"PROFILE OF OCULAR TRAUMA AMONG PATIENTS IN AND AROUND KOLAR ATTENDING A TERTIARY CARE HOSPITAL"

By

DR.JYOTSNA SHARMA

Dissertation Submitted to
SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH
KOLAR

In partial fulfillment
Of the requirements for the degree of

MASTER OF SURGERY
IN
OPHTHALMOLOGY

Under the Guidance of

DR. KRISHNAMURTHY D. M.B.B.S., M.S.,

DEPARTMENT OF OPHTHALMOLOGY
SRI DEVARAJ URS MEDICAL COLLEGE
TAMAKA, KOLAR

(APRIL - 2016)

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled

"PROFILE OF OCULAR TRAUMA AMONG PATIENTS IN AND AROUND KOLAR ATTENDING A TERTIARY CARE HOSPITAL"

is a bonafide and genuine research work carried out

by me under the guidance of

DR.KRSHNAMURTHY D, M.S.

Professor

Department of Ophthalmology

Sri Devaraj Urs Medical College

Kolar, Karnataka.

.

DATE: SIGNATURE OF THE CANDIDATE

PLACE: KOLAR **DR. JYOTSNA SHARMA**

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled

"PROFILE OF OCULAR TRAUMA AMONG PATIENTS IN AND AROUND KOLAR ATTENDING A TERTIARY CARE HOSPITAL"

is a bonafide research work done by

DR. JYOTSNA SHARMA

Under my guidance and supervision,

in partial fulfilment of the requirement for the degree of

M.S. IN OPHTHALMOLOGY.

SIGNATURE OF GUIDE

Date:

Place:

DR.KRISHNAMURHTY .D, M S

Professor

Department of Ophthalmology,

Sri Devaraj Urs Medical College,

Tamaka, Kolar

ENDORSEMENT BY THE HOD, PRINCIPAL / HEAD OF THE INSTITUTION

This is to certify that the dissertation entitled

"PROFILE OF OCULAR TRAUMA AMONG PATIENTS IN AND AROUND KOLAR ATTENDING A TERTIARY CARE HOSPITAL"

is a bonafide and genuine research work carried out by

DR. JYOTSNA SHARMA

under the guidance of

DR.KRISHNAMURTHY D, M.S

Professor

Department of Ophthalmology

Sri Devaraj Urs Medical College

Seal & Signature of the HOD	Seal & Signature of the Principal
Dr. K.KANTHAMANI, *M.S.*	**Dr. B.G. RANGANATH,** *M.D.*
Professor and H.O.D.	Principal
Department of Ophthalmology	Sri Devaraj Urs Medical College
S.D.U.M.C., Tamaka, Kolar.	Tamaka, Kolar.
Date:	Date:
Place:Kolar	Place : Kolar

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION & RESEARCH

ETHICAL COMMITTEE CERTIFICATE

This is to certify, the ethical committee of

Sri Devaraj Urs Medical College, Tamaka, Kolar

has unanimously approved,

Dr. JYOTSNA SHARMA
Post Graduate student in the subject of Ophthalmology

at Sri Devaraj Urs Medical College, Kolar

to take up the dissertation work titled

"PROFILE OF OCULAR TRAUMA AMONG PATIENTS IN AND AROUND KOLAR ATTENDING A TERTIARY CARE HOSPITAL"

to be submitted to Sri Devaraj Urs Academy of Higher Education and Research, Kolar, Karnataka

Signature of Member Secretary — Signature and seal of the Principal

Ethical committee — **Dr. B.G.RANGANATH**

Date: — Sri Devaraj Urs Medical College

Place: Kolar — Kolar, Karnataka

COPYRIGHT

DECLARATION BY THE CANDIDATE

I hereby declare that the Sri Devaraj Urs Academy of Higher Education And Research, Kolar shall have the rights to preserve, use and disseminate this dissertation in print or electronic format for academic / research purpose.

Date: Signature of the Candidate

Place: Kolar

Dr. JYOTSNA SHARMA

Post Graduate student

Department of Ophthalmology

Sri Devaraj Urs Medical College

Kolar, Karnataka.

ACKNOWLEDGMENT

It is with great reverence, deep sense of gratitude and respect that I would like to Thank my teacher and guide, **DR. KRISHNAMURTHY.D, M.B.B.S.,M.S,** Professor in Department of Ophthalmology, Sri Devaraj Urs Medical College Tamaka, Kolar for her guidance, encouragement, and valuable insights during the entire period of this study and postgraduation course.

I want to express my profound gratitude to **Dr K. KANTHAMANI,** Professor and HOD and my professors **Dr.NARENDRA.P.DATTI**, **Dr.M.S.PADMAJOTHI**, Department of Ophthalmology Sri Devaraj Urs Medical College Tamaka, Kolar whose knowledge and experience has guided me throughout my post graduation course.

I would like to express my heartful thanks to **DR.NAGESHA** for his constant help, patience, encouragement and suggestions during this study.

I would like to express my heartful thanks to my Assistant Professors **DR.USHA B.R, DR.RAJESHWARI**, **DR. RASHMI**, **DR.RANJITHA.C.S,** Department of Ophthalmology, Sri Devaraj Urs Medical College Tamaka, Kolar for their help and suggestions rendered to me during this study.

I am immensely thankful to all my PG Colleagues especially **Dr.Preeti, Dr.Bindushree, Dr.Rickey, Dr.Chandan, Dr.Dilip, Dr.Shalini** & **Dr.Sneha** for their timely support and encouragement.

My gratitude and thanks to **Dr.B.G.Ranganath** M.D, (Community medicine), Principal, Sri Devaraj Urs Medical College Tamaka, Kolar , for letting me use the college and hospital facilities and resources.

I would like to thank my parents **MR H.S.SHARMA, Mrs. Saroj Sharma , and my dear sisters Dr. Neha, Dr.Shweta, Dr. Trisha** for having the confidence in me and standing by me in my difficult times, and whose cherished blessings and countless sacrifices are behind every success I have achieved in my life

My heartful gratitude to all **my patients** who submitted themselves most gracefully and whole heartedly participated in this study. I sincerely thank my institute Sri Devaraj Urs Medical College,Tamaka , Kolar for giving me a wonderful foundation and forum of knowledge in the field of Ophthalmology which stands for the rest of my life. Last, but not the least, I would like to express my gratitude to the **almighty** for all his blessings .

Date: **Signature of the Candidate**

LIST OF ABBREVIATIONS USED

SL. NO.	ABBREVIATION	FULL FORM
1.	BCVA	Best corrected visual acuity
2.	CT	Computed tomography
3.	DOV	Diminution of vision
4.	D	Diopter
5.	HM +	Hand movements present
6.	HTN	Hypertension
7.	PCIOL	Posterior chamber intraocular lens
8.	SCH	subconjunctival hemmorhage
9.	IOFB	intraocular foreign body
10.	MRI	Magnetic resonance imaging
11.	BB	ball bullet
12.	RIOFB	Retained intraocular foreign body
13.	RTA	Road traffic accident
14.	RAPD	relative afferent pupillary defect
15.	Yrs	Years
16	CGI	closed globe injury
17	OGI	Open globe injury

ABSTRACT

TITLE OF THE TOPIC: PROFILE OF OCULAR TRAUMA AMONG PATIENTS IN AND AROUND KOLAR ATTENDING A TERTIARY CARE HOSPITAL

NEED FOR THE STUDY:

Eye injuries are the major and unrecognized cause of disability and ocular morbidity and especially affects the young. Although nature has provided bony walls and lids to cover the eyes to protect it from injuries, it is exposed to all types of injuries. The public health importance of such ocular trauma is undeniable.

The incidence of ocular injuries is constantly on rise, it is difficult to accurately measure or even estimate the incidence of eye injuries. Approximately 1.6 million people are blind owing to ocular trauma, 2.3 million are bilaterally visually impaired and 19 million have unilateral visual loss. The impact of trauma on a human eye may range from occurance of minute corneal abrasions, subconjunctival haemorrhages to a badly lacerated globe .In most cases of ocular injuries it is the anterior segment of the eye which bears the burden of the direct and indirect force of the injuries

Objectives of the Study:

1) To analyze the clinical pattern - type of trauma, risk factors, circumstances, time gap between injury and presentation.

2) To assess the final visual outcomes

MATERIAL AND METHODS:

Source of Data:

A total 250 patients of all age group with ocular trauma were included in the study.

All patients fulfilling the inclusion criteria underwent ocular examination after taking

informed consent. In all cases a detailed demographic history was taken including address their literacy status, occupation and financial status. A detailed clinical history was also taken which included history of the mishap, cause of injury, and nature of circumstance.

The ocular examination including visual acuity, slit lamp examination, a dilated fundus examination with direct ophthalmoscope and indirect examination with 90D lens was carried out. Cases with hazy media have undergone a B scan to evaluate posterior segment. An Intra ocular tension was measured in all patients except people presenting with open globe injuries. A gonioscopy exam was done for patients with closed globe injuries. All the details were recorded as per proforma.

The time gap between injury and surgical intervention noted and type, nature of surgery done and post-op details were documented as per proforma.

The cases were managed according to the nature of injury and severity . Day to day clinical observations were recorded of all admitted patients till discharge. Periodic follow up was done at 1 week, 1 month, 3 months and 6 months.

RESULTS Age –wise analysis showed that ¼ th (24.4%) of patients were in age group between 21-30 years and males outnumbered females by ratio of 3.6:1. RE was involved (48%), 117 cases LE was involved (46.8%). Both eyes were involved in 13 cases(5.2%).It was observed that highest incidence of blunt injuries was among students 91(36.4%) followed by business 38(15.2%) and manual labour 22 (8.8%) industrialist 16 (6.4%) .Eyelid inuries are majority of the times associated with either closed or combined globe injuries hence accounting to 84.8% in present study

INTERPRETATION AND CONCLUSION

Road traffic accidents under the influence of alcohol was the most common cause of ocular trauma. The current study points towards students as the high risk groups. Most common object causing ocular trauma was foreign body and stone. Visual acuity at time of presentation and final outcome varied significantly. These patients can be educated about safety measures to prevent ocular trauma and its consequences and to undergo treatment at the earliest to prevent permanent blindness

KEYWORDS: Ocular trauma, Road traffic accidents, Visual acuity, Blunt trauma

TABLE OF CONTENTS

LIST OF TABLES

LIST OF GRAPHS

LIST OF FIGURES

LIST OF PHOTOGRAPHS

INTRODUCTION

Ocular trauma is a major cause of monocular blindness and visual impairment throughout the world. Very little is known about its epidemiology or associated visual outcome in developing countries, unlike other major blinding conditions such as cataract, trachoma, xerophthalmia, where epidemiological studies have contributed much.

Ocular trauma is an important, preventable public health problem worldwide. Half a million people in the world are blind as a result of ocular injuries. As reported in many studies, nearly 40% of monocular blindness is related to ocular trauma. [1,2,3] In India, National Program for Prevention of Visual impairment and Control of Blindness reported 1.2% blindness due to injury.[4]

These injuries can occur in almost any setting involving recreational and sport related activities, workplace, home, rural, agricultural setting and road traffic accidents. Prsesentation of ocular trauma may vary from minor injuries like subconjunctival hemorrhage to perforating injuries. According to a study by Gupta et al [5] it was observed that 1.16% of total blindness was due to ocular trauma while as per Dada et al study in 1984, 5.55% people were totally blind due to ocular trauma. [6]

High rates of ocular injury in young adults have been observed consistently in nearly all descriptive and controlled epidemiologic studies. This high incidence reflects a high proportion of work, assault, sports, and motor vehicle crash-related ocular injuries in the young adult age group particularly among young men [7,8,9,10].

The impact of ocular trauma in terms of need for medical care, loss of income and cost of rehabilitation services clearly points towards the strengthening of preventive measures worthwhile and also many studies have acknowledged that with the knowledge

of circumstances of injury, their nature and damage caused, early appropriate management can be taken and preventive measures may be advised.[7]

The demographic profile and clinical pattern of eye injuries can be very diverse depending on occupation, nature of domestic injuries and other factors like culture, habitat, risk factors associated with geographic area.

There is wide variation in clinical spectrum of ocular trauma between different regions, different countries and so the preventive measures. Study of regional variation and risk factor evaluation for ocular trauma is more appropriate and rationalistic approach to curb this menace.

It was in great need to know the burden of visual impairement and possible risk factor evaluation due to ocular trauma in our set-up which is predominantly rural – urban transition zone located in southern part of India.

