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An analysis of the time delay of surgical treatment of ocular trauma at a Tertiary Institution in Johannesburg, South Africa: a 1-year retrospective review

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An Analysis of the Time Delay of Surgical Treatment of Ocular Trauma at a Tertiary Institution in Johannesburg, South Africa

A 1- year Retrospective Review

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Medicine in the branch of Ophthalmology.

Johannesburg, 2017

Declaration

I, Teboho Seobi declare that this thesis is my own work. It is being submitted for the degree of Master of Medicine in Ophthalmology at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

Signed…….

On this……..day of …….2017

Dedication

To God who helps me overcome and to be victorious

To my husband, Anati who has walked a mile with me and still loves and supports me

To my parents, Jacob and Eva for your constant love and prayers

To my siblings Mmathabo and Mosa for your effortless love

Publications and presentations arising from this study:

None.

Abstract

Study Aim: To determine whether patients admitted with open globe injuries are surgically repaired within the 24-hour period after injury.

Method: A retrospective, cross-sectional descriptive study of patients who were admitted with ocular trauma at the St John Eye Hospital from 01/01/2014 to 31/12/2014.

Results:

Five hundred and eighty-three patients with ocular trauma were admitted. Four hundred and sixty-seven patients met the inclusion criteria. Patients <18 years had statistically significant fewer cases delayed post-admission as compared to patients >18 years (12.82% vs 28.46%). The time between injury and surgical treatment was > 24 hours in 89.74% of patients <18 years and 92.31% in patients >18 years. The reasons for delay were insufficient general anaesthetic time, anaesthetic failure, logistical failures and patient factors.

Conclusion:

Time delay to surgical treatment was mainly as a result of delayed presentation to the health facility. The majority of patients received surgical treatment within 24 hours after admission. The delay in surgical treatment of admitted patients was mainly due to late presentation and system failures.

Acknowledgements

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To Cindy, the clerk working in the wards at St John Eye Hospital, for her tireless efforts in helping me obtain patient records

To the clerks at St John Eye Hospital for assisting me in obtaining patient information

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Chapter 1: Literature review

Introduction

The epidemiology of ocular trauma is becoming of increasing interest worldwide.[1] Traumatic ocular injuries are an important topic because they are preventable. A better understanding of the causes and epidemiology of injuries is imperative in planning to reduce the incidence of ocular trauma [2]

It is estimated that worldwide 2.3 million people are bilaterally visually impaired and 19 million have unilateral visual loss. In the United States of America (USA) it is estimated that 1.6 million people are blind secondary to ocular trauma. In Colombia, it is estimated that 500 000 years of lost eyesight occur annually nationwide and injury is the most important cause for eye-related hospital admissions.[3]

There are approximately 2.5 million new eye injuries in the USA each year. Between 40 000 and 60 000 patients are diagnosed with blindness as a result of ocular trauma.[4] One in 400 of every 100 000 USA citizens sustain either unilateral or bilateral eye injuries. Forty percent of all cases of monocular blindness are the result of trauma.[4]

In many industrialised countries ocular trauma is a reason for hospitalisation among patients with eye problems.[4] The National Safety Council in the USA estimates that the cost of job-related eye-trauma amounts to approximately $300 million annually. This includes medical, hospital, and work compensation bills.[5] The burden of blindness is related not only to the

obvious effect on the quality of life but also to the loss of productivity associated with the remaining blind person-years.[1]

In developed countries 5% of all ophthalmic admissions are trauma related and in developing countries the percentage is much higher. In developing countries, ocular trauma is a significant cause of blindness and disability, despite the fact that it is preventable in the majority of cases.[2] Injuries generate a significant and avoidable toll in terms of medical care, human suffering, morbidity, loss of productivity, rehabilitation services and socio-economic cost. The overall financial cost derived from ocular injuries can only be estimated, but the direct and indirect costs combined run into hundreds of millions of dollars per year. Developing countries are the least able to afford the costs.[3]

Background of the Study

Soweto is the largest township and is located south of the city of Johannesburg in South Africa. It is the iconic township where the uprisings took place, and where there is still a high rate of violence. It is in this township that Chris Hani Baragwanath Academic Hospital, the third largest hospital in the world, is located. This medical centre is a high-capacity tertiary hospital. Seventy percent of all admissions to this hospital are emergencies. St John Eye Hospital is the ophthalmology department. It has 111 beds and sees approximately 50 000 patients per year.[6] This unit is a referral center for both primary and secondary medical centres around Johannesburg and other provinces such as Limpopo and Mpumalanga. This results in budgetary and resource constraints.[7] Emergency cases may not be attended to timeously as

there is limited surgical time. Due to the referral process itself and the distances patients need to travel to St John Eye Hospital, there may also be a delay in surgical management.

The purpose of this study is to assist in identifying any shortfalls in the delivery of the service provided and help to improve on the surgical management of patients with open globe trauma. In addition, the results of this investigation may be used to motivate for a designated anaethetist and theatre for ocular trauma at our facility to prevent delays in surgery.

What follows is a brief overview of the basic and essential anatomy of the eye and orbit which is essential in understanding the ways in which trauma results in eye injuries. This is followed by a literature review of studies conducted, looking at the epidemiology of ocular trauma in both developed and underdeveloped areas. The review ends by looking at the recommended management of patients with penetrating ocular trauma to prevent serious ocular complications.

Anatomy

The anatomy can be described as the orbit, ocular appendages and ocular structures. The eye is situated in the orbit. The orbit is a structure that is a composed of skeletal bone on the face. Its main function is to support and protect the globe and the other intraorbital structures, for example the extraocular muscles, arteries, veins, and orbital fat. The ocular appendages would be the eyebrows, the eyelids, conjunctiva, and the lacrimal apparatus.[8]

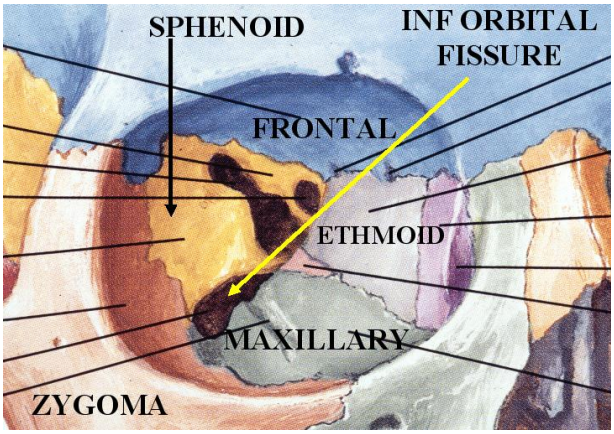


Figure 1.1 Anatomy of the orbit (www.humangrossanatomy.com)

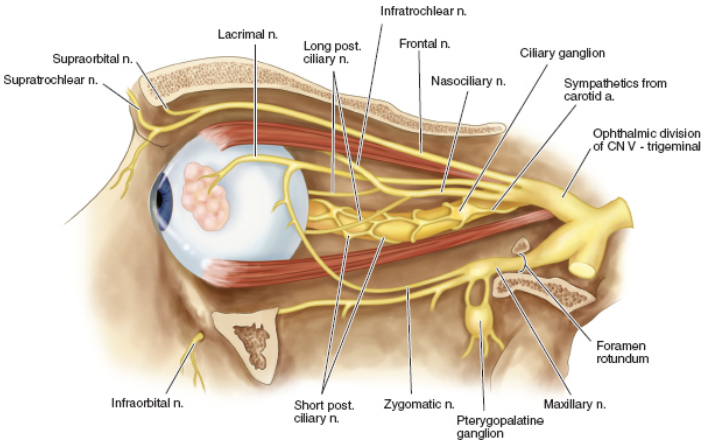


Figure 1.2 Anatomy of the orbit (www.entokey.com)

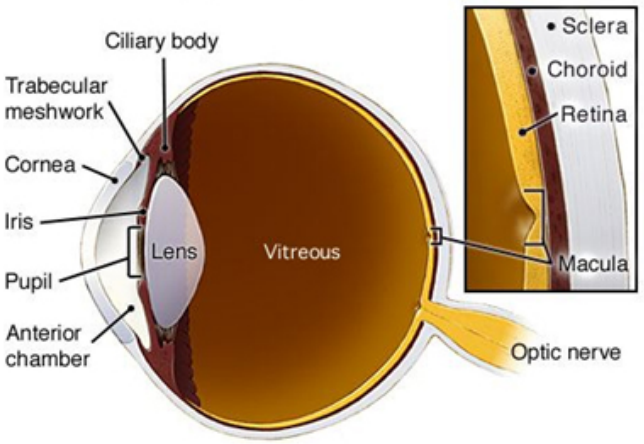


Figure 1.3 Anatomy of the lacrimal system (www.outlanderanatomy.com).

