
| Zone I/ Zone II | Ref |  | Ref |  |
| Zone III | 1.52(1.36-1.71) | <0.001 | 0.89(0.73-1.09) | 0.276 |
| **Cause of Injury** |  |  |  |  |
| Metal | Ref |  |  |  |
| Vegetative Matter & Others | 0.91(0.73-1.11) | 0.352 |  |  |
| **Type of Eye Globe Injury** |  |  |  |  |
| Penetrating/Perforating | Ref |  | Ref |  |
| Intraocular Foreign Body/Rupture | 1.51(1.35-1.68) | <0.001 | 1.14(0.99-1.30) | 0.064 |
| **Size of Ocular Injury** |  |  |  |  |
| ≤10 mm | Ref |  | Ref |  |
| >10 mm | 1.73(1.48-2.02) | <0.001 | 1.51(1.29-1.77) | <0.001 |
| **Secondary surgery** |  |  |  |  |
| No | Ref |  | Ref |  |
| Yes | 1.60(1.41-1.82) | <0.001 | 1.25(1.04-1.47) | 0.014 |



**DISCUSSION**

A total of 184 patients with open-globe injuries (OGIs) were treated in the study, with penetrating injuries making up the majority (60.9%). This high incidence was mainly due to occupational hazards, particularly in agriculture where sharp tools like machetes are commonly used, and in industrial environments involving machinery. Socioeconomic challenges also contributed, as many people could not afford protective eyewear. Additionally, cultural practices, recreational activities with sharp objects, limited healthcare access, and low awareness of eye safety further influenced the pattern and frequency of injuries in the Kilimanjaro region.

Perforating injuries accounted for 27.7% of cases, which is significantly higher than the 3.3% reported in previous studies (Peleja *et al.*, 2022). This difference could be due to regional trauma mechanisms and the prevalent use of machetes in local farming. Injuries with intraocular foreign bodies (IOFBs) were less frequent (2.2%), lower than rates reported in other regions (Nainiwal *et al.*, 2016; Puodžiuvien, 2021), likely due to differences in industrial exposure and diagnostic capabilities. Rupture injuries represented 9.2% of cases, a figure lower than some reports (Guven *et al.*, 2019) but similar to others (Nainiwal *et al.*, 2016), highlighting how injury severity varies based on factors like urbanization, healthcare access, and socioeconomic conditions. Understanding these regional differences is essential for developing specific prevention and management approaches.

The majority of injuries were located in Zone I (59.3%), followed by Zone II (27.7%) and Zone III (13%). The anterior location of Zone I makes it more vulnerable to direct trauma, unlike Zones II and III, which are somewhat shielded by the orbit and surrounding tissue. Zone I injuries were commonly due to flying debris, sharp tools, or accidents during physical activities such as sports and manual labor, especially in agricultural and construction environments. The lack of eye protection heightened the risk. These injuries tend to be promptly reported and treated because of their visibility and associated symptoms.

These findings align with a previous study(Peleja *et al.*, 2022), which found Zone I injuries in 54.2% of cases. Another study (Batur *et al.*, 2016) reported slightly lower rates at 53.2%. Conversely, studies by (Nainiwal *et al.*, 2016; Yildiz *et al.*, 2016) Observed a predominance of Zone III injuries, ranging from 62.5% to 64.8%, showing how trauma patterns vary across regions. These results emphasize the need for region-specific strategies based on the most affected anatomical zones.

Visual outcomes varied, with 29.9% of patients achieving good best-corrected visual acuity (BCVA) after surgery. Recovery depended on injury severity, IOFB presence, and the effectiveness of surgical intervention. Injuries involving critical structures like the optic nerve or macula led to worse outcomes. The presence of IOFBs complicated surgery and raised the risk of complications. The skill and timing of surgery were crucial, along with factors like patient age, overall health, and adherence to postoperative care.

Other studies reported different outcomes. For instance,(Puodžiuvien, 2021) observed good vision in only 19.5% of cases, while (Han and Yu, 2010) found that 78.4% achieved light perception or better. A broader outcome range—from 20/20 vision to light perception—was reported by (Fujikawa *et al.*, 2018). Additionally, (Kong *et al.*, 2015)found 47.2% achieved 6/12 or better. These discrepancies reflect differences in injury types, surgical methods, and patient care quality. The diversity in outcomes highlights the complexity of OGIs and the importance of tailored management strategies.

Additional studies (Bunting, Stephens and Mireskandari, 2013; Lee, Jung and Lee, 2017; Gaier *et al.*, 2019) also demonstrated variable outcomes, with 40% to 60% of patients achieving 20/40 to 20/70 or better. These findings highlights the importance of standardized treatment protocols and effective rehabilitation to improve both short- and long-term vision.

Key predictors of poor visual outcomes included delayed surgical treatment. Long wait times increased infection and tissue damage risk. Studies (Shrestha *et al.*, 2021) found that such delays were linked to worse outcomes due to inflammation, infection, and tissue necrosis. This stresses the importance of timely surgical repair.

The anterior chamber’s condition at the time of injury was also a critical factor. Complications like hyphema and endophthalmitis were linked to poorer outcomes, as confirmed by(Lee, Jung and Lee, 2017). Hyphema can impair vision, increase intraocular pressure, and lead to glaucoma. It can also damage or displace the lens, causing cataracts or aphakia. Severe inflammation may result in synechiae, glaucoma, and chronic complications. However, (Rahman *et al.*, 2006) did not find a direct relationship between hyphema and poor visual results, possibly due to differing classification systems.

Injury size also influenced prognosis—larger injuries caused more complications, as supported by (Ozturk *et al.*, 2019; Gao *et al.*, 2023) Extensive tissue damage made surgery more difficult and increased risks like retinal detachment. Surgical complexity also played a role. According to (Publishers and All, 2009), more complex surgeries led to higher inflammation and complication rates. Similarly,(Rahman *et al.*, 2006; Surgeon *et al.*, 2021) noted that poor initial vision and complex surgical procedures were strong predictors of poor outcomes, stressing the need for meticulous surgical planning and care.

**CONCLUSION**

At KCMC, 29.9% of patients with open-globe injuries achieved good post-operative visual outcomes, with penetrating injuries (60.9%) and Zone I being most common. Prognosis depended on injury timing, anterior chamber condition, injury characteristics, and surgical techniques, emphasizing the need for timely intervention and proper management to improve visual recovery.

**Strength of the study**

The study's strength lies in its large sample size, comprehensive analysis of injury patterns, risk factors, and outcomes, and identification of predictors of poor prognosis. It highlights regional differences, supports preventive strategies, and informs improvements in clinical care and follow-up.

**Study recommendations**

Improving emergency response and public awareness is vital for early diagnosis and timely treatment. Emphasis on prevention through eye safety education, protective eyewear, and injury programs is essential. Advancing surgical care and creating a trauma registry will enhance outcomes, data tracking, and long-term patient management.

**Ethical Approval:**

Ethical approval for the study was obtained from Tumaini University, KCMUCo Research and Ethical Committee (PG 86/2023). Additional permissions were sought from the Director of KCMC Hospital, the Director of Postgraduate Studies, and the Head of the Eye Department. Patient confidentiality was strictly maintained, with only the research team having access to the data. Study identification codes were used instead of patient names to ensure privacy

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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