Thus, this study has been undertaken to know the CLINICAL profile of ocular trauma which includes modes of clinical presentation, the demographic profile, management of injuries, prognostic indicators for visual outcome and common causes of visual disability.

OBJECTIVES OF STUDY:

1) To analyze the clinical pattern - type of trauma, risk factors, circumstances, time gap between injury and presentation.

2) To assess thefinal visual outcomes.

REVIEW OF LITERATURE

LITERATURE SURVEY:

WHO has reported 55 million eye injuries causing restriction of daily activities, of which 1.6 million go blind every day. Vats et al., have reported the prevalence of which 1.6 million go blind every day, and prevalence of ocular trauma to be 2.4% of population in an urban city in India, 11.4% of these being blind.[11]

A study by Kadappu S et al [12], on the aetiology and outcome of childhood open and closed globe eye injuries in Sydney, showed that 122 had closed globe injuries. Parameters affecting the final visual outcome such as type of injury, zone of injury, initial visual acuity, wound length (only in open globe injuries) and lens injury were assessed. Most of the eye injuries resulted from the child poking itself or being poked accidentally (26%), with the home being the most common place of injury.

A favourable visual outcome was noted with closed globe injuries as compared with open globe injuries ($P < 0.01$). Parameters that indicated a poor visual outcome included globe ruptures, zone 3 injuries, poor initial visual acuity, wound length >10 mm and lens trauma. Final visual acuity of 6/12 or better was observed in 68% of injured eyes.

Misra et al, [12] studied 60 patients of ocular trauma in a rural area of Western India where ocular injuries were more commonly seen in adult (55 per cent) patients who were associated with agricultural work (43.33 per cent). They were more common in male patients (71.67 per cent). Closed globe injury (68.33 per cent) was more common than open globe injury (31.67 per cent). Both in open and closed globe injuries, the commonest object causing injury was a wooden stick. Only 26.7 per cent of the patients

had a visual acuity better than 6/60 at presentation; while after completed treatment at two months follow-up, 68.3 per cent had best corrected visual acuity better than 6/60. Hence agricultural trauma is an important cause of monocular blindness in rural India. The visual outcome depends upon the site and size of the injury and the extent of the ocular damage.

A five year retrospective study by Salvatore Cillino et al,[13] showed that of the 298 eyes studied, there were 152 closed globe injuries. The annual incidence of eye injuries was 4.9 per 100,000. Most injuries occurred in men (84.6%, $p < 0.0005$), with an average age of 33.0 vs. 49.9 for women ($p = 0.005$). Cause of injury differed significantly by gender ($p = 0.001$) and urban vs. rural location ($p = 0.009$).

The most frequent causes in men were outdoor activities related injuries (30.9%), work-related (25.4%), and sport-related (17.5%), and in women were home-related (52.2%) and outdoor activities related injuries (30.4%). In urban areas, road accidents were more frequent; in rural areas, work-related injuries were more frequent with a greater rate of intraocular foreign bodies (IOFBs) than in urban areas. The incidence of open globe injuries (OGI) and closed globe injuries (CGI) differed in work-related injuries ($p < 0.0005$), sport-related injuries ($p < 0.0005$), and assaults ($p = 0.033$). Initial visual acuity was found to be correlated with final visual acuity.

According to "The Aravind Comprehensive Eye Survey" on "Ocular trauma in a rural South Indian Population",[14] prevalence of blindness in any eye caused by trauma was 0.8%, Odds ratio for trauma was higher for males and laborers and lower in literates. In this study, it was concluded that ocular trauma is to be considered as a priority in South Indian population, because lifetime prevalence of ocular trauma is higher than that

reported for glaucoma, age related macular degeneration or diabetic retinopathy for this population.

Simple measures such as education regarding the use of protective eye wear could possibly significantly decrease this preventable cause of visual disability.[15]

R V Azad et al did a study to know the profile of ocular trauma at tertiary eye centre. Out of total 523 eyes registered large proportion was <25years of age (67%), males (88%) and literate (77%). Forty-four percent belonged to rural area and 38% were students. Most of the open globe injuries were Zone 1(50.8%). 75% presented >1 week after injury. The incidence of intraocular foreign body and retinal detachment was 17.4% and 11.3% respectively. Diagnosis of post traumatic endophthalmitis was made in 20.5% of open globe injuries. Development of endophthalmitis correlated with younger age, rural setting, illiteracy, presence of foreign body and lens disruption.[16]

A two year prospective study done at Wilmer Ophthalmological institute found that domestic accidents and assault each accounted for approximately one third of the injuries in their study.[17]

Kyle J alliman et al studied ocular trauma and visual outcome secondary to paintball projectiles and they found that mean age of trauma was 21 yrs, 86% were males and most common ocular finding was hyphema. 81 % eyes needed surgical intervention and 22% needed enucleation. They found that 97 % were not wearing eye protection at the time of trauma.[18]

In a study done at L V Prasad Eye Institute, Hyderabad involving 325 patients of ocular trauma, males(86.8%) out numbered females(13.2%) and children (<16 years) constituted 46.8% of the total affected population. Anterior segment was involved in 51.1 %, posterior segment in 8.9% and both in 31.4% of the patients. The factors associated

with visual impairment (VA < 6/18) were poor initial visual acuity, full chamber hyphaema, retinal detachment and vitreous hemorrhage.[19]

Fasina Oluyemi studied the epidemiology of penetrating ocular trauma in Ibadan.The cohort consisted of 135 cases. The follow-up was for an average period of 24.6 weeks (range, 12-312 weeks). Injuries were most likely to occur at home, in a domestic setting (58%). The most common mechanism of injury was projectile missiles hitting the eye. The age range for injuries was 9 months to 70 years. Penetrating ocular injury was most frequent in the 20-29 years group (31.9%) followed by the 0-9 years age group (31.1%). Males were more frequently involved than females (ratio 4:1). The final visual acuity was better than 6/18 in 14.8% and less than 3/60 in 59.3% of cases.[20]

Jalali et al did a study on hypodermic needles as a source of ocular trauma and endophthalmitis in children. The average age of the patients was 10.3 years (range, 4-20 years). A small self-sealed corneal or scleral laceration was seen in 11 eyes; in 8 eyes, the site of injury was occult. Initial visual acuity was no light perception (PL) (3 eyes) or hand movements (HM) or light perception (16 eyes). Surgery in 18/19 eyes included vitrectomy with intraocular antibiotic injections for endophthalmitis (14 eyes), evisceration for panophthalmitis (2 eyes), and cataract extraction for traumatic cataract (2 eyes). Final visual acuity was no light perception or light perception only in 10 eyes, 20/400-20/60 in three eyes, and 20/40 or better in six eyes[21]

Khodam Rostomian et al studied 50 children with open globe injuries and found a male preponderance (71%). The average age of patients in their study was 5 yrs. Sharp objects caused majority of injuries (92%).The cornea was involved in 92 % of cases and 32 eyes required only primary repair. 5 eyes were enucleated. Visual acuity of 20/40 or better was obtained in 45% of cases. The factors related to unfavourable visual outcome

were retinal detachment, relative afferent papillary defect (RAPD), vitreous hemorrhage and hyphema. Endophthalmitis following penetrating eye injuries has a relatively poor prognosis due to the underlying eye trauma and the frequency of more virulent organisms such as Bacillus species. Risk factors for infection include 1) retained intraocular foreign body, 2) a rural injury setting, 3) delay in primary wound closure, and 4) disruption of the crystalline lens.[22]

Charles C Wycoff, Harry W Flynn, Darlene Miller et al who studied exogenous fungal endophthalmitis found that 24% of such cases occurred after penetrating ocular trauma.[23]

In a study done by Imtiaz A, Choudhry et al, who studied visual outcome of endophthalmitis associated with IOFB, it was found that delayed removal of IOFB following trauma significantly increased the chances of endophthalmitis.[24]

Reynolds DS et al did a study on post traumatic endophthalmitis and found that endophthalmitis following penetrating eye injuries has a relatively poor prognosis due to the underlying eye trauma and the frequency of more virulent organisms such as Bacillus species. Risk factors for infection include 1) retained intraocular foreign body, 2) a rural injury setting, 3) delay in primary wound closure, and 4) disruption of the crystalline lens.[25]

In a retrospective analysis of 258 cases of penetrating ocular trauma in Bascom Palmer Eye Intitute, Thompson et al found that there was an increased relative risk of infection in eyes with disruption of the crystalline lens. Endophthalmitis caused by coagulase-negative staphylococci had the best visual outcome, with 7 (64%) of 11 patients obtaining visual acuity of 20/400 or greater.[26]

It was found that the risk of developing glaucoma following penetrating ocular trauma was 2.67%, in a cohort study done by Cristopher A Girkin et al, wherein 3,627 patients who met with penetrating ocular injury were studied.[27]

Sharma T et al at Vision Research Foundation, Madras, studied 100 children with penetrating injury with broomstick bows and arrows. They found that successful reconstruction of the globe with attached retina was attained in 85% of the eyes. Improvement in visual acuity of two Snellen lines in eyes with measurable pre operative acuity or improvement to at least 2 / 60 with pre operative acuity of PL or HM, was attained in 62% of the eyes; acuity of 6/9 or better was achieved in 28%. Predictors of poor anatomical success were injuries involving both anterior and posterior segment, endophthalmitis and presence of retinal detachment.[28]

Sternberg et al studied the penetrating ocular injuries in young patients. The injury was caused by sharp objects in 49% of cases, missiles in 35%, and blunt trauma in 14%. Of 159 patients with at least 6 months follow-up, 110 (69%) achieved final vision of 5/200 or better, and 77 patients (48%) achieved final visual acuity of 20/50 or better. The prognosis after a penetrating injury is strongly influenced by the nature of the injury and the extent of initial damage. Several factors were found to correlate with an unfavorable visual outcome, including: (1) initial preoperative visual acuity of worse than 5/200, (2) injuries due to blunt trauma, (3) wounds involving the sclera, (4) double penetrating injuries, (5) dense vitreous hemorrhage, and (6) wounds associated with an intraocular "BB" pellet.[29]

A study was done by Lamkin JC et al to know the outcomes of simultaneous corneal laceration repair, cataract removal and PCIOL implantation found that corneal lacerations with traumatic cataract without any other associated complications like

vitreous loss are amenable to cataract extraction and lens implantation at the time of primary repair. They found that this approach obviated the need for additional operative procedure and anesthetic risks while affording more timely visual rehabilitation. [30]

Steqmann R and Miller D did a study on use of sodium hyaluronate in penetrating injuries and the study describes the surgical treatment and eventual outcome of 15 cases of anterior-segment penetrating ocular trauma that would be classically considered as having a poor prognosis. Signs of poor prognosis included: corneal lacerations, complicated by signs of infection ranging from infiltration to necrotic digestion; large scleral lacerations, with ciliary body or choroidal prolapse; and an exaggerated inflammatory response to the trauma. Treatment included careful microsurgical techniques, vitrectomy (when necessary), use of antibiotics and anti-inflammatory agents, and the liberal use of sodium hyaluronate to break fibrin adhesions and maintain the chamber at the close of surgery. Such treatment resulted in no enucleations, an average best corrected visual acuity of 20/80, an average normal angle of 314 degrees and 13 cases of normal intraocular pressure without medication.[31]

Sternberg P Jr et al studied factors predicting visual outcome in 281 eyes that underwent primary repair of penetrating ocular injury, and found that in patients with initial visual acuities worse than 20/800, a laceration limited to the cornea was the best predictor of good visual outcome.[29]

In a study done by Esmaeli et al, predictors of excellent final visual outcome (2/60 or better) in cases of penetrating ocular trauma were initial visual acuity of 20/200 or better, wound location anterior to the plane of insertion of the recti muscles, and wound length 10 mm or less.[32]

A study done by David Leonardo Cruvinel Isaac et al analysed the prognostic factors in open globe injuries and showed that length of laceration, elapsed time between trauma and surgery, presence or absence of vitreous loss, cataract, hyphema and retinal detachment were important factors related to poor post operative visual acuity.[33]

CLINICAL ANATOMY

1. ORBIT – the globe is well protected by the structure of the orbit (Fig-1) - a quadrilateral pyramid and is suspended within the socket cushioned by the fat which acts as a shock absorber. Seven bones takes part in formation of the orbit: Frontal, Maxillary, Zygomatic, Lacrimal, Ethmoid, Sphenoid and Palantine. Roof of orbit is thin. In the event of orbital trauma, it can be punctured by a sharp objects.