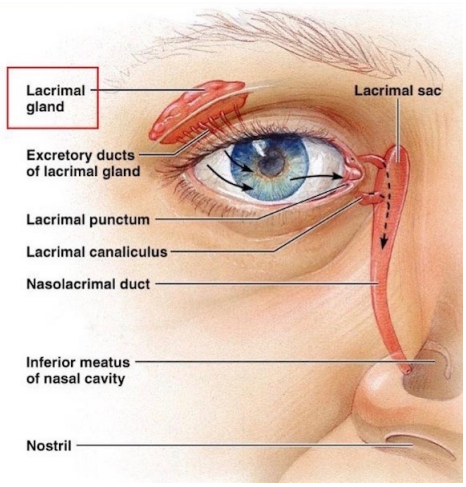


Figure 1.4 Anatomy of the eyeball (www.precisionfamily.com)

The eyeball can be divided into two major parts. The anterior segment and the posterior segment. The anterior segment is the cornea, the anterior part of the sclera, the iris, ciliary body and the lens. The posterior segment is made up of the sclera, the choroid, the retina and the optic disc and optic nerve. All of the structures of the orbit, ocular appendages and the globe are susceptible to traumatic injury.[8]

Classification of trauma

Ferenc Khun, a world-recognised authority on ocular trauma, formulated an eye trauma terminology system in 2002 that standardises the manner in which ocular injury is described, thus making communication between doctors about ocular trauma more understandable and effective. This system has also been utilised in many studies to describe traumatic injuries. This terminology of mechanical injuries is called the Birmingham Eye Trauma Terminology.[9]

Table1.1 The Birmingham Eye Trauma Terminology[9]

Term	Definition	Comment
Eye wall	Sclera and cornea	Clinical and practical purposes dictate that violation of only the most external tissue(sclera) is to be considered
Closed globe injury	No full thickness wound of eye wall	The cornea and the sclera are not breached completely
Open globe injury	Full thickness wound of the eye wall	The cornea and or sclera are breached completely
Contusion	No wound of the eye wall	The damage may be due to direct energy delivery or shock wave by the object, or to change in the shape of the globe
Lamellar laceration	Partial thickness wound of the eye wall	The wound is not through the eye wall, but into the wall
Rupture	Full thickness wound of the eye wall, caused by a large blunt object	The eye is filled with incompressible liquid, the impact results in instant IOP rise. The eye wall yields at its weakest point. The actual wound is produced by an inside-out mechanism and tissue prolapse is unavoidable
Laceration	Full thickness wound of the eye wall caused by a sharp object	The wound is at the impact site and is created by an outside-in mechanism. Since IOP elevation is unavoidable, tissue prolapse is common

Penetrating injury	An entrance wound is present	If more than one wound is present, each must have been caused by a different object
Intraocular foreign body	One or more foreign objects are present	A penetrating injury. Different clinical implication
Perforating injury	Both an entrance and an exit wound are present	The two wounds caused by the same agent

Open globe injuries are classified into zones according to the following

- Zone I – involves the cornea
- Zone II- involves the cornea into the anterior 5mm of the sclera
- Zone III- involves the cornea and extends more than 5mm from the limbus[10]

Closed globe injuries are classified into zones according to the following

- Zone I- involves conjunctiva, sclera, cornea
- Zone II- involves the anterior chamber, including the lens and zonules
- Zone III- involves the posterior structures including the vitreous, retina, optic nerve, choroid, ciliary body[10]

Literature Review

The demographic characteristics of patients presenting with ocular trauma shows little variation when comparing developed and developing countries. Khatry *et al.* conducted a prospective study aimed at estimating the incidence of ocular trauma in a rural area of Nepal. The study aims were to identify the risk factors for trauma and to describe the visual acuity in the injured eye at the time of clinical presentation and also to assess visual outcomes 2-4 months after the occurrence of injury. The study included 525 patients presenting with ocular trauma between 1995 and 2000 to a primary eye care centre in Nepal. The crude incidence of ocular trauma was 0.51 per 1000 population. The incidence peaked in the 40-49 age group for both males and females. The incidence for males was 0.65 per 1000 per year as compared to females, which was 0.38 per 1000 females per year. The relative risk of injury for males compared to females was 1.74.[11]

Sukati *et al.* conducted a retrospective study in Kwa-Zulu Natal in South Africa to ascertain the epidemiological data of ocular injuries among patients using the eye clinic services in Kwa-Zulu Natal. The cases were analysed for demographics, place and nature of injury, type of injury and visual outcome. The records of 220 patients at two urban hospitals were analysed. Males constituted 79.1% of the study population. The age group most affected was between the ages of 21 to 30 years of age. [12] Gyasi *et al.* conducted a retrospective review of all cases of severe ocular injuries in the Upper East Region of Ghana. A total of 941 patients with ocular injuries were included. Of the 941 patients in the study 96 (9.5%) were serious enough to be admitted for in-patient care. This constituted 6.2% of all admissions.[13]

The majority of studies report that people younger than 40 years of age were the most affected by ocular injuries. There seems to be no significant difference between developing and developed countries. Madhusudhan *et al.* conducted a study at the University Hospital in Sains Malaysia. This study was aimed at identifying the aetiology of open-globe injuries presenting to the hospital over a 10-year period from January 2000 to December 2009. The study population was 220 patients. The mean age range was reported as 19 to 22 years. Thirty percent of cases were below 30 years of age and 33% of these patients were below 10 years of age.[1] Similarly Balaghari *et al.* reported that the highest prevalence of admissions for ocular trauma was in patients between 25-34 years. Patients younger than 10 years comprised 12.4% of the study group while elderly were only 4%. [2] Similar findings were described by Khatry *et al* who reported the mean age of patients being 28.1years[8]. Sukati *et al* reported the mean age of 21 to 30 years, and Gyasi *et al.* reported the mean age being younger than 30 years.[12,13]

All the studies reviewed found males were most affected by ocular trauma. In the studies conducted in developing countries, Gyasi *et al.* reported that 75% of their study population were males.[13] Balaghafari *et al.*, Sukati *et al.* and Khatry *et al.* reported similar findings of 75.8%, 79.1% and 65.1% respectively of their study populations to be male. [2,11,12]
Armstrong *et al.* found that male children accounted for 62% of children (647,405) with a male to female ratio of 1.6:1. [14]

It is generally accepted that open globe injury results in more hospitalisation and a poorer visual outcome than closed globe injury.[1] Corneal injury specifically can cause a permanent disability which cannot be corrected by glasses. Lens trauma can lead to cataract. Injuries to the retina or optic nerve are irreversible.[2]

The majority of the studies report a higher number of closed globe injuries as compared to open globe injuries. Fea *et al.* found the majority of injuries were corneal abrasions (29.6%,) and corneal foreign bodies (49.5%). Retinal detachments (0.14%) occurred in work-related injuries or motor-vehicle injuries. Open globe injuries consisted of penetrating injuries (0.47%) and intraocular foreign bodies (0.19%). [15] Chen *et al.* found that the most common type of injury was contusion injuries (49.4%) followed by open globe injuries (34%).[16]

In the paediatric study, Serrano *et al.* reported that closed globe injuries were more frequent than open globe injuries. Closed globe injuries were lamellar lacerations (43.3%), contusions (32.3%), and superficial foreign bodies (19.8%). Open globe injuries were penetrating injuries (78.9), intraocular foreign bodies (14.1%), and ruptures of the eyeball (4.2%,). [3]