- Medial wall is formed by lamina papyracea- thinnest bone of orbit.
- Lateral portion is thick and deficient to protect the eyeball completely.
- Extraocular muscles help orbit be in its position.
- Bony protection is deficient in lower half

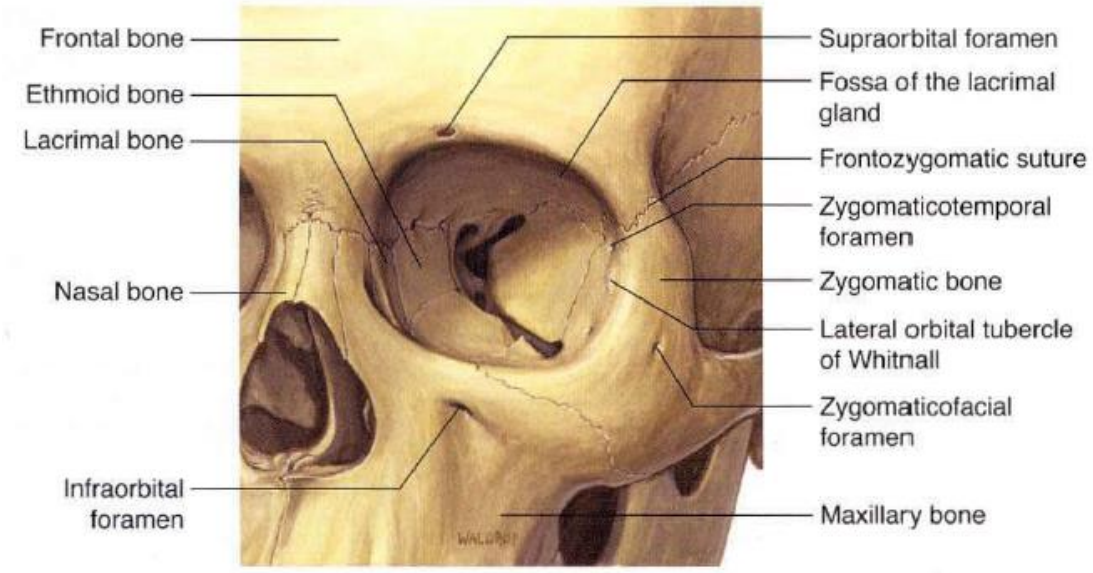


Figure – 1a: Showing bony orbit and bones forming it.

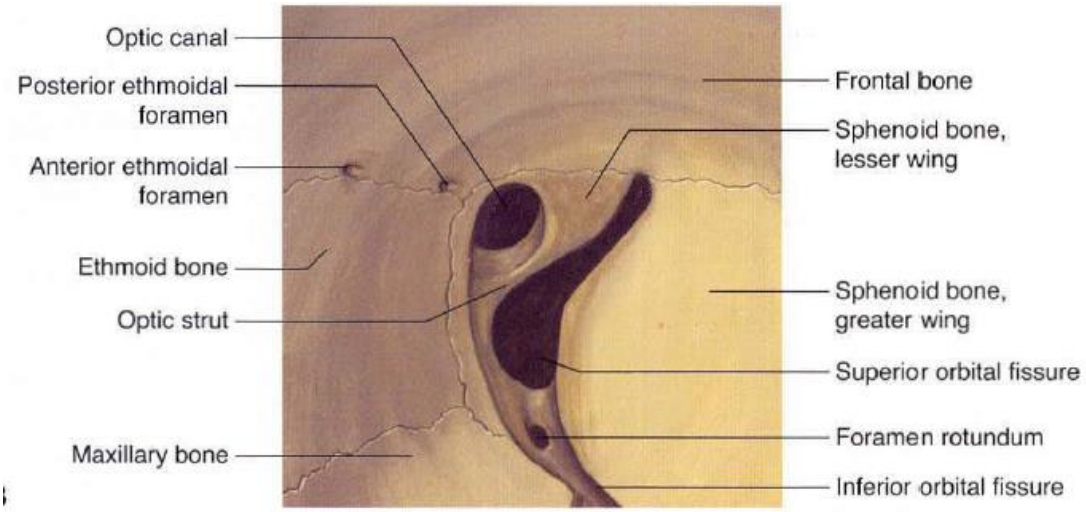


Fig 1b: Apex of the bony orbit showing Orbital fissure and optic canal.

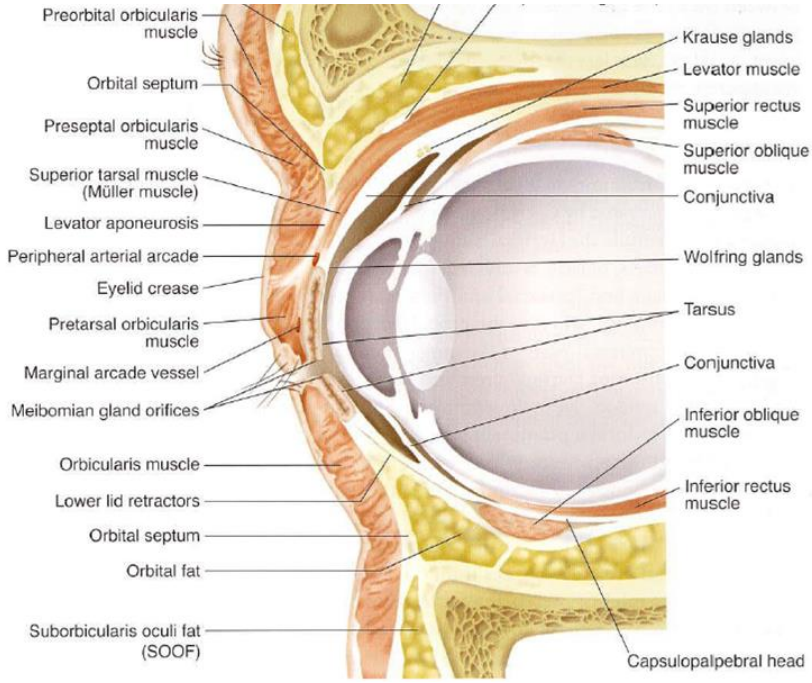


Fig 2: Periorbital anatomy of the eye

2. CORNEOSCLERAL JUNCTION – greatest expansion approaches the corneoscleral margin and therefore tends to give way easily.

3. IRIS – iris is the thinnest at its root and may be torn away from its insertion into the ciliary body resulting in iridodialysis.

4. LENS – zonules are most prone to damage and can rupture depending on the severity of injury resulting in subluxation or dislocation.

5. MACULA – posterior pole is in line with the direct Contrecoup force impinging on the anterior part of the globe resulting in marked feature of retinal edema.

6. RETINAL TEARS – predisposing factors for damage due to blunt trauma are degenerative conditions of retina

PATHO-MECHANISM OF OCULAR TRAUMA

The total effect on the eyeball due to blunt trauma is due to three types of forces: [34]

1. COUP AND CONTRECOUP:

- Courville[35] introduced the concept of coup and contrecoup injury to explain brain damage caused by blunt trauma to the head.

- Coup refers to local trauma at the site of impact. Contrecoup refers to injuries at the opposite side of the skull caused by shock waves that traverse the brain.

2. ANTERIOR–POSTERIOR COMPRESSION AND EQUATORIAL

EXPANSION:

- The volume of a closed space cannot be changed. Therefore, when the eye is compressed along its anterior–posterior axis, it must either expand in its equatorial plane or rupture.

- Using high-speed photography, Delori and associates studied blunt trauma in enucleated pig eyes. The cornea was indented 8.5 mm, reducing the original anterior–posterior axis by 41% and bringing the posterior surface of the cornea into contact with the iris and the lens. The equatorial plane was expanded to 128 % of its original length.

1. **Arlt** [36] stated that, when a force hits the eye in the anteroposterior direction, there is a forcible expansion of the globe around the equator which involves anteroposterior compression with vertical or horizontal elongation.

2**. Forster** [37] stated that when a wave of pressure traverses the fluid content of the eye, the cornea is driven in and aqueous is forced back, the anterior chamber compressed, the iris and lens are forced posteriorly followed by rebound of the lens. The vitreous is forced against the posterior pole which in turn forces the retina and choroid against the sclera.

3**. Ogilive** [38] compared the eye to a fluid filled elastic sphere. An impinging blows acts in the direction of the impact as well as with an explosive force in all direction from the centre towards the periphery hurling the ocular contents against their outer envelope. When this occurs, there are sudden movements of the various tissues of the eye in relation to eachother.

ANTERIOR SEGMENT MANIFESTATIONS OF BLUNT TRAUMA

LID INJURIES

1. Edema and hemorrhage:

- Laxity of structure and paucity of the subcutaneous fat permits an almost instantaneous swelling due to edema and hemorrhage which it creates enough pressure to cause pain.
- Extravasation of blood in the subcutaneous tissue leads to black eye.
- Initially deep purple in color and disappears after 2- 3weeks.

2. Crush wounds:

- Blunt force striking the orbital margins compress the tissue between the impinging

Object and the bone, due to which the tissue is stretched, ruptured or torn.

3. Emphysema due to fracture of orbital bones:

- An increase in intra-orbital pressure may result in a blow out fracture, as the floor of the orbit decompresses into the maxillary antrum this is a rare but important type of facial fracture that may result in damage to the inferior rectus muscle and orbital septae causing restriction in eye movements and diplopia.

INJURIES TO THE LACRIMAL SYSTEM [39]

- Canaliculus is the most vulnerable portion of the lacrimal drainage system.
- Blunt force applied medially to laterally can tear the lid at the medial canthus.

INJURIES TO CONJUNCTIVA

1. Sub conjunctival hemorrhage:

- It appears as a bright red patch of conjunctival tissue with distinct or feathered borders.
- Generally resolves spontaneously in 7 to 10 days, its color evolves from bright red to yellow green. Occasionally, when the hemorrhage involves the perilimbal conjunctiva, blood breakdown products can be seen in the anterior peripheral corneal stroma as a greenish discoloration.
- The management of SCH is hopeful expectancy, although it must be ensured that the hemorrhage does not indicate or conceal a deeper and extensive injury.[40]

2. Chemosis: Accumulation of transudate in the subconjunctival tissue as a result of increased orbital pressure from contusion.[40] if it is severe, the conjunctiva may become elevated and prolapse through the palpebral fissure.

3. Laceration: following direct impact thin conjunctiva tends to give way.

- Treatment of small lacerations involves only antibiotic ointment. Larger lacerations may require closure.

LESIONS OF SCLERA

1. Rupture of sclera:

- Ruptures are due to direct impact on the globe by a slowly moving blunt force which is sufficiently powerful. There are two types of contusion ruptures: direct ruptures and indirect ruptures.

- Direct scleral rupture: These are seen over the anterior part of the sclera and are more common and tend to occur when the sclera is thin due to an old inflammation, high myopia staphyloma, and buphthalmos or with a normal sclera following a blow from the horn of a cow or a similar powerful force.

Mechanism: When the force hits the eye with sufficient intensity the site of impact is suddenly compressed and ruptures, this is of two types:

- Complete direct rupture, when all the layers of the sclera are ruptured:

- Incomplete direct rupture: occurs when only a part of the scleral thickness is affected.

Incomplete ruptures commonly occur in the region of the canal of Schelmm and usually following minor trauma at the limbus.

b. Indirect scleral ruptures: They occur following a severe blunt trauma to the globe they are usually associated with gross intraocular damage. Cherry PM [41] observed that the rupture occurs away from the site of impact.

CLINICAL FINDINGS OF RUPTURED GLOBE:

- Cardinal sign is softness and collapse of the globe.
- Lids-swollen; bruised and often it is difficult to open the eye.
- Proptosis is with orbital hemorrhage.
- If conjunctiva is intact, ecchymosis obscures the rupture.
- If conjunctiva is split, the contents of the globe may extrude out associated with hemorrhage.
- Tear in the sclera remains everted, gaping edged through which the black uveal tissue bulges.
- Anterior chamber is abnormally deep or shallow.
- Iris may protrude, torn or iridodialysis may occur.
- Severe hyphema is present, which obscures further viewing into the inner aspect of the eye.
- Massive vitreous hemorrhage.
- Lens: An anterior dislocation is very common, rarely a posterior dislocation may occur.
- Traumatic aniridia may be associated; there may be a dialysis of the ciliary body.

- Usually the retina and choroid remain intact but they may be torn or if there is a massive choroidal hemorrhage they may be detached

CORNEAL INJURY

- Abrasion: Minor trauma can result in mechanical debridement of corneal epithelial cells, which heals without any further scarring.[40]

- Interstitial edema: Swelling of corneal lamellae with criss-cross striated appearance and folds in Bowman's layer (Lattice like opacities of Casper) and folds in Descemet's membrane (Lattice like opacities of Schirmer). More commonly occur due to hypotony and inflammation. Appear as delicate gray striae with double optical contour as described by Von Grafe [42] as 'Traumatic Striate Keratopathy'. Persistent endothelial cell loss can lead to corneal edema and bullous keratopathy.

- Blood staining of cornea: Massive hyphema and raised intraocular pressure can cause blood staining of entire cornea leaving a clear ring at the periphery due to entry of blood into corneal stroma. Appears rusty brown or greenish black, with gradual change to greenish yellow and disappears over a period of two years or more by absorption of blood pigments from anterior chamber.[43]

- Lacerations: Complete or partial due to elasticity of Bowman's membrane, with spectrum of intraocular damage [44] Tears in Descemet's membrane – first described by De Wecker in 1896 and True in1898 due compression injuries following birth injuries. Tears are single or multiple, long, sinous and crescentric, broader in middle and tapers at the end, double contoured. Tears rarely heal, endothelium

grows over bare areas and healing occurs by formation of fibrous tissue leaving behind a permanent opacity.

- Corneal rupture: uncommon complication.[44] Since the corneoscleral junction is weak, gives way producing a rupture at that site, enhanced by the presence of old cicatrix. Can be associated with iris prolapse, rupture of lens, vitreous & uveal tissue prolapse

Posterior corneal rings : Described by Cibis G W et al and Maloney et al. [45,46] Localized corneal edema can result from endothelial concussive injury following impact with high-speed foreign bodies[47,48,49].It is postulated[45,46] that the rings result from the transmission of foreign body impact-induced hydrostatic shock waves from the corneal surface to the endothelium. In humans, specular microscopy and slit-lamp photography demonstrated that the ring was the result of endothelial swelling. These lesions resolve spontaneously without detectable abnormalities.

Pigmentary deposits: When the cornea is forced against the iris, there is a temporary contact between these two structures. Rarely the pigments at the pupillary margin form an imprint on the cornea. This appears as an annular pigmentary deposit on the posterior surface of the cornea, and resembles a vossius ring.

INJURIES OF IRIS AND CILIARY BODY

Mechanism of Injury

- Injuries of the iris compromise its function as an optical aperture and a mechanical barrier between the AC and the posterior chamber/vitreous.

- The iris base, along with the ciliary body and angle, is especially sensitive to the shear stress caused by contusion.

- In most of the blunt injuries, however trivial there is some effect on the uveal vessel. Initially there is a vasospasm, followed by a reactive vasodilatation.Hence a reactive hyperemia of the anterior segment of the uveal tract occurs.[50]

- Traumatic Iridocyclitis: was first observed by Mendel. D.C.[51]

- The aqueous flare is often very short lasting and frequently when examined an hour after the injury there may be no traces of the flare.

- Iridocyclitis may be of considerable severity and prolonged when, associated with extra uveal complications.

- Most of the cases resolve with topical steroids.

PUPILLARY CHANGES

1. Traumatic Miosis and Spasm of Accommodation: Following a blunt trauma to the cornea, a spastic miosis occurs immediately. This intense constriction of the pupil is transient; and may or may not be followed by a post traumatic mydriasis, but is frequently followed by an iridoplegia. It is usually associated with a spasm of accommodation, which is transient.

2. Traumatic Iridoplegia and cycloplegia: Once the traumatic miosis passes off, pupillary dilatation may occur. This pupillary dilatation is usually associated with paralysis of accommodation this is termed as traumatic mydriasis.

3. Interstitial Tears of the Sphincter: They are usually small, single or multiple, in the presence of a sphincter tear, the pupil is irregular in shape, the torn areas appear as 'V'

shape the apex of the 'V' being towards the root of the iris.[44] On transillumination the torn area appears as a pleat or twists in the radial strands of the iris with reddish glow.This pleated appearance is due to the defective action of the muscle at the point, where it has given way.

5. Iridodialysis: this is a term used when the iris is torn away from its insertion at ciliary body.

Mechanism: The expansion of the corneo- scleral ring is opposed by the contraction of the iris sphincter. The pressure wave of the aqueous impinges on the stretched iris & the iris is torn away from its attachment to the ciliary body [52]

6. Traumatic Aniridia: When the injury is very severe, the root of the iris is fully torn from its attachment to the ciliary body where initially the lesion may be obscured by hyphema.

9. Traumatic Cyclodialysis: In severe blunt injuries, where the force is in the anteroposterior direction, the ciliary body may be torn off from its anterior scleral attachment along with the iris. The ciliary body is then displaces backwards and may at times reach the equator, thus the anterior chamber becomes continuous with the supra choroidal space. A choroidal detachment can occur following traumatic cyclodialysis.

TRAUMATIC HYPHEMA: An accumulation of blood in the anterior chamber is known as hyphema. Grading of hyphema[39]

Grade Hyphema Size

I <1/3rd

II 1/3rd To ½

III ½ To Near Total

IV Total

Hyphema can be Primary, Secondary or Recurrent:

1. Primary Hyphema: It occurs at the time of the injury & the bleeding is self limiting.

2. Secondary Hyphema: Secondary hyphema is more common when the amount of blood initially is large.[53]

3. Recurrent Hyphema:

Rarely hemorrhage into the anterior chamber recurs for weeks or months. Recurrent hyphema following a blunt injury to the eye may be associated with a more severe prognosis than occurring from the initial trauma. The complications which can develop are higher risk of glaucoma, corneal staining & poor visual acuity.

The indications for surgical intervention include [54,55]

• IOP elevation >50 mm Hg for 5 days

• IOP elevation >35mmHg for 7 days to avoid optic nerve damage

• IOP elevation >25 mm Hg for 5 days in cases of total or near-total hyphema to prevent corneal blood staining.

Hemorrhage occurring on the second to fifth day has an incidence of 5% to 30%.[56].

THE LENS AND ZONULES

Injury to the lens and the zonules is a common occurrence following a blunt injury, can even develop following minor trauma to the eye. [57]

Types of Lenticular Opacities:

- Vossius ring opacity:- A ring corresponding to the pupillary aperture composed of pigment granules disposed flatly on the anterior lens capsule, about 1 mm in breadth which develops following a concussion injury.

- Sub epithelial disseminated traumatic opacities: These are discrete, punctate or flattened flake like opacities, which lie beneath the anterior epithelium following a blunt trauma.

- Cataract nodiformis: It is a rare type of sub epithelial opacity which is dense round and has many layers. It occurs due to the mechanical damage to the epithelium, and hence, an interference with the permeability.

- Traumatic rosette shaped opacity: These appear like a thin filmy structure supporting fine dust like opacity which commonly occurs in the anterior subcapsular area. There is no rupture of the capsule. These occur due to the mechanical damage to the epithelium and hence, an interference with the permeability.

1. Early Rosette

2. Late Rosette

i) Early rosette.

These opacities may be evident within few hours after the injury, or may take weeks or a few months to develop

ii) Late rosette opacities:

At the time of injury there are some minimal damages to the subcapsular fibers which do not become clinically apparent until at a later date. These opacities lie deep in the cortex or in the adult nucleus as the overlying lens fibers are clear

Other varities are

- Diffuse Concussion cataract:
- Traumatic Zonular (lamellar) cataract:
- Post traumatic atrophy of the lens:

2. Displacement of Lens:

They are classified as follows:

1. Subluxation: The displaced lens which lies within the patellar fossa.

II. Luxation or dislocation: The lens is completely displaced from the patellar fossa.

- Types of subluxation:

When the subluxation is of greater degree the lens may shift slightly from its axial position.

1. Lateral subluxation:

When the equatorial edge appears as a crescent in the pupillary area, dividing the pupil into a phakic and aphakic part i.e, the lens moves to either sides or above or below.

2. Axial subluxation:

The lens becomes spherical leading to myopia and astigmatism. Vitreous may herniate through the pupil or extrude into the anterior chamber. Equatorial edge appears as a black

crescent in the pupillary aperture due to total internal reflection of the light coming from the fundus. A golden rim is seen on slit lamp examination and it is associated with phacodonesis.

- Dislocation of lens:

1. Incarceration of the lens in the pupil:
2. Anterior dislocation:
3. Posterior dislocation:

The lens is dislocated into the vitreous

5. Subscleral dislocaton:
6. Wandering lens:

The lens moves freely from one locality to another during ocular movements or postural changes of the head.

7. Phacocoele and extra ocular dislocation:

POSTERIOR SEGMENT MANIFESTATIONS OF BLUNT TRAUMA

VITREOUS

Vitreous is often affected even after a trivial trauma.

Vitreous hemorrhage: The hemorrhage is initially directed into the vitreous itself or is in the subhyloid region, it results in the same.

The following are the sources of the vitreous hemorrhage following a blunt trauma.

1. Retinal tear: Following a blunt trauma, when the vitreous contracts, because of its attachments to the retina a retinal tear occurs, the retinal vessels, if simultaneously torn, give rise to a subhyaloid or a vitreous hemorrhage.

2. Choroidal hemorrhage: When the choroidal hemorrhage is profuse. The blood passes through the retinal pigmentary epithelium, the retina and then percolates into the vitreous.

3. From the ciliary region: Hemorrhage is due to the injury to the ciliary vessels the blood may aggregate on the posterior capsule of the lens or may accumulate in the anterior vitreous.Rarely the hemorrhage collects in the retrolental space (hyphema of the retrolental space); the hemorrhage does not extend beyond this space and is limited by the Egger's line, along which the vitreous is in contact with the posterior capsule of the lens.

4. Vitreous detachment: Detachment of the vitreous can be a common occurrence following a blunt trauma.

RETINAL MANIFESTATIONS OF BLUNT TRAUMA

Damage to the retina after a blunt trauma is a common occurrence. They assume much importance because, though the ophthalmoscopic appearances of the abnormality are transient, the after effects may be permanent and disastrous.

1. Berlin's edema: retinal whitening/opacification that results from a blunt injury. There is no treatment of proven benefit for commotio retinae. Visual acuity tends to recover in the majority of cases, except in those with severe macular involvement or other associated intraocular damage.[57]

2. Concussion necrosis of retina: If the concussion is serious, extreme vasodilatation of the retinal and choroidal vessels occur this gives rise to pooling of the blood, followed

by edema. Due to the resultant anoxia the retinal tissues undergo autolysis the direct impact of

3. Traumatic retinal hemorrhages: Following a blunt trauma of sufficient severity, intra-retinal haemorrhages develop varying in size from small hemorrhages, round or flame shaped depending on the level of the hemorrhages, which may be single or multiple.

4. Retinal tears: According to Dean Eliolt, et al[58], strong vitreo retinal adhesions are susceptible to traumatic damage.Peripheral retinal breaks are a common source of posttraumatic retinal detachment.

5. Retinal dialysis: Retinal dialysis may be defined as a break or separation occurring at the anterior edge of the ora serrata and, unlike tears secondary to posterior vitreous detachment with or without a history of trauma, the vitreous remains attached to the posterior edge of the dialysis.

6. Traumatic retinal detachment: According to Goffstein R, Burton TC et al (1982) [59] of all retinal detachments, trauma plays a primary role in about 15% following a blunt trauma to the eye. In 80% retinal detachment usually occurs as a later sequelae, occasionally, detachment may occur at the moment of injury or shortly after trauma. It remains the most common cause of detachments in children.

Types of post traumatic retinal detachment:

1. Immediate

2. Delayed.

I. Immediate Retinal detachments: A severe blunt trauma producing a rupture of the globe and collapse is followed by a retinal detachment, in addition to a generalized disorganization of the eye.

II. Delayed retinal detachment: A retinal detachment occurs following: Contraction of the organized vitreous hemorrhages as stated by Goffstein Traumatic macular cysts and holes: Knapp (1869) and Noyer (1871)[60] were the first to describe full thickness macular holes. Traumatic macular cysts and hole occur as a consequence to a macular edema it is very difficult to differentiate between a macular hole , macular cyst and retinal thinning of the macula.