The majority of cases in the studies reviewed received medical treatment as opposed to surgical treatment. Serrano *et al.* found that 77.4% had medical management only while 22.6% of cases required surgery.[3] May *et al.* showed that 44% of ocular trauma patients underwent some kind of surgery. Of those who had surgical treatment, 21% required a second operation, whilst 12% required a third operation or more.[4]

Seasonal variations in the presentations of ocular trauma have also been reported. In Iran, Balaghafari *et al.* found that the majority of injuries occurred during their winter period (30.9%) .[2] In the United States of America, Armstrong *et al* reported that the highest incidents occurred from April to July, that is, Spring to Summer.[14] In Ghana, Gyasi *et al.* noted a pattern of bimodal distribution over a one-year period. The increase in cases occurred between March

and May tapering off in June and a second increase occurred in September to November, tapering off in December. These patterns were especially so for the farming and schooling occupational groups. It was thought to be linked to the farming seasons.[13] In Colombia, Serrano *et al.* found that peak clusters occurred in November, December and January and then again in August and September. These months are when there is less rainfall and people are more active outdoors. [3]

Endophthalmitis is a devastating complication of open globe injury. It results in poor visual prognosis of traumatised eyes.[17] It is a serious intraocular inflammatory disorder resulting from infection of the vitreous cavity. Exogenous endophthalmitis results from infectious organisms gaining entry by direct inoculation from intraocular surgery or penetrating trauma. Post-traumatic endophthalmitis has a worse visual prognosis than other categories of endophthalmitis, with approximately 22-42% obtaining 6/60 or better final visual acuity. The reasons for this are the initial injury and delay in diagnosis due to the diagnostic dilemma in the setting of post-traumatic inflammation.[18]

Post-traumatic endophthalmitis comprises approximately 25% of endophthalmitis cases.[18,19] The incidence of post-traumatic endophthalmitis is 2.6-54.16%.[17] The incidence of endophthalmitis after penetrating ocular injury in particular is estimated to be approximately 2% to 7% with studies ranging between 0% to 13%. [18,20,21,22] The incidence of endophthalmitis with injuries that have intraocular foreign bodies is slightly higher and ranges from 11-30%. [18]

Independent risk factors of endophthalmitis are dirty wounds, lens capsule ruptures, age greater than 50 years, retained intraocular foreign bodies, and delayed presentation of more than 24 hours after injury.[18,19,20] There is a fourfold increase in the infection rate of all ages when primary repair is delayed by more than 24 hours.[19] The National Eye Trauma System (NETS) data reported that 3,5% of patients who had primary repair and removal of intraocular foreign bodies within 24 hours after injury developed endophthalmitis compared to 13.4% who had surgery after 24 hours post injury. The risk of endophthalmitis increases with each hour of delay.[18,22]

Zhang *et al.* conducted a retrospective study to identify factors that affected the frequency of endophthalmitis in open globe injuries. They demonstrated that primary repair after 24 hours of injury, retained intraocular foreign body, penetration, perforation, no intraocular tissue prolapse, and I or II zone of wounds were statistically significant factors. Protective factors were laceration, primary repair within 24 hours, intraocular tissue prolapse, and self-sealing of wounds.[17] Narang *et al.* concluded that delayed primary repair beyond 24 hours after open globe injury was a significant risk factor for the occurrence of endophthalmitis and resulted in even poorer final visual acuity.[17]

Ahmed *et al.* conducted a literature review to outline the findings of studies that looked at endophthalmitis following open globe injuries. They reported that the time delay in wound closure of more than 24 hours increased the rate of traumatic endophthalmitis four-fold. The most important prophylactic factor for traumatic endophthalmitis is primary wound closure within the first 24 hours of injury.[23]

Endophthalmitis may not occur when primary repair is delayed in certain cases of open globe injuries where a delay of 12 to 24 hours may be tolerated, however primary repair should be initiated as soon as possible as this is a link that can be easily controlled in the prophylactic treatment of endophthalmitis.[18,20] Delay in presentation is more relevant and important than delay in surgery as treatment cannot be performed early and endophthalmitis cannot be prevented with prophylactic antibiotics or primary surgical repair if the patients present late or once endophthalmitis is already present.[24]

Du Toit *et al.* conducted a prospective study at Groote Schuur Hospital in Cape Town with the aim of determining the time elapsed from the occurrence of open globe injury to the time of surgical management and to establish whether the surgical time delay affected the visual outcome of the patients. The study included 169 patients with open globe trauma. They reported that the mean time from the occurrence of the ocular injury to the surgical management was 80.14 hours and this was longer than the 24 hours recommended in the literature. The delays mainly occurred between the time of presentation and surgery.[24]

In summary, ocular trauma is a worldwide problem. It affects individuals from both developed and under-developed areas. The majority of people who are affected are young males. Penetrating ocular trauma may result in sight-threatening complications. Emergency surgical intervention is needed to prevent endophthalmitis. In a setting with a constrained budget as well as limited surgical time, staff and surgical resources, distributing these resources between elective cases and emergency cases brings about an ethical dilemma. It may compromise the management of patients needing surgical management for ocular trauma. There is a need to determine the burden of ocular trauma on the health system. Du Toit et al conducted a

prospective study at Groote Schuur Hospital, in Cape Town between July 2009 and June 2011 that determined both the burden of ocular trauma on the surgical resources and the efficiency in treating open globe trauma.[24] This study will be the second in South Africa to determine this.

Chapter 2: METHODS

This is a retrospective, cross-sectional descriptive study. Five hundred and eighty-three medical records of patients who were admitted with ocular trauma at the St John Eye Hospital from 01/01/2014 to 31/12/2014 were reviewed. Four hundred and sixty-seven patients' files met the inclusion criteria.

2.1 Study Aim

The aim of the study was to determine whether patients admitted with open globe injuries are surgically repaired within the 24 hour period after ocular injury which is recommended in the literature.

2.2 Study Objectives

1. To describe the demographic profile of the patients admitted with the diagnosis of ocular trauma
2. To determine the number of open globe *vs* closed globe injuries admitted during this period
3. To describe the number and types of surgical procedures performed as surgical management of ocular trauma
4. To determine the time lapsed from the occurrence of ocular injury to the time of surgery.
5. To determine the waiting period from time of admission to time of surgery
6. To determine the reasons for delay in surgical management

7. To determine the seasonal variation in presentation of ocular trauma

2.3 Data Collection

2.3.1 Inclusion Criteria

- Patients who have been admitted with the diagnosis of ocular trauma between January 2014 and December 2014.
- The date of admission, age, gender and diagnosis is clearly stated
- The date of the surgical procedure is clearly stated
- The diagnosis is clearly attributable to trauma

2.3.2 *Exclusion* Criteria

- The diagnosis is not given or is illegible

The standardised data capture sheet was used to capture the information. (see Appendix A). The information was recorded on an electronic Microsoft Excel spreadsheet.

The following data was retrieved and recorded on the data collection sheet:

- The age and gender of the patient
- The date the injury occurred
- The date of admission and discharge of each patient
- The diagnosis at time of admission

- The age and gender of the patient who had the surgical procedure
- The type of surgical procedure
- The reason for the delay in surgery

Data collection

Patient information was collected from the admission records at the female and male wards and the theatre register books at St John Eye Hospital. The inpatient files for all patients admitted between 01/01/2014 to 31/12/2014 were accessed at the records department at St John Eye Hospital. All the patient records of patients who were admitted for ocular trauma were reviewed and the data extracted from them. Further information was obtained from these patient files and was used to verify that the information recorded in the admission records and the theatre register books were correct.

2.4 Statistical Analysis

The statistical analysis was performed using Microsoft Excel and STATA Data Analysis software. The critical value of significance was set as a p-value less than 0.05. This test was used to determine statistical significance for all variable tests. Where appropriate, Fischer's exact test and Pearson Chi^2 test were performed.

2.5 Ethical Considerations

The study protocol was approved by the Postgraduate Committee of the Department of Neurosciences, Faculty of Health Sciences, University of the Witwatersrand. Ethics approval was obtained from the University of the Witwatersrand Human Research Ethics Committee (Medical)- clearance certificate no. M151105

Chapter 3: RESULTS

From 1 January 2014 to 31 December 2014 there were 583 patients admitted in the unit due to trauma. There were 467 patients' records that met the inclusion criteria and were included in the study.