LESIONS OF CHOROID

The choroid suffers from mild to severe injuries following blunt injury:

1. Choroidal hemorrhages: It is probably caused by the rupture of a short/long posterior ciliary artery, rapidly filling the suprachoroidal space with blood due to shearing forces (anteroposterior shortening and equatorial expansion of the globe).

2. Choroidal detachment: Choroidal detachment following a blunt trauma occurs due to severe choroidal hemorrhage, Exudation of fluid from dilated blood vessels occurs due to bleeding from the tearing of posterior ciliary arteries

3. Choroidal rupture: Direct choroidal rupture: They are rare following a blunt injury. They occur due to a direct impingement of a force and located anteriorly at the site of impact and is oriented parallel to the ora. It is thought to be caused by compression necrosis as stated by Kaufar G., Zimmerman LE.(1996).[61] Indirect choroidal rupture: occurs opposite the site of impact and appears as a typical curvilinear shaped lesion of the posterior pole, oriented concentric to the disc margin.

LESIONS OF THE OPTIC NERVE

The most common cause of an avulsion of the optic nerve is a penetrating injury of the orbit

2. Traumatic Optic Neuropathy: The patient has loss of vision that cannot be explained by injury to the globe, intra orbital optic nerve or posterior visual pathways.There is usually an relative afferent pupillary defect.[62] The visual loss is then assumed to be due to injury to the optic nerve in the bony canal according to Michael P Joseph[63]

3. The prognosis is very poor in cases with severe trauma, the vision is severely impaired due to vitreous opacities and proliferation of fibrous tissue in the posterior segment of the globe and also with lens damage [64-65.].

OCULAR ADNEXA

1. Luxation of the globe: It is a condition in which there is a forward displacement of

   The eye, so that the eyelids close behind .it is very rare and usually occurs following a

   Forceps delivery, it can also occur following extensive orbital rim fractures. The globe can be reposited back into the socket. The fundus of a luxated globe appears pale and regains normal colour and function following reposition.

2. Emphysema: It is an accumulation of air in the tissue of the lids of the orbit. Emplysema is due to a communication between the orbital tissues and the nasal sinuses.

There are three types of emphysema:

1. Emphysema of the lids: It is due to a fracture of the lacrimal bone in front of the torso orbital fascia.

2. Orbital emphysema: It is due to fracture of the orbital walls behind the torso orbital fascia commonly there is a fracture of the orbital floor or the medial wall, the air collects in the fatty tissues and the muscle cone and produces proptosis

3. Orbital palpebral emphysema: In these cases, the air from the orbit traverses along the torso orbital fascia and produces swelling of the lids and conjunctiva.

3. Concussion injuries to the extra ocular muscles and nerves.

4. Orbital hemorrhage:

5. Orbital Blow- Out Fractures

1. Pure blow out fractures: - These are not associated with involvement of the orbital rim

2. Impure blow out fractures: - These are associated with other fractures about middle third of the facial skeleton

PENETRATING INJURY[67-69]

Penetrating injury is defined as a single full thickness wound of the eye wall (corneosclera) and ranges from a small fine puncture wound without clinical symptoms to extensive lacerating wound which may disorganize the entire globe.

UNCOMPLICATED CORNEAL WOUNDS

Immediately after the wound is made, the imbibition of fluid by the corneal lamellae makes the edges swell and turn opaque; this, together with the outpouring of exudative material, tends to bring the edges into apposition with the result that, particularly if the wound is oblique and valvular, coaptation is rapid and in favourable circumstances cohesion may be sufficient to withstand intraocular pressure within half an hour. When the edges of the wound are in opposition, coaptation first occurs in the central

area, while anteriorly and posteriorly the peripheral parts, retracted by the elasticity of the tissue, tend to gape, leaving an anterior and posterior triangle where the lips of the wound pout open.

When no intervention is done in such cases, the approximated edges of the substantia propria, seal with fibrinous matrix and become infiltrated with leucocytes and macrophages and new fibrous lamellae are laid down. It takes at least a month before this new connective tissue is consolidated.

INCARCERATION OF TISSUES IN THE WOUND

A penetrating injury is very frequently complicated by incarceration of one or more of the intraocular tissue which are swept between its lips with the rush of escaping aqeous humour. If left to its own devices this incarcerated tissue consolidates with fibrous tissue formed in the regeneration of the cornea to form a dense opaque mass (adherent leucoma) which, although aids in the mechanical closure of wound initially, may eventually lead to chronic irritative changes which may endanger the safety of the eye.

INCARCERATION OF IRIS

Incarceration of the iris is the most common event. This tissue is either caught in the posterior part of the wound to form an anterior synechia or is carried outwards to protrude from the wound as a prolapse of iris. Such a prolapse may involve a portion of the body of the iris which then protrudes as a knuckle, or a free margin of the iris in which case a tag hangs freely over cornea. A small marginal wound may thus involve the incarceration of a localized portion of the iris to form partial synechia or prolapsed which,

when the AC re forms, puts the iris under considerable tension creating a pear shaped pupil.

If the iris remains in contact with the wound, it is first glued down with a grayish yellow, exudative coagulum which renders the wound water tight so that the anterior chamber reforms. Eventually it becomes firmly fixed with newly formed granulation and then fibrous tissue. The corneal epithelium rapidly grows over the surface and a pseudo cornea eventually results.

INCARCERATION OF LENS AND ITS CAPSULE

It is less common and is usually always associated with prolapse of the iris. In some cases when the wound is small and capsule is uninjured, the opening may be occluded by a prolapse of the lens which becomes gummed to the back of cornea by a coagulum. Here it may remain and a subcapsular cataract may form. As the anterior chamber reforms, the exudates which bind the lens to the cornea may be stretched so that separation of the two tissues ensues, an anterior polar cataract marking the original site of apposition opposite the corneal scar. In the worst cases, the entire lens may be extruded and lost.

INCARCERATION OF VITREOUS IN THE WOUND

Incarceration of vitreous in wound occurs when the zonule is ruptured or the lens is absent. It has variable effect but always delays wound healing. The adherent vitreous stimulates a fibroplastic formation from the cornea and is freely invaded by the cells so that a dense scar may result. This frequently results in a localized area of corneal oedema which persists with recurrent formation of large epithelial bullae.

In more extensive lesions of the ciliary body, the choroid and retina may become widely detached after expulsion of the lens and incarcerated in the wound or even prolapse out of the globe.

PENETRATING SCLERAL WOUNDS

If a sclera wound is uncomplicated and its edges remain apposed, infection is rare and healing is rapid, the resultant scar is inconspicuous and function is unimpaired. But if the wound gapes and uveal tissue or retinal tissue is incarcerated, complications arise. Cellular reaction occurs followed by a fibrous reaction. The resultant cicatrix causes traction over the retina and may result in formation of tears and retinal detachment.

RETAINED INTRAOCULAR FOREIGN BODY[67]

Foreign bodies enter the eye with speed as projectiles or they enter the eye due to the sheer force of impact. Foreign bodies are either metallic or non metallic, with metallic being divided into magnetic and non magnetic foreign bodies. It is extremely important to note if the foreign body is magnetic because this not only indicates the presence of toxic iron content, but also means that the foreign body is amenable to removal from the eye using magnetic devices.

Iron, Copper, Mercury, Aluminium, Nickel, Zinc and Lead are toxic metals whereas Gold, Silver, Platinum and Tantalum are non toxic. Among non metallic foreign bodies, vegetable matter, cilia, cloth particles are toxic and stone pieces, glass, porcelain are non toxic.

The Ocular effects due to foreign body is due to following effects:

- Mechanical damage

- Effect of metallic composition of foreign body
- Introduction of infection

ENDOPHTHALMITIS[68]:

Staphylocci, streptococci and bacillus are the common species causing post-traumatic endophthalmitis. Endophthalmitis in the setting of penetrating trauma is usually associated with a poor outcome. An increased risk of infection has been found with retained intraocular foreign bodies, rural injury, and injury to the crystalline lens. Eyes with severe injuries that result from blunt ocular trauma may have a lower risk of infection than those with lacerating injuries or injuries related to foreign bodies. Endophthalmitis may be difficult to diagnose but should be suspected when unusual inflammation is present—this includes hypopyon, retinal vasculitis and vitritis. Pain out of proportion to the injury can be a useful indicative symptom.

GLAUCOMA[69]

IOP immediately after a penetrating injury is frequently reduced because of the open wound or the associated iridocyclitis. After closure of corneal or sclera wound, however, glaucoma may develop because of the tissue changes induced by the penetrating injury. Factors associated with development of post traumatic glaucoma included advancing age, lens injury and intraocular inflammation.

CHEMICAL INJURY [70-74]

Acid injuries tend to be less severe, as they remain confined to the ocular surface. Mild burns result in loss of the corneal and conjunctival epithelium, which is usually fully recoverable.

More severe injuries cause ischaemic damage to the limbal area, which affects the epithelial stem cells that are vital for subsequent epithelialisation and, hence, recovery of the eye. At the initial examination valuable information can be obtained regarding the severity and, thus, prognosis of the injury by evaluating the amount of epithelial loss, the degree of limbal ischaemia and the haziness of the cornea

The outcome of any chemical burn depends on the concentration and pH of the offending agent and duration of exposure. Alkalis, in particular, cause severe injuries, as they damage cells and penetrate the tissues rapidly.

.

MATERIALS AND METHODS:

This prospective study was conducted between period of November 2013 to march 2015 in R.L JALAPPA HOSPITAL attached to SRI DEVARAJ URS MEDICAL COLLEGE and RESEARCH CENTER, Tamaka, kolar.

INCLUSION CRITERA:

All patients with ocular trauma due to any cause, mode and type of injury

EXCLUSION CRITERIA:

1. Eyes with pre-existing ocular morbidity like glaucoma
2. History of previous ocular surgery.
3. where clinical findings is of non-traumatic nature
4. ocular injuries associated with head trauma

METHOD OF COLLECTION OF DATA:

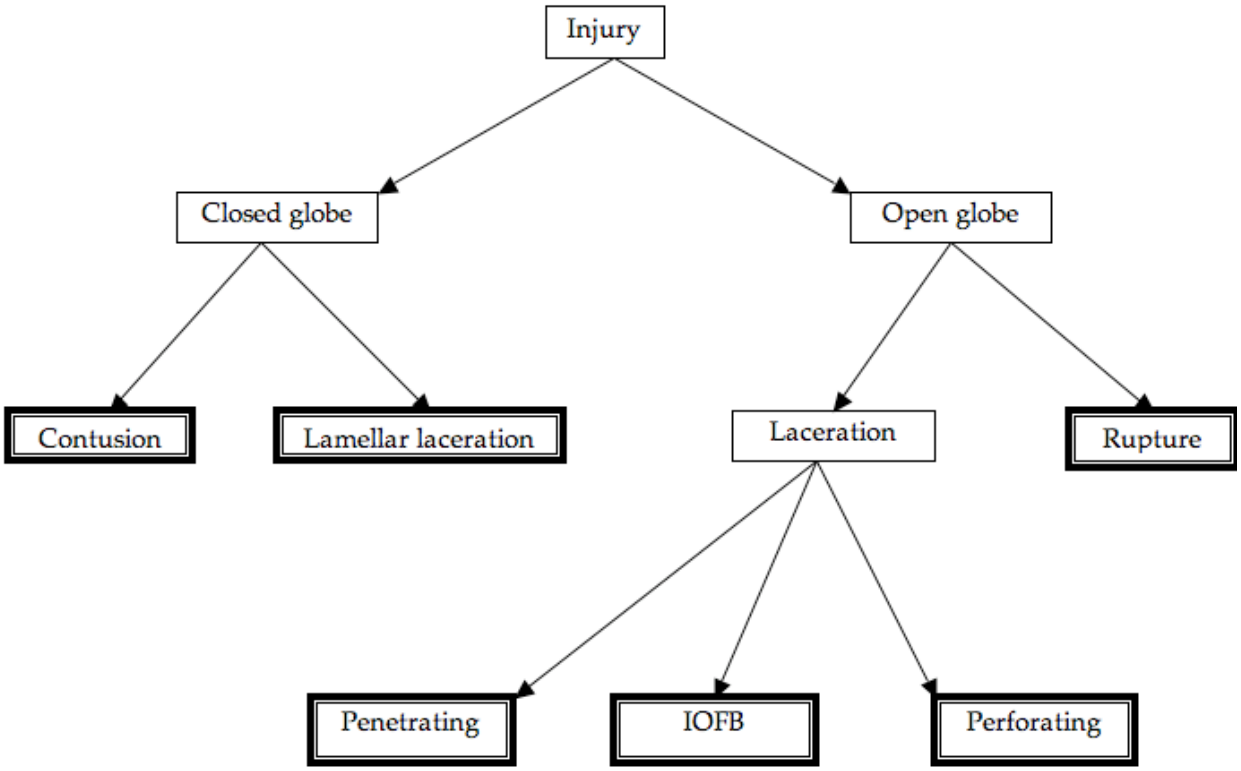
A total 250 patients of all age group with ocular trauma were included in the study. All patients fulfilling the inclusion criteria underwent ocular examination after taking informed consent. In all cases a detailed demographic history taken including address, their literacy status, occupation and financial status. A detailed clinical history was also taken which included history of the mishap, cause of injury, and nature of circumstance.

The ocular examination including visual acuity, slit lamp examination, a dilated fundus examination with direct ophthalmoscope and indirect examination with 90D lens was carried out. Cases with hazy media have undergone a B scan to evaluate posterior segment. An Intra ocular tension was measured in all patients except people presenting with open globe injuries. A gonioscopy exam was done for patients with closed globe injuries. All the details were recorded as per Proforma.

The time gap between injury and surgical intervention noted and type, nature of surgery done and post-op details were documented as per proforma.

The cases were managed according to the nature of injury and severity. Day to day clinical observations were recorded of all admitted patients till discharge. Periodic follow-up was done at 1 week, 1 month, 3 months and 6 months.

The ocular trauma was grossly classified into below mentiones classification system (Fig 3)



The first objective of assessement of clinical pattern of ocular injuries were done under as per proforma. Circumstance of injury was devided as follows

1. Domestic
2. Occupational hazard
3. Play / recreational activity related
4. Physical assualt
5. Road traffic accident
6. Others (chemical)

The nature of injury was devided into following subtypes:

1. Eyelid and periorbital injuries
2. Closed globe injury
3. Open globe injury
4. Chemical (Burns) injury
5. Orbital injury

Visual acuity was devided into range as follows

VISUAL ACUITY RANGE	
6/6 to 6/18	Normal
<6/18 to 6/60	Visually impaired
<6/60 to 3/60	Severely visual impaired
<3/60 to 1/60	Blind
<1/60 to PL	Blind
NPL	Bilnd

STATISTICAL ANALYSIS:

Sample size was estimated based on previous study report statistical analysis and sample size obtained was 250.

With P=20.55,Z =1.96,Error = 0.05

$n = Z\alpha^2 P q/(d^2)$

The data collected was tabulated and analys using descriptive statistics like mean ,standard deviation and proportion and confidence interval.

CT brain, MRI brain and orbit X-ray, B-scan was done in cases with hazy media, A fundus photograph wase taken in needed case

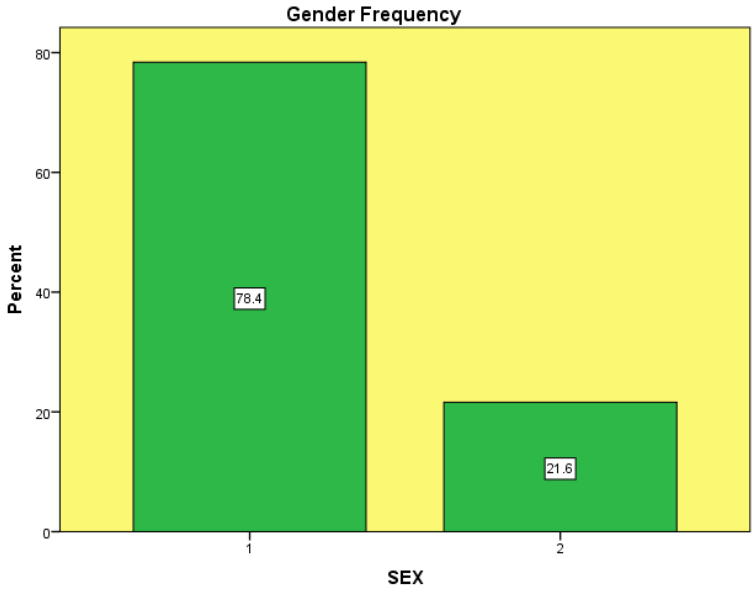
These are non invasive, standardised, time tested accepted and affordable procedure

RESULTS

Table 1: Frequency distribution of gender

Gender	Frequency	Percentage	Cumulative Percent
MALE	196	78.4	78.4
FEMALE	54	21.6	100.0
Total	250	100.0	

Chart 1: Bar diaggram showing gender frequency of 250 patients.



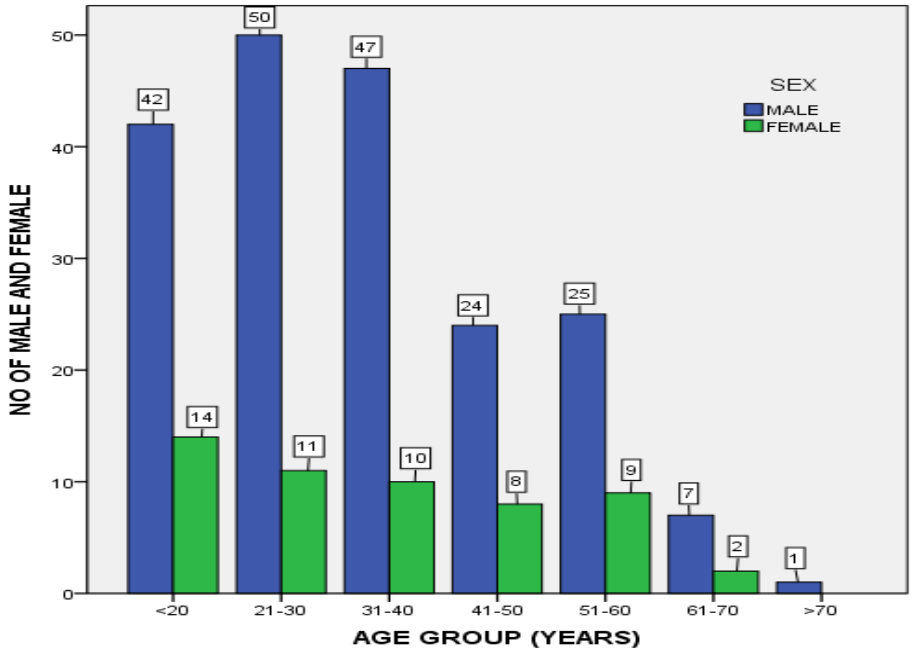
Of the total 250 patients, 196 were male and remaining 56 were female.

Table 2: Frequency table showing age distribution of patients with respect to gender

AGE_CATEGORY * SEX Crosstabulation

AGE GROUP	SEX		Total
	No of MALE (%)	No of FEMALE (%)	
LESS THAN 20	42(21.4)	14(25.9)	56
21 to 30	50(25.5)	11(20.4)	61
31 to 40	47(24.0)	10(18.5)	57
41 to 50	24(12.2)	8(14.8)	32
51 to 60	25(12.8)	9(16.7)	34
61 to 70	7(3.6)	2(3.7)	9
MORE THAN 70	1(0.5)	0	1
Total	196	54	250

Chart 2: Frequency table showing age distribution of patients with respect to gender



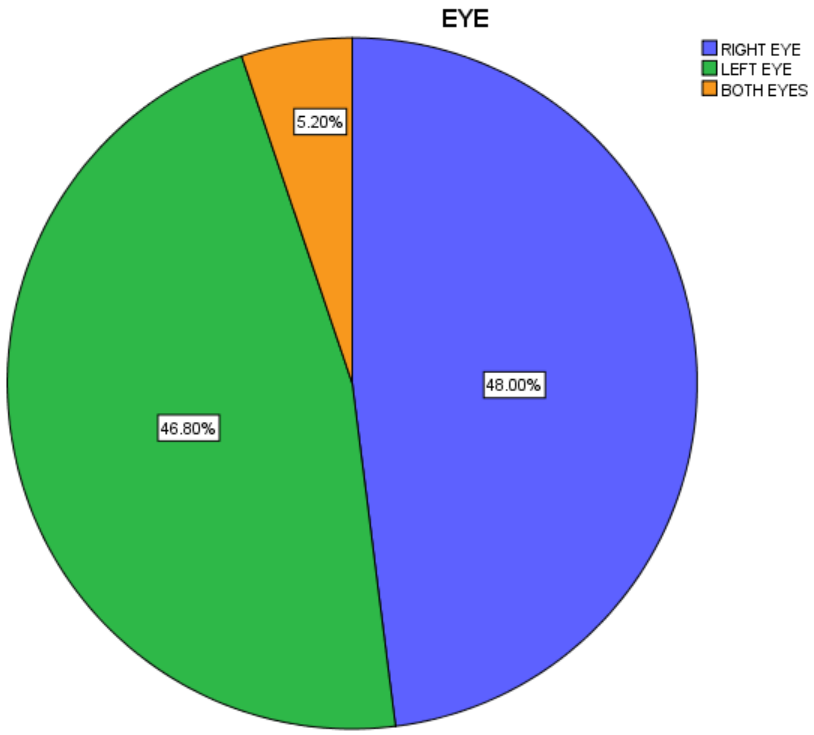
The age ranges from 10 days to 75 years with mean age of 33.32 +/- 15.8 years. 21-30 year range accounts for highest number of patients in male category and 11-20 years in female category which is marginally high compare to 21-30 age group.

Nearly half of the patients fall under 30 years who succumbed oculat trauma which is economically and socially productive age.

Table 3: Frequency table showing laterality of eye affected.

	Frequency	Percent	Cumulative Percent
RIGHT EYE	120	48.0	48.0
LEFT EYE	117	46.8	94.8
BOTH EYES	13	5.2	100.0
Total	250	100.0	

Chart 3: Pie chart showing distribution of laterality of eye.

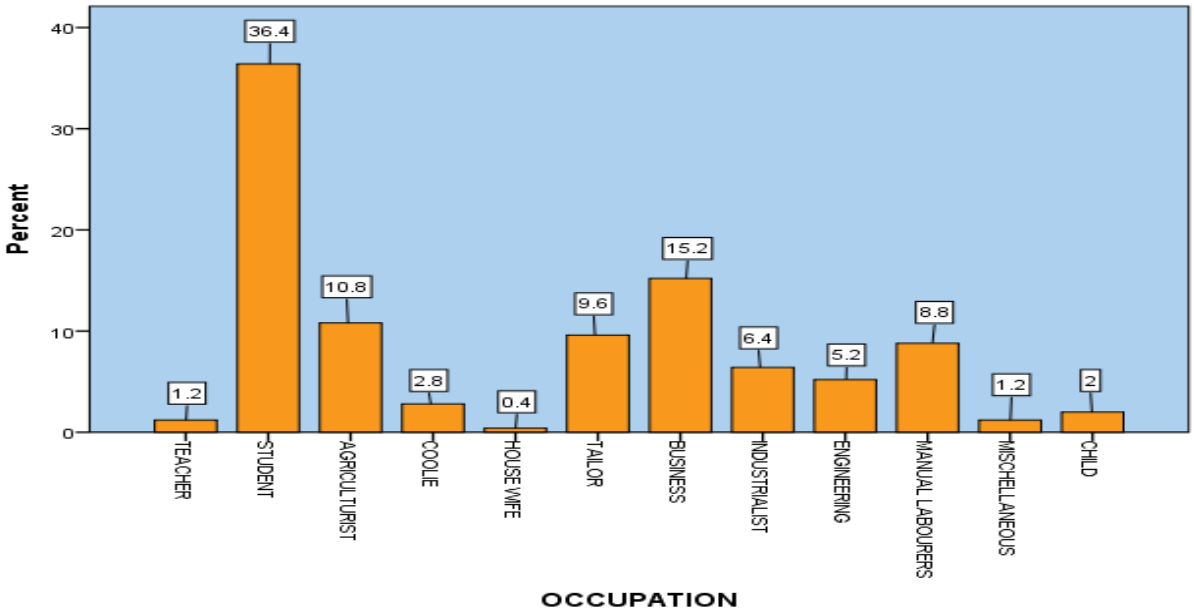


No statistical significance noted between right and left eye involvement with respect to frequency of involvement. Majority of the bilateral involvement cases were related to chemical injuries.