3.1 Demographics of Patients

Of the 458 patients, 75% (344 cases) of the patients were males and 25% (114 cases) were females. Nine paediatric patients did not have the details of their gender specified in the records. The maximum age was 89 years and the minimum age was 10 months. The mean age of the study population was 28 years. The mean age for females and males was the same at 29 years. However, the age distribution was broader for females as shown in Figure 3.4. When categorizing patients into under 18 years and over 18 years old, the number of patients was 131 and 336 patients respectively. There were 454 African patients. There was only one Caucasian patient, one Indian and seven Colored patients.

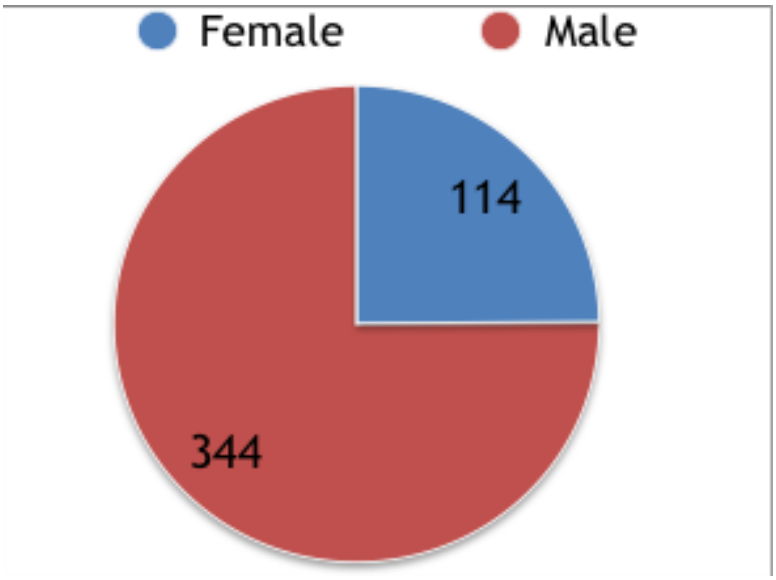


Figure 3.1 Gender Distribution

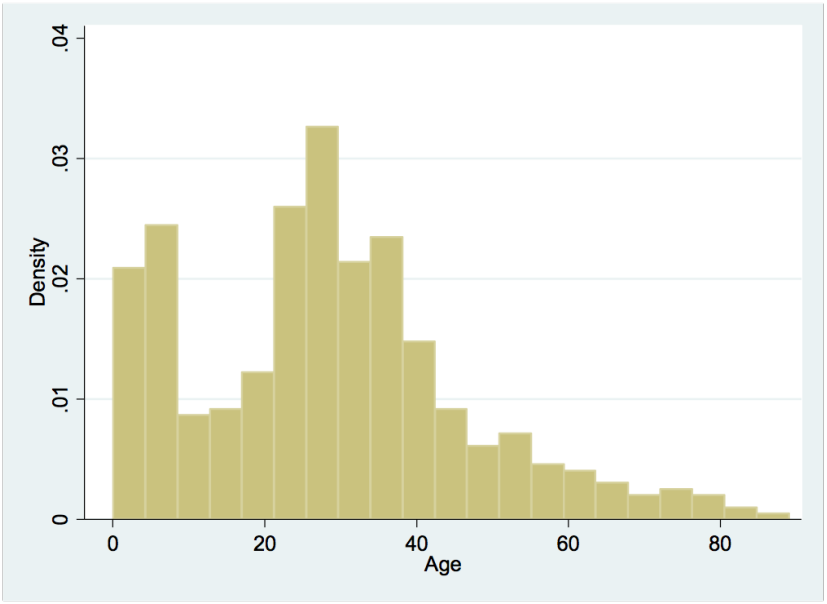


Figure 3.2 Age Distribution

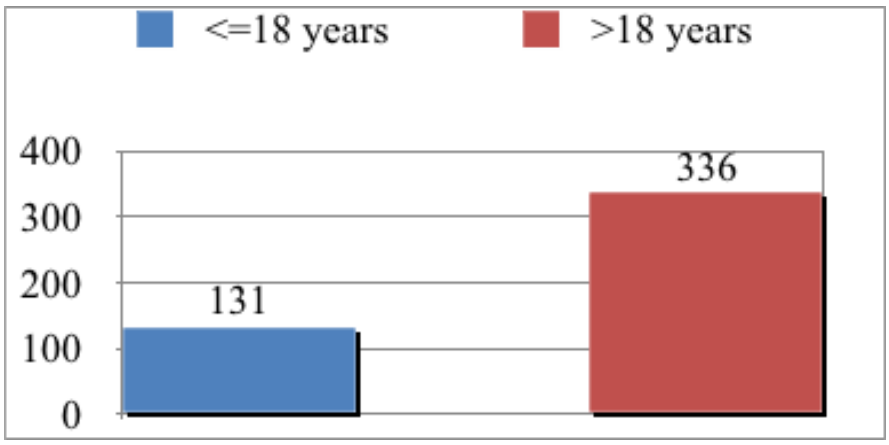


Figure 3.3 Age categorised as <=18 and > 18 years

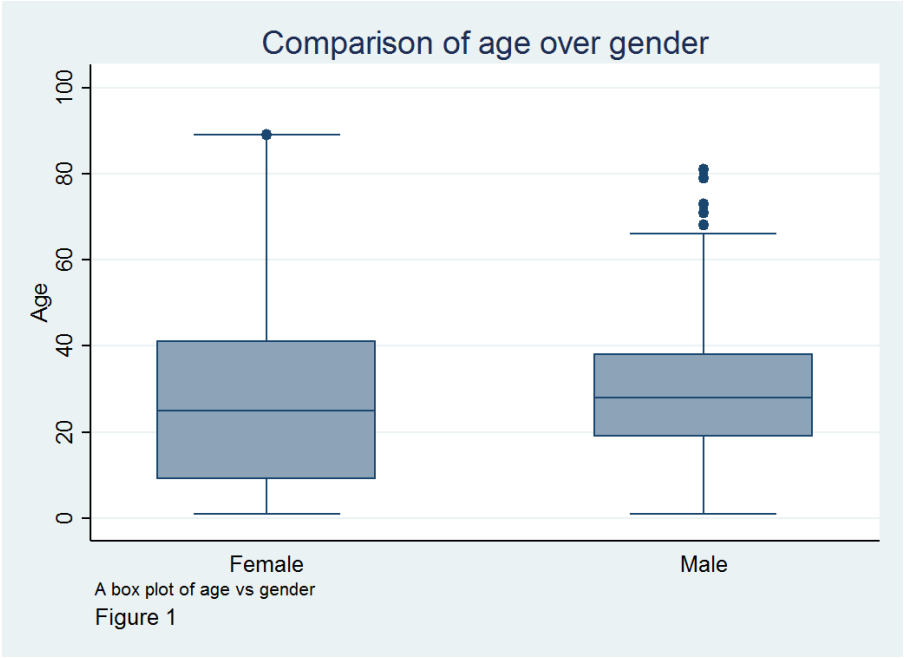


Figure 3.4 Comparison of age over gender

3.2 Types of Injuries

The number of open globe injuries was 266 (57%) and the number of closed globe injuries was 201(43%). Female patients had more closed globe injuries (55.26%) than open globe injuries (44.74%). Male patients had more open globe injuries (62.21%) than closed globe injuries

(37.79%). There was a statistical significant difference between males and females. Males had more open and closed globed injuries as compared to females.

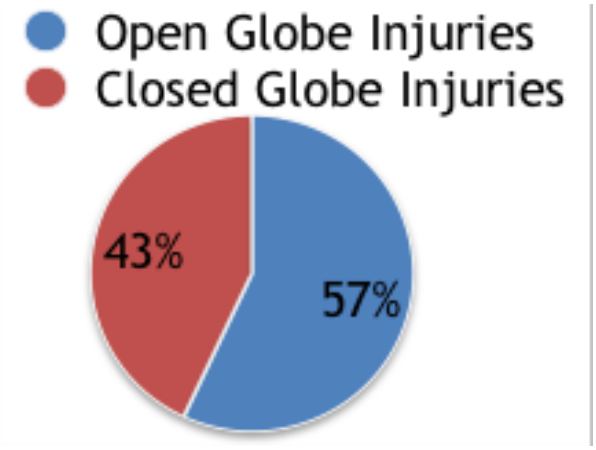


Figure 3.5 Comparison of Open Globe vs Closed Globe Injury

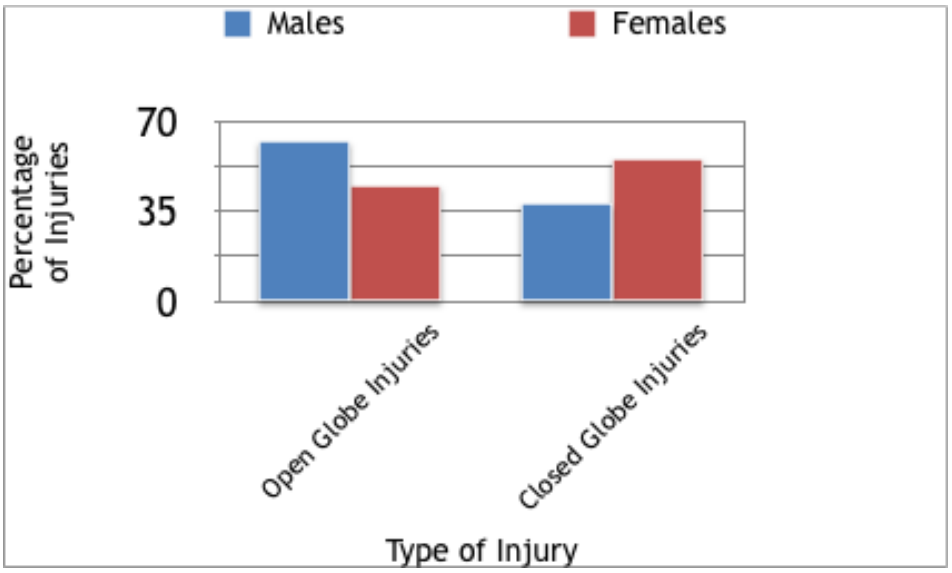


Figure 3.6 Comparison of Types of Injury as per Gender

Table 3.1 Open and Closed Injury as per Gender

	Female	Male	Total
Open Globe	51 44.74%	214 62.21%	265 57.86%
Closed Globe	63 55.26%	130 37.79%	193 42.14%
Total	114 100%	344 100%	458 100%

*p value=0.001

3.3 Types of Surgical Procedures

There were 22 types of surgical procedures performed for patients with traumatic injuries. Corneoscleral laceration repair 14.99% (70 cases) and corneal repair 14.78% (69 cases) were the two most commonly performed procedures. Evisceration and silicone ball insertion 14.13%(66 cases) was the third most performed procedure. Scleral laceration repair 6.42% (30 cases) was the fourth. Lens-related surgery was the fifth (3.85%; 18cases). Open globe procedures were performed more in male patients as compared to females.

Table 3.2 Types of Surgical Procedures

Type of Surgical Procedure		
Procedure	Freq.	Percent
Corneoscleral laceration	70	20.65
Corneal Laceration	69	20.35
Evisceration +/- silicone ball insertion	66	19.47
Scleral Laceration	30	8.85
Cataract Surgery	20	5.9
Orbital Fracture Repair	16	4.72
Foreign Body Removal	15	4.42
Lid Laceration Repair	14	4.13
Canalicular Laceration Repair	9	2.65
Anterior Chamber Washout	7	2.06
Conjunctival Repair	4	1.18
Debridement	4	1.18
Pars Plana Vitrectomy	4	1.18
Lid Reconstruction	3	0.88
Rectus Reattachment	2	0.59
Intravitreal Tap and Antibiotics	2	0.59
Lateral Canthotomy	2	0.59
Facial Laceration Repair	1	0.29
Examination Under Anaesthesia	1	0.29
Total	339	100.00

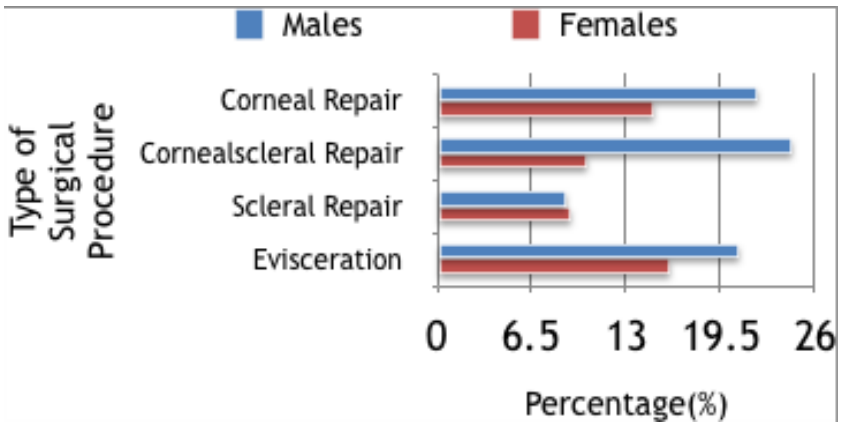


Figure 3.7 Types of Surgical Procedures as per Gender

3.4 Time Interval from Injury to Surgical Management

The number of cases with either corneoscleral injuries, corneal injuries and scleral injuries was 169 cases. The percentage of open globe procedures performed were: corneal repair (40%), corneoscleral repair (41%) and scleral repair (17%). Factors that were considered as affecting the interval between injury and surgical management were type of procedure, gender and age.

Type of Surgical Procedure

For corneal repair, corneoscleral repair, and scleral repair there were 92.75%, 91.43% and 90% of patients respectively who had an interval of more than 24 hours between injury and surgical treatment. There was no statistical difference between procedures (p=0.895).

Table 3.3 Time from Injury to Surgery as per Procedure

	Corneal Repair	Corneoscleral Repair	Scleral Repair	Total
<=24hours	5 7.25%	6 8.57%	3 10%	14 8.28%
>24 hours	64 92.75%	64 91.43%	27 90.00%	155 91.72%
Total	69 100%	70 100%	30 100%	169 100%

*p value= 0.895

Gender

One paediatric patient did not have a gender specified. A total of 168 cases was included in the gender analysis. One hundred percent of the female patients were found to have injury to surgery interval of more than 24 hours. The majority of the male patients (89.86%) had a time interval between injury to surgery of more than 24 hours. There was no statistical significance.

Table 3.4 Time from Injury to Surgery as per Gender

	Female	Male	Total
<= 24 hours	0 0.00%	14 10.14%	14 8.33%
> 24hours	30 100.00%	124 89.86%	154 91.67%
Total	30 100%	138 100%	168 100%

*p value 0.068

Age

The mean age of patients who did not have delay from injury to surgery was 28.5 and for those who did have a delay from injury to surgery was 28.2. The time interval between injury and surgical treatment was more than 24 hours for 89.74% of patients <=18 years and 92.31% for patients >18 years. There was no statistical significance.

Table 3.5 Time from Injury to Surgery as per Age

	<=18 years old	>18 years old	Total
<= 24 hours	4 10.26%	10 7.69%	14 8.28%
> 24hours	35 89.74%	120 92.31%	155 91.72%
Total	39 100%	130 100%	169 100%

*p value 0.610

3.5 Time Interval from Admission to Surgical Management

Type of Surgical Procedure

Patients experienced <24 hours between admission and surgical treatment in 73.91%, 75.71%, 76.67% instances, respectively, for corneal repair, corneoscleral repair and scleral repair. There was no statistical difference between the procedures (p=0.949).