Table 4: Frequency distribution showing occupation profile among study patients

OCCUPATION	Frequency	Percent	Cumulative Percent
TEACHER	3	1.2	1.2
STUDENT	91	36.4	37.6
AGRICULTURIST	27	10.8	48.4
COOLIE	7	2.8	51.2
HOUSE WIFE	1	.4	51.6
TAILOR	24	9.6	61.2
BUSINESS	38	15.2	76.4
INDUSTRIALIST	16	6.4	82.8
ENGINEERING	13	5.2	88.0
MANUAL LABOURERS	22	8.8	96.8
MISCHELLANEOUS	3	1.2	98.0
CHILD	5	2.0	100.0
Total	250	100.0	

Table 5: Bar chart showing frequency distribution showing occupation profile

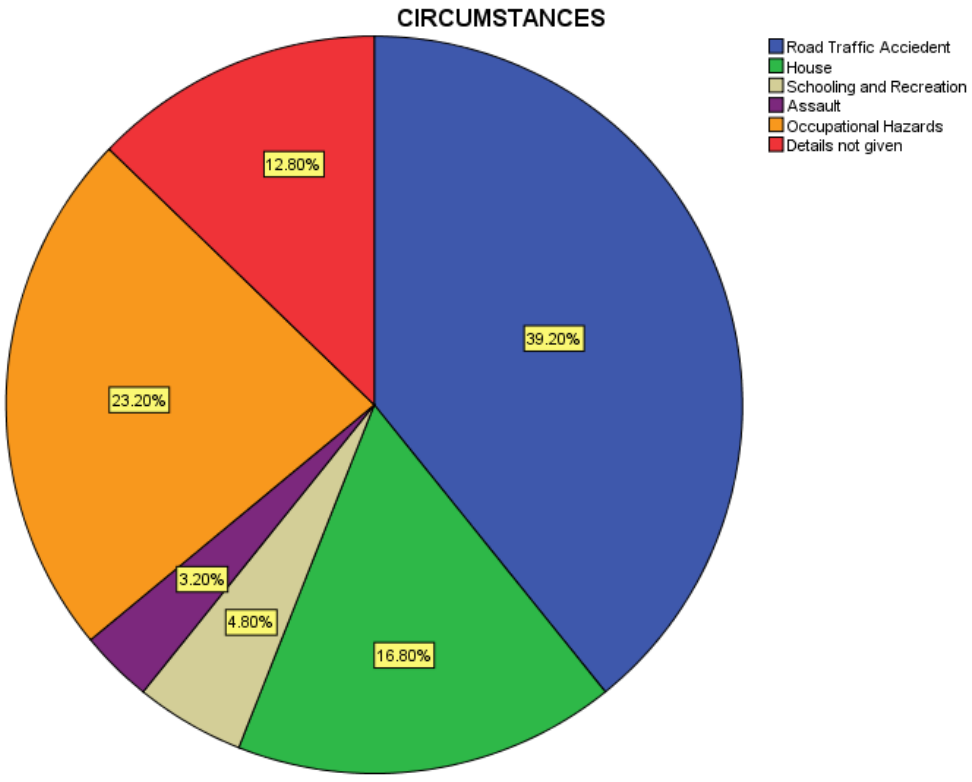


Students were hign in number to succumb truma (36.4%) followed those who occupied in commercial business (15.2%) and agriculturist (10.8%) accounted for 3 rd most.

Table 5: Spectrum of circmstances of ocular injury

Circumstances	Frequency	Percent	Cumulative Percent
RTA	98	39.2	39.2
HOUSE	42	16.8	56.0
SCHOOLING AND RECREATION	12	4.8	60.8
ASSAULT	8	3.2	64.0
OCCUPATIONAL HAZARD	58	23.2	87.2
DETAILS NOT OBTAINED	32	12.8	100.0
Total	250	100.0	

Chart 5: Pie chart showing circumstances of injury

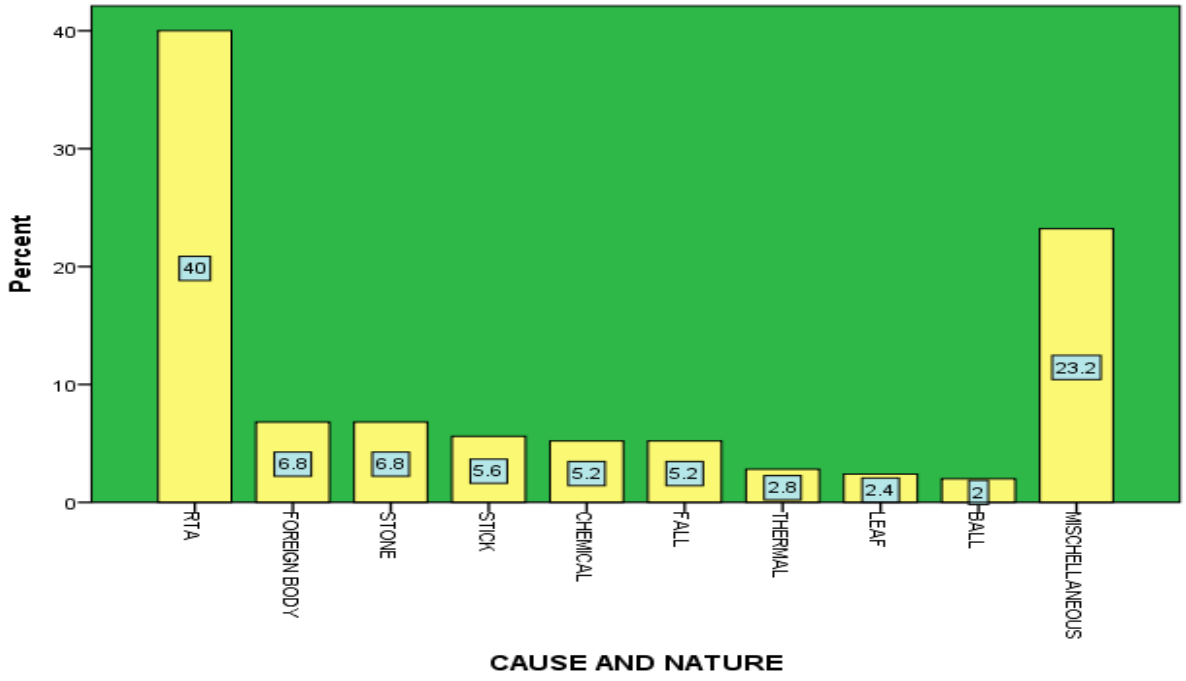


Road traffic accidents accounted for maximum cases of ocular injury (39.2%) followed by occupation related injuries (23.20%) where as trauma during recreational activities and due to hysical assualt accounted for minor percentage of cases.

Table 6: Tabulation showing various causes of ocular injury

Cause of injury	Frequency	Percent	Cumulative Percent
RTA	100	40.0	40.0
FB	17	6.8	46.8
STONE	17	6.8	53.6
STICK	14	5.6	59.2
CHEMICAL	13	5.2	64.4
FALL	13	5.2	69.6
THERMAL	7	2.8	72.4
LEAF	6	2.4	74.8
BALL	5	2.0	76.8
MISCHELLANEOUS	58	23.2	100.0
Total	250	100.0	

Chart 6: Bar chart showing casuative agents in ocular trauma

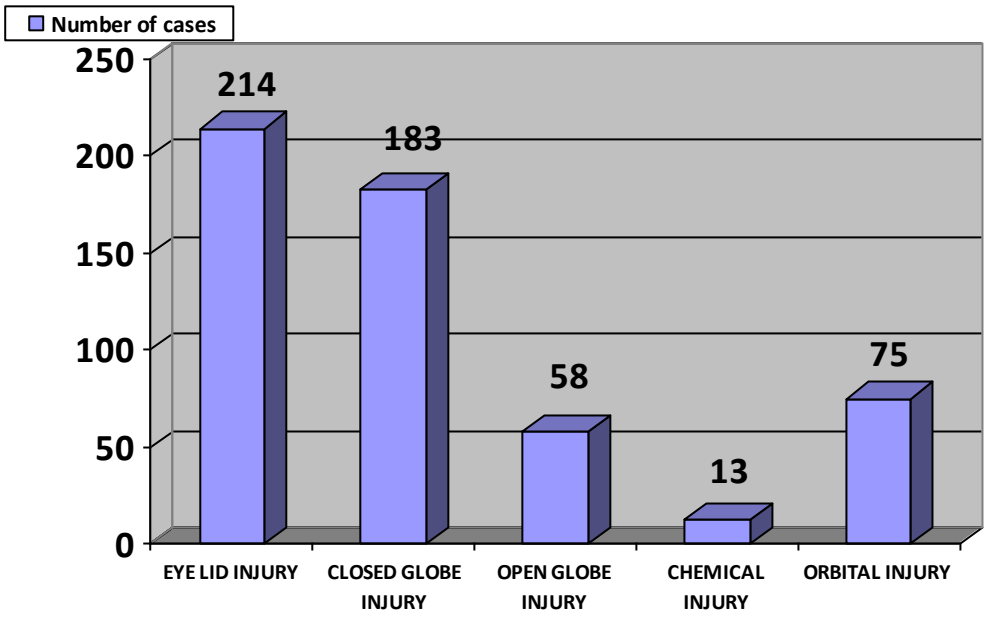


Road traffic accident related eye injury were most common (40%) followed by foreign body injury (6.8%), wodden stick (6.8%) and others. Chemical injuries accounted for 5.2% and injury during play with ball accounted for minority (2%)

Table 7: Frequency distributon of nature of injury

Nature of injury	Frequency	Percent
Eyelid injury	214	85.6
Closed gobe injury	183	73.2
Open globe injury	58	23.2
Chemcial injury	13	5.2
Orbital injury	75	30.0

Chart 7: Bar chart showing nature of injury and its frequenct



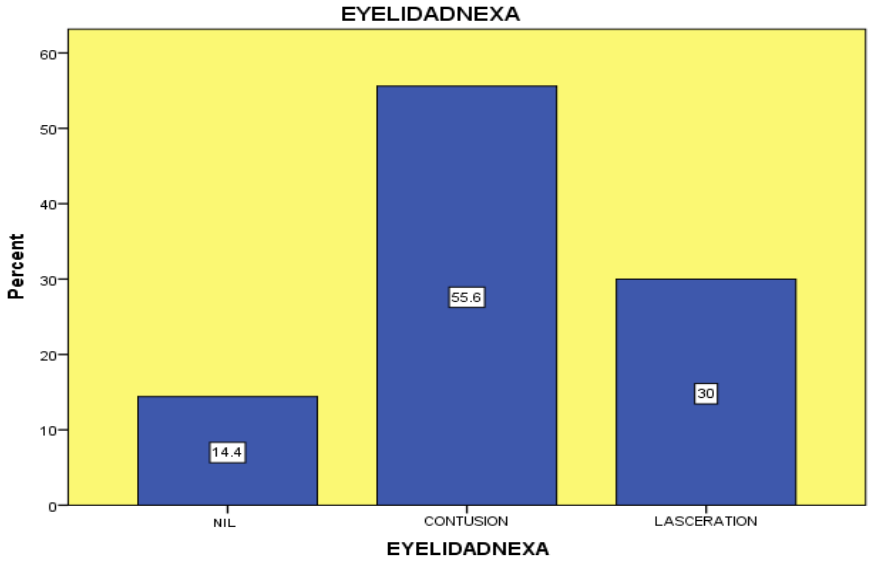
Majority of patients had eyelid injuries at the time of presentation (85.6%) many of whom had associated globe injuries. Closed globe injuries accounted for 73.2 % and Open globe injuries were 23.3 %. Chemical injuries were least common occurance and accounted for 5.2%.