Table 3.6 Time from Admission to Surgery per Procedure

	Corneal Repair	Corneoscleral Repair	Scleral Repair	Total
<=24 hours	51 73.91%	53 75.71%	23 76.67%	127 75.15%
>24hrs	18 26.09%	17 24.29%	7 23.33%	42 24.85%
Total	69 100%	70 100%	30 100%	169 100%

*p value 0.949

Gender

For male patients 79.71% (110 cases) of the patients had a time interval between admission and surgery of less than 24 hours. For female patients 53.33% of them had a time interval from admission to surgical treatment of less than 24 hours. There were 20.29% of male patients who had more than 24-hour delay between admission to surgery. That was less than 46.67% of the female patients who had a delay of more than 24 hours between admission and surgery. There was a statistical difference between the two genders (p=0.002).

Table 3.7 Time from Admission to Surgery as per Gender

	Female	Male	Total
<= 24 hours	16 53.33%	110 79.71%	126 75.00%
> 24 hours	14 46.67%	28 20.29%	42 25.00%
Total	30 100.00%	138 100%	168 100%

*p value 0.002

Age

For patients <=18 years, 87.18% of them had surgery less than 24 hours post-admission and 12.82% had surgery more than 24 hours post admission. For patients >18 years 71.54% had surgery less than 24 hours post-admission and 28.46% had surgery more than 24 hours post-admission. The percentage difference between the two age categories was statistically significant (p=0.047) for more than a 24-hour delay from admission to surgical management.

Table 3.8 Time from Admission to Surgery as per Age

	<=18 years old	>18 years old	Total
<= 24 hours	34 87.18%	93 71.54%	127 75.15%
> 24hours	5 12.82%	37 28.46	42 24.85%
Total	39 100%	130 100%	169 100%

*p value 0.047

3.6 Reasons for Delay of Surgical Management

Thirty-two patients had the reasons for delay of ocular surgery documented in the inpatient files. Of these 32 patients, 61% had delay of surgery due to not enough general anaesthetic time on the surgical slate. The second reason (23%) for surgical delay was patient factors: for example, in one case, a paediatric patient was coughing, so the surgery had to be postponed. In another case, the patient had eaten. The third reason (13%) related to the anaesthetic, and included availability of oxygen and/or of an anaesthetist.

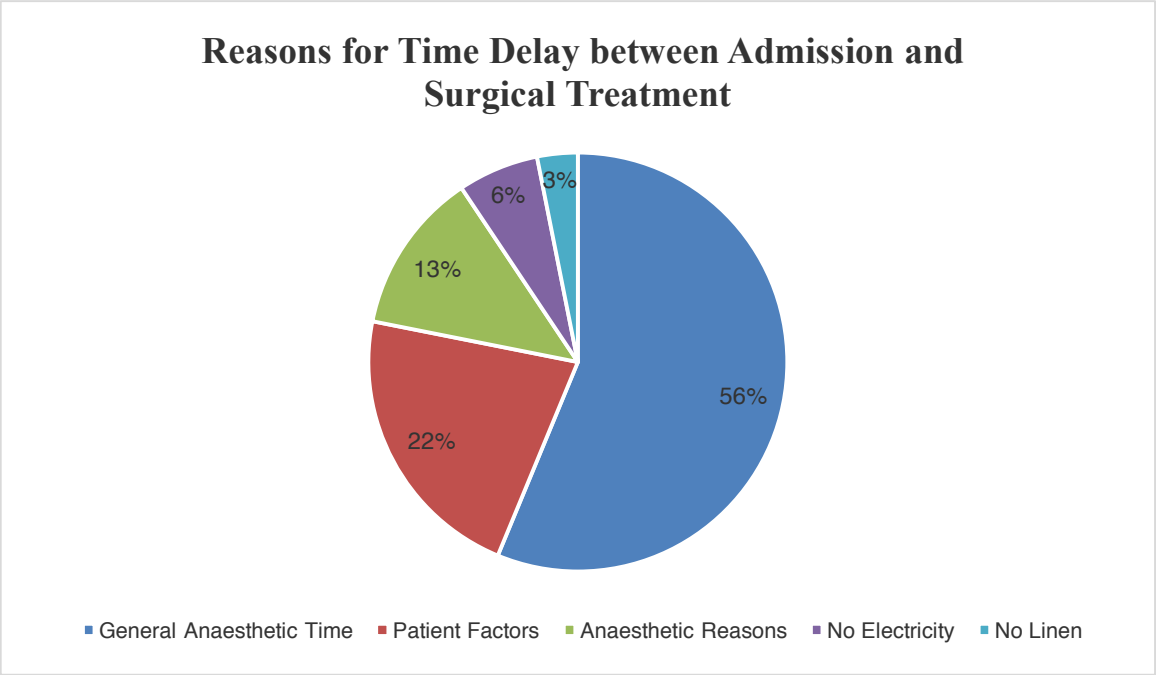


Figure 3.8 Reasons for the time delay to surgical management

3.7 Seasonal Variation

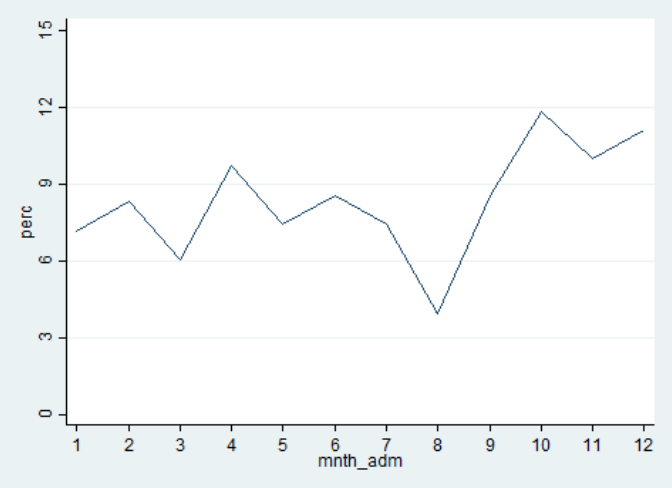


Figure 3.9 Number of admissions of patients with ocular trauma

The highest number of admissions was towards the end of the year, peaking in the period from October to December. There was no correlation between seasons and the volume of admissions.

Chapter 4: DISCUSSION

Information available on the distribution, magnitude and frequency of ocular trauma in developing countries is very scarce. The existing data is difficult to interpret because reporting is extremely poor and especially because of the various settings of the occurrence of ocular trauma.[3] The primary objective of this study was to determine if the recommendation of surgical management of open globe trauma within 24 hours of the injury was being adhered to at St John Eye Hospital, a tertiary institution in Johannesburg. The secondary objectives were to determine the epidemiology of patients admitted due to trauma and to determine the types of ocular trauma that were admitted to the institution. St John Eye Hospital is located in Soweto because of the previous apartheid government's Group Areas Act, a large number of African patients reside in the surrounding area. It is the iconic township where the uprisings took place, and where there is still a high rate of violence. The high rate of violence results injuries, including ocular injuries.

The study included 467 patients admitted to the St John Eye Hospital secondary to trauma from 01 January to 31 December 2014. In this study 75% of the study population were males and 25% were females. Ninety eight percent of the study population were African. This is similar to the findings reported in the literature. Sukati *et al* reported similar findings in Kwa-Zulu Natal, a rural setting in South Africa. They reported that males constituted 68.9% of their study population and that 97.7% of their study population were African.[12] Balaghafari *et al* conducted their study in the city of Sari in Iran between 2009 and 2010. They reported that 75.8% of their study population were men and 24.2% were women.[2] Serrano *et al* conducted a study investigating the epidemiology of childhood ocular trauma in Columbia. They reported that in their paediatric population, 64.9% were males.[3] Khatry *et al* conducted a study in Nepal. They

reported a relative risk of injury for males compared to females of 1.74 (95% CI 1.45 to 2.09).[11] This demonstrated that males are more at risk of ocular trauma compared to females. The difference is most likely due to occupational hazards and more frequent involvement of males in violent activities.[2]

In this study, the majority of patients were in the younger age group between the ages of 20 and 45 years. The mean age for this study was 29 years. The maximum age was 89 years and the minimum age was 10 months. The mean age for patients with open globe injuries was 27 years. Sukati *et al* reported that their study population ages ranged from 1 year to 89 years with a mean and standard deviation of 29 years ±16.82 respectively. Furthermore, the 21 to 30 year age group (31.4%), was the most affected followed by the 31 to 40 year age group (20.9%), the 0 to 12 year age group (12.7%). Patients over 65 years (2.3%) were the least affected. [12] Du Toit *et al* reported a mean age for males of 32.6 (+/-11.7) years and females 34.5 (+/-14.8) years[24]. Gyasi *et al* reported that the mean age was 18.4 years. Patients less than 30 years constituted 82.3% of their study population.[13]Khatry *et al* conducted a study in Nepal, in a rural setting, and reported an age range from newborn to 87 years with a mean age of 28.1 years.[11]

In this study, the most affected age group was between 20 to 45 years. This is the age group that forms the most productive part of society. The injuries have major financial implications for patients and the society. [2] At this age people are making career choices. Monocular blindness limits the career options of an individual; for example, they cannot be employed as a heavy vehicle driver or a heavy machinery operator. It also has psychosocial implications as it may affect the individual's intimate relationships or work-related relationships. Binocular blindness then makes an able-bodied person disabled and dependent on other people and social

systems for financial assistance. This is the reality that affects young males as they are the most affected by ocular trauma as demonstrated in this study and in the literature.

Of the169 patients with open-globe injuries, 130 (76.92%) patients were over the age of 18 years. Thirty-nine of the patients (23.08%) were younger than 18 years. Children constituted the least number of the study population. This is related to the cause of open-globe injury. Madhusudhan *et al.* conducted a study at the Hospital University in Sains Malaysia. The aim of the study was to identify the aetiology of open-globe injury presenting to the hospital over a 10-year period from January 2000 to December 2009. They reported that in children less than 16 years old domestic related injuries were the commonest (54.6%), animal or agriculture related injuries accounted for 23.7% of injuries seen. In the people over 16 years of age the commonest type of injuries were occupational injuries (40%) followed by MVA (24%). The domestic injuries were acquired while playing, Do-It-Yourself activities and falls.1 Fifty seven percent (266 cases) of the ocular injuries were open globe injuries versus 43% (201 cases) closed globe injuries.

These findings are similar to those of Gyasi *et al* who conducted their study in the upper east region of Ghana in a rural setting. They reported open globe injuries of 62.5%.[13] Sukati *et al* likewise reported open globe injuries of 56.1% and closed globe injuries of 43.9% in a rural setting in Kwa Zulu Natal.[10] Du Toit *et al* conducted their study in Cape Town, a mixed rural and urban setting. They reported 142 (34.6%) closed globe injuries and 249(63.7%) open globe injuries. Assault accounted for 183 (73.5%) injuries and accidental injuries accounted for 66 (26.5%) injuries.[24] This is in contrast with Chen *et al* who conducted their study in an industrialised setting in Taiwan. They reported open globe injuries (34%) and closed globe injuries (49.4%).[16] Similarly, Fea *et al* conducted their study in an industrialised city in Italy.

They reported open globe injuries to be 0.66% of their cases in their study.[15] The National Eye Trauma System Registry in the USA collected data from 1985 to 1991 on 2939 cases of open globe injuries at 48 eye trauma centers. They reported that 77% of the open globe cases were the result of accidental injuries and 22% the result of assault.[25] This finding is important as open globe injuries have a worse visual prognosis as compared to closed globe injuries.[1,3] In a resource-limited setting this has major financial and psychosocial implications for individuals who are affected, available medical resources, and broadly, society.

In most rural poor communities, injuries occur primarily in the agricultural sector, compared to developed urban communities where injuries are more likely to be related to industrial activities.[13] Gyasi *et al* reported that 51.1% of injuries were caused by sharp objects, 41.3% by blunt objects and 7.1% were indeterminate.[13] Du Toit *et al* reported that 73.5% of open globe injuries were the result of assault and 26.5% were accidental. The objects used to cause the open-globe injuries were knives (19%), bottles (19.35%), glass (12.1%), stick (4%), stone (4%), fist (2.8%), car door (0.4%) and unknown (35.6%)[25].

In another study, conducted by May *et al* on the epidemiology of serious eye injuries from the US eye injury registry, they reported that in 30% of cases the injury was caused with blunt objects and in 18% of cases with sharp objects. Other causes were motor vehicle accidents, gunshots, nails, pellet guns, fireworks and falls.[4] These studies illustrate that in non-developed or rural areas the injuries are mainly the result of sharp objects used during violent altercations. In Cape Town, South Africa, these objects have been used to assault people. In developed countries, the injuries are more often accidental and blunt objects are the chief cause of injuries in the majority of cases.[4]

In this study males constituted the majority of the open globe injuries (214 cases; 80.75%) as compared to female patients (51 cases; 19.92%). The study showed that female patients had more closed globe injuries (55.26%) than open globe injuries (44.74%). Males had more open globe injuries (62.21%) than closed globe injuries (37.79%). This is statistically significant with a p-value of 0.001. Sukati *et a*l reported that blunt trauma was more common in females (39.1%) as compared to males (31%). They also reported that penetrating injuries were more common in males (14.4%) as compared to females (13%)[12]. A study conducted at the Massachusetts Eye and Ear Infirmary in the USA, investigating the patterns of injury and outcomes after multi-system trauma over a 3-year period, reported that men are more likely to suffer penetrating injuries and women more likely to experience blunt globe rupture.[25] This demonstrates that males are more prone to getting involved in more harmful or dangerous activities that result in more severe ocular injuries.

Three hundred and thirty-seven patients (337) had surgical procedures. There was a total of 169 patients who had either corneal laceration or corneo-scleral laceration or scleral laceration repairs. In the study, it was found that 14.78% patients had a corneal laceration repair, 14.99% had a corneo-scleral laceration repair, whilst only 6.42% had a scleral laceration repair. Evisceration and silicone ball insertion (14.13%) was the third most commonly performed surgical procedure. As this procedure involves removal of the ocular contents, it results in patients being monocular. This procedure was performed on 66 (14.13%) patients, the majority being males. This further illustrates that males are more prone to being involved in more aggressive activities or occupations that expose them to various situations that result in more severe ocular injuries requiring surgical intervention as management. This may further impact on their socio-economic status, necessitating that they change their jobs, as the majority of these patients who are employed work as mechanics, drivers and manual labourers.[13]

One hundred and three (103) patients received various other surgical procedures that included intracapsular cataract extractions and lens washout (5.9 %), orbital fracture repairs (4.72%), foreign body removals (4.42%), repair of lid laceration (4.13%), lid laceration with canalicular repair (2.65%), anterior chamber washouts (2.06%), and conjunctival laceration repairs (1.18%). Furthermore, pars plant vitrectomies (1.18%), wound debridement (1.18%), extraocular muscle reattachments (0.59%) and lateral canthotomies (0.59%) were also amongst the procedures for trauma that were performed. Du Toit *et al* reported that the primary procedures were 70.3% repairs, 24.5% eviscerations and 5.2% others. The secondary procedures were 25% globe evisceration, 22.9% cataract extraction and lens implant, 16.7% intraocular lens implant, 8.3% retinal detachment surgery, 8.3% eyelid surgery, and 2.1% squint surgery.[24]

Prompt diagnosis, referral and treatment are some of the factors that are associated with visual prognosis.[3] Several factors have been hypothesised to have an influence on the time interval to surgical management: namely, the type of surgical procedure, the age of the patient, as well as the gender of the patient. There was no difference in the time delay between the types of surgical procedures. From injury to surgical management 90 to 92.75% of patients had a time delay of more than 24 hours. From admission to surgical management 73.91 to 76.67% of patients had a time interval of less than 24 hours. The time delay to surgical management is mainly due to the late presentation of patients after their injury. The ocular repair procedures were delayed in 23.33 to 26.09% of patients. This is a high percentage of patients who still have delayed surgical repair after admission. Gyasi *et al* reported that 57.3% of patients presented between 24 to 48 hours after injury and the remaining patients (42.7%) presented within one week or thereafter. [13]

The majority (89.74%) of patients younger than 18 years old had a time interval between injury and surgical management of more than 24 hours. For patients older than 18 years, 92.31% had a time interval between injury and surgical management of more than 24 hours. There was no statistical difference between the two age groups. This shows that most patients, regardless of their age, present late to the institution for surgical management. Possible reasons may be delayed referral from the primary care centers, or the patients presenting late to the referring centre themselves.

Age was found to have an impact on time delay to surgical management after admission. There was a marginal statistical difference (p-value = 0.047) in the time delay between admission and surgical management of patients under the age of 18 compared with those who were older than 18 years old (12.82% vs 28.46%). This may be because children are prioritised on the surgical slate. Patients older than 18 years old may not have been prioritised over elective cases on the surgical slate. This finding has not been reported in the studies conducted in the literature. This could be because all open globe injuries need to be repaired within 24 hours of the ocular injury irrespective of age.

Khatry *et al* reported that 48.5% of patients presented to primary eye care clinics, 42% presented to the local pharmacies, doctors or health-posts and 10% presented to the traditional healers. When the first place of presentation was at a local pharmacy or health-post the mean time to seeking treatment was 2.5 days. The mean time between occurrence of injury and presentation to their eye clinic was 7.8 days. The mean time between the incident of injury and any form of eye care, regardless of location was 7 days.[11] This highlights the need for patients

and health-care staff at primary and secondary level centers to be educated about the importance of urgent referrals of these cases.

Serrano *et al* conducted a study in Brazil investigating the epidemiology of ocular trauma in children. They reported that 73.7% of children were examined within the first 24 hours of their injury. The remaining patients (26.3%) were examined more than 24 hours after trauma. They demonstrated that the delay in presentation was due to distance (40.5%), money (22%), negligence (19.7%), delayed referral (10.6%), and no symptoms (9.1%).[3] The reasons for delay between occurrence of injury and presentation to the hospital have not been demonstrated in this study and therefore further studies are warranted.

Surgical treatment cannot be performed within the recommended 24 hours of injury if the patient presents late to the appropriate center for definitive surgical treatment. Du Toit *et al* reported that 14.8% (25 cases) had <24 hours time interval between injury and surgical intervention and 85% (144 cases) had >24 hours post injury. This study was conducted in a developing country. Of the delayed repairs 31.4% occurred >72 hours post injury. The mean time from injury to surgical treatment was 3.3 days for all cases.[24] A retrospective study conducted in India reported a time interval from injury to surgical intervention of 4 days[15] Gyasi *et al* reported that in the Northern region of Ghana, a rural setting, only 33% of patients reported within 24 hours of injury while 21% reported more than one week after injury.[11] A retrospective study conducted in Australia, reported that the average time from injury to surgery was 1.5 days.[24] This contrast between developing and developed countries illustrates the point that perhaps the level of patient education, the availability of health services and the training of the health staff play a role in patients receiving surgical treatment promptly.

In this study 46.67% of the female patients had a time delay of more than 24 hours. There were 20.29% of the male patients who had a >24-hour delay post admission. There was a statistical significant difference between the two genders (p=0.002). This may be confounded by a reduced number of female patients needing surgical treatment of their ocular injuries. These results appear to be biased towards males since there are a greater number of male patients with open globe injuries and therefore requiring surgery.

The reasons for the time delay to surgery in this study included the lack of general anaesthetic time (56%), patient factors (22%), anaesthetic reasons (13%), the non-availability of electricity (6%), and the lack of linen (3%). The lack of general anesthetic time is because of elective cases being prioritised over emergency cases. There is also a lack of a dedicated theatre and anaethetist for trauma cases on a daily basis at St John Eye Hospital. As mentioned previously, younger age was a factor that influenced the decision-making in prioritizing the patient with ocular trauma on the surgical slate. The second reason is various issues regarding the anaesthetic staff. This may be because of no anaesthetist being allocated to the ophthalmic theatre on weekends. It could also be that the general equipment and gases needed to perform general anaesthesia, for example, oxygen, often do not function optimally. Patient factors also played a role in the time delay post admission. One patient had eaten on the morning of his surgical procedure. Patient factors constituted 21.88% of the reasons for time delay to surgical management. Other reasons were a lack of linen as well as electricity failure. This highlights the point that reasons for delay are often modifiable reasons.

In this study, there was no statistically significant variation in seasonal pattern seen. There was however a peak in admissions of patients with ocular trauma from October to December. This

may be attributed to the holiday season that occurs around this time in South Africa. Also, it may be that it is the summer season and people are more active and more prone to be involved in outdoor activities. During this period most South Africans begin preparing for the holiday season celebrations and get involved in recreational activities that at times may involve alcohol. Gyasi *et al* reported a bimodal distribution over one year. There was a rise in cases between March to May and September to November. These patterns were prominent in the farming and schooling occupational groups. This was attributed to an increase in the farming activities in the region.[13] Serrano *et al* reported clusters in November to January and in August and September. They attributed the cluster in November to January to children being out of school and the Christmas and New Year holidays. Children have access to fireworks, and they spend more time outside playing with friends and neighbours, with less adult supervision.[3]

As with all retrospective studies there are several limitations to this study. The first limitation is due to poor record keeping by healthcare staff. This resulted in patients being excluded from the study because their diagnosis was not noted in the file as being as a result of trauma for example retinal detachments, eviscerations and cataracts. Patient diagnosis was noted as trauma on some of the files and was not specified as what type of injury. A limited number of patients had the reasons for their delay of surgery documented in their inpatient files. Secondly, the date of injury was not documented in the majority of the patient files. A third limitation is that nine of the paediatric patients did not have their genders noted in the file and therefore may bias the results.

Chapter 5: CONCLUSION

Conclusion

The demographic findings in this study correlate with what has been reported previously in the literature: that ocular trauma is more common among young males. These are mainly young patients who are seeking work opportunities and are starting to gain financial independence in a challenging economy where the unemployment rates are currently unprecedented. Open globe trauma may result in poor visual acuity. Monocular visual impairment undoubtedly limits jobs where binocular single vision forms an essential part of the job description. Bilateral visual impairment converts people who are independent and productive into people who are dependent on social welfare because of poor visual acuity. The majority of these patients in the study were African. This is because the hospital is located in Soweto and the majority of the population is African because of the land act of the previous apartheid regime. The majority of admitted patients had open globe injuries. The major time delay to surgical treatment was because of delayed presentation of the patients. In the majority of cases, the time interval from admission to surgical management was less than 24 hours. Patients who were less than 18 years old had their surgeries prioritised more often than patients who were older than18 years old. In the cases which were delayed post-admission, the reasons for delay were due to poor prioritisation by the surgical staff, logistical system failures, failure of anaesthetic equipment, non-availability of the anaesthetic staff on weekends and various patient factors. This study demonstrated that there is a significant number of patients who still do not receive prompt surgical management within 24 hours of ocular injury as recommended in the literature. The services need to be improved to allow this.

Recommendations that arise from this study are the following:

- Logistical factors need to be rectified to improve the time interval from admission to surgical management.
    - An anaesthetist needs to be allocated on weekends for ocular trauma cases.
    - Functioning equipment and services need to be installed to reduce the system failures.
    - Nursing staff need to ensure patients are prepared for theatre to ensure patient factors are eliminated.
- Patients with ocular trauma need to be prioritised over elective cases as this will result in a greater adherence to the recommended 24-hour post injury interval
- Further investigation has to be conducted to determine the reasons why patients present to the health facility late.
- The causes of ocular trauma in this setting and study population needs further investigation because this will assist in finding ways to reduce the number of ocular injuries.
- The visual outcomes in patients with ocular trauma need to be studied as this will assist in knowing the severity of injuries, the factors that affect visual acuity and the prognosis of visual acuity in our patient population.
- There needs to be education and training of health professionals at primary and secondary health facilities about the importance of prompt referral of patients with ocular trauma.
- There needs to be community education to raise awareness about the importance of seeking medical help after ocular injury.

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Appendix A: Capture Sheet

Case Number	Age	Gender	Diagnosis at time of Admission	Date of Injury	Date of Admission	Date of Surgery	Right/ Left Eye	Surgical Procedure	Reason for Time Delay