Table 8: Tabulation showing nature of lid injury

EYELIDADNEXA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	NIL	36	14.4	14.4	14.4
	CONTUSION	139	55.6	55.6	70.0
	LASCERATION	75	30.0	30.0	100.0
	Total	250	100.0	100.0	

Chart 8: Bar chart showing nature of lid injury frequency distribution

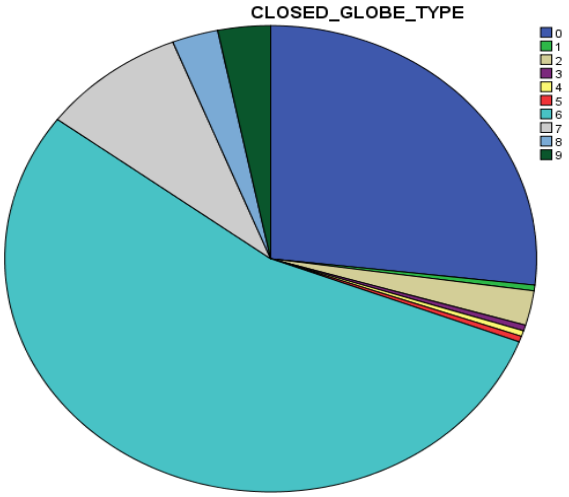


Majority of the patients had lid injury as common mode of presentation (85.6%) either isolated lid and adnexal injury or associated with globe / orbital injuries. In overall trauma cases, 55.6% had blunt trauma lid like contusion, black eye and 30% had lacerated soft tissue injuries like partial thickness/ full thickness injuries.

Table 9: Frequency table of nature of injury in closed globe trauma

	Frequency	Percent	Cumulative Percent
NIL INJURY	67	26.8	26.8
1	1	.4	27.2
2	6	2.4	29.6
3	1	.4	30.0
4	1	.4	30.4
5	1	.4	30.8
6	136	54.4	85.2
7	22	8.8	94.0
8	7	2.8	96.8
9	8	3.2	100.0
Total	250	100.0	

Chart 9: Pie chart showing distribution of nature of injuries in closed globe trauma

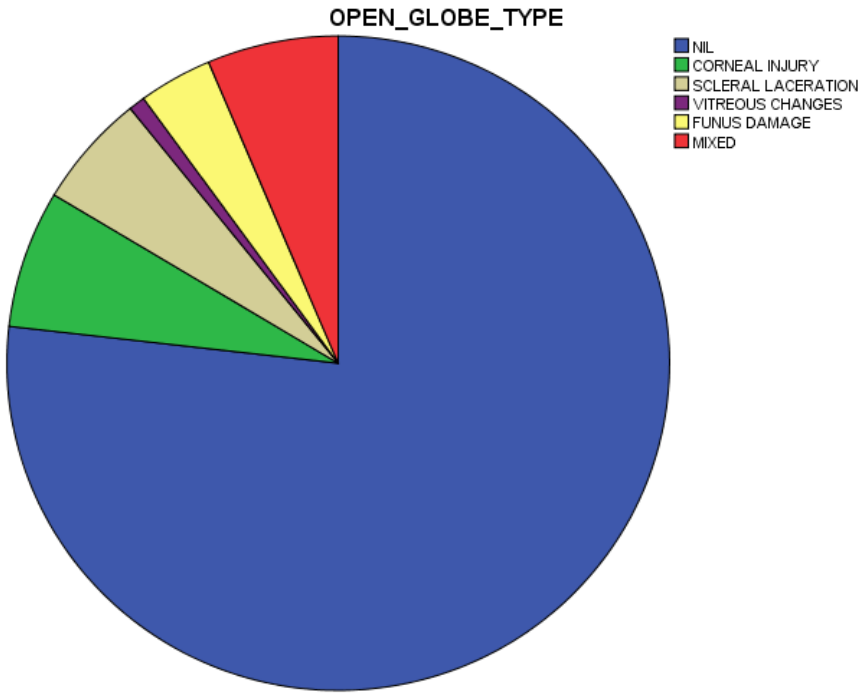


Half of the closed group injury patients had conjuncival involvement wither contusion or laceration along with corneal involvement viz edema, partial thickness laceration, opacification. Second most common presentation was lens injury in the form of traumatic cataract, subluxation, dislocation which accounted for 8.8% of closed globe injury.

Table 10: Tabulation of nature of open globe injury

Nature of injury	Frequency	Percent	Cumulative Percent
Nil	192	76.8	76.8
CORNEAL LACERATION	17	6.8	83.6
SCLERAL LACERATION	14	5.6	89.2
VITREOUS CHANGES	2	.8	90.0
FUNDUS DAMAGE	9	3.6	93.6
COMBINED INJURY	16	6.4	100.0
	250	100.0	

Chart 10: Pie chart showing frequency distribution of open clobe injury subtypes



Among 23.2% open globe injuries, 6.8% haas corneal laceration and 5.6% had scleral tear. About 3.6 % of patients had fundus changes like retinal detachment, retinal tear, retinal incarceration and 6.4% had combined anterior and posterior segment injuries.

Table 11: Calculation showing presenting visual acuity and final visual acuity after intervention

Vision impairement due to ocular trauma

	Mean	N	Std. Deviation	Std. Error Mean
Presenting visual acuity	0.7139	228	.53007	.03510
Final visual acuity	0.2932	228	.31497	.02086

*No PL, PL , HM not taken for analysis in Paired T test

The Mean presenting visual acuity in LOGMAR was 0.7139±0.53 and final visual acuity was 0.2932±0.314 LOGMAR units.

Table 12: Frequency of Visual acuity (Final Visual acuity)

VISUAL ACUITY RANGE	Frequency	Percent(%)	
6/6 to 6/18	191	76.4	Normal
<6/18 to 6/60	41	16.4	Visually impaired
<6/60 to 3/60	4	1.6	Severely visual impaired
<3/60 to 1/60	8	3.2	Blind
<1/60 to PL	1	0.4	Blind
NPL	5	2.0	Bilnd

Majprity of patients (76.4%) had attained visual outcomes of 6/18 or better and on the other side 5 patient lost their vision completely with NO PERCEPTION of light. Persons with severly visual impaired and blind accounted for nearly 7.2%.

Table 13: Calculation showing statistical significance in terms of visual acuity change

Parameters				
	Mean	Std. Deviation	Std. Error Mean	Sig. (2-tailed)
PRESENTING VA	0.7139	.53007	.03510	.000
FINAL VA	0.2932	.31497	.02086	

Statistically significant difference was noted between the the groups in terms of change in visual acuity before and after active intervention. (p value 0.000)

DISCUSSION

Study of ocular trauma and its management is paramount at current situation where it is said to be one of the most common cause for mono ocular blindness which is very easily amenable to prevent. But there is wide variation in clinical spectrum of ocular trauma between different regions, different countries and so the preventive measures. Study of regional variation and risk factor evaluation for ocular trauma is more appropriate and rationalistic approach to curb this menace.

Thus, this study has been undertaken to know the CLINICAL profile of ocular trauma which includes modes of clinical presentation, the demographic profile, management of injuries, prognostic indicators for visual outcome and common causes of visual disability.

Elaborative data was collected with respect to demographic prolife, clinical presentation, nature and severity of injury and structural, functional outcomes. The analysis was made after tabulating the data in various group and subgroups which is as follows.

Characteristics of Demographics and diagnosis:

Age –wise analysis showed that ¼ th (24.4%) of patients were in age group between 21-30 years and males out numbered females by ratio of 3.6:1. Predominant male dominance is because of greater involvement in occupational outdoor activities, increased exposure to risk of road traffic accidents, recreational activities of youngsters.

Gender	Mohan et al	Singh d.v.et al	Khatry et al	Our study
males	71%	88.55%	65 %	78.4%
females	29%	11.5%	35%	21.6%

As the above tabulation clearly figured out the difference in male female risk of succumbing ocular trauma. The reason being the same observation as mentioned above and present study also showed similar pattern of risks involvement.

Both Age and gender were found to correlate with the susceptibility to ocular trauma. However, the mean age for ocular injury in this study was 33.2 years, which corresponds to most other studies in which a mean age of approximately 30 years has been reported. This is likely due to the work-related injuries.[75-76]

LATERALITY

RE was involved (48%), 117 cases LE was involved (46.8%). Both eyes were involved in 13 cases(5.2%). Majority of bilateral involvement cases were because of chemical injuries depicting serious threat and potential to cause both eye blindness.

OCCUPATION

It was observed that highest incidence of blunt injuries was among students 91(36.4%) followed by business 38(15.2%) and manual labor 22 (8.8%) industrialist 16 (6.4%) Study done by Singh D.V. found ,students formed the largest group (38%),factory worker (11%),manual laborers(7.5%), farmers(9%) were commonly affected Higher proportion of students can be explained by increase involvement in activities at risk, playing bow and arrow, unsupervised fire work and also due to a large number of young patients affected by ocular trauma.

CIRCUMSTANCES

CIRCUMSTANCE	d.v. singh	Singh govind	Dhasamana et al	Present study
RTA	4.4%	39.2	39.77%	32.7%
DOMESTIC	29.9%	16.8	14.77 %	9.1%
SCHOOLING AND RECREATION	12.6%	4.8		25.5%
ASSAULT	5.3%	3.2	5.8 %	7.3%
OCCUPATIONAL HAZARD	6.12%	23.2	28.40%	20%
MISCELLANEOUS	– 34.8%	12.8 –	10 %	– 5.5%
TOTAL	100	100.0	100	100.0

Our referral institute is closely located to national highways and on other side poorly infrastructured transport in this rural dominated district is one of the cause for increased referral of RTA cases and hence the bulk number. This observation has been made by several others authors from indian studies emphasising poorer infrastructure and liberal road traffic rule regulations were the cause for mishap and hence the major concern of road traffic accidents. Occupational and recreational activities made second majority in our referrals among which injury with wooden stick was one of most common cause for injury.

NATURE OF INJURY

	Mayura et al	Titiyal et al	Dhasamana et al	present
EYELID	50 %	21.8%		84.8%
CLOSED	26.51 %	31.9%	53.39 %	71.6%
OPEN	18.07 %	45.5%	38 %	22%
CHEMICAL	11.40%	-	7.76 %	5.2%
ORBITAL	5.42 %			30%

Above tabulation shows inter study variation in frequency of nature of injury. Eyelid injuries are majority of the times associated with either closed or combined globe

injuries hence accounting to 84.8% in present study. Injuries b chemical and isolated orbital injuries are relatively rare but serious injuries especially chemical injuries which usually presents with both eye involvement.

Open globe injuries are often due to road traffic accidents and work place injuries which accounted for 22 % only after more common closed globe injury. Majority of our patients had combined damage suggesting more severe the presentation of ocular trauma.

EYELID ADNEXA

Among 250 patients in 139 cases had eyelid contusion (14.4%) . Followed by `laceration 75 cases (30%).study conducted by Orlando or Doty JH (1996) in which they evaluated 125 patients with ocular injuries due to sports and reported lid edema (39%), lid abrasion (7%) and lid laceration (8%),36% of lid contusion

According to Titiyal govind singh et al adnexal injuries were present in 21.8% of cases. In our study eyelid and adnexal injuries accounted for 84.8% of cases and orbital injuries for 30% of cases, chemical injury for 5.2% of cases. According to Mohan Amit et al chemical injuries were present in 5.4% of cases

According to Melsaether et al Ocular burns may represent up to 18% of ocular traumas presenting to emergency departments[8]. Macewan CJ (1989) studied 5671 patients with ocular injuries and found out 73 that 98.3% of all injuries involved periorbital or superficial ocular structures only. Though the number looks high, isolated adnexal injuries are relatively less majority has mixed globe and periorbital injuries.

CLOSED GLOBE INJURY

Closed globe injuries were accounted for 73.2% only after eyelid injuries. The injuries ranged from subconjunctival hemorrhage, conjunctival laceration to vitreous hemorrhage and retinal detachment. 54.4% had corneal injury with or without periobital soft tissue injury and 8.8% had lens damage in the form of traumatic cataract, subluxation and dislocation.

In a study done at L V Prasad Eye Institute, Hyderabad involving 325 patients of ocular trauma, Anterior segment was involved in 51.1 %, posterior segment in 8.9% and both in 31.4% of the patients. Posterior segment injuries constitutes minority of eye injuries but potential to cause serious visual dysfunction.

Min Wu et al pointed out that in his analysis non-work-related type of eye trauma had significantly higher rates of closed-globe ocular injury compared to the work-related type (RR=1.33, 95%CI 1.12-1.58).open-globe injuries were significantly higher in work-related type of eye trauma compared to the non-work-related type (RR=1.35, 95%CI 1.14-1.61), that means while working, open-globe injuries were more common.[77]

Misra et al, [12] studied 60 patients of ocular trauma in a rural set-up of Western India Closed globe injury (68.33 per cent) was more common than open globe injury (31.67 per cent).

In our present study, majority of closed globe injuries are due to road traffic accidents followed by domestic and occupation related injuries.

OPEN GLOBE INJURY

Among 23.2% open globe injuries, scleral and corneal full thickness lacerations were more common (corneal - 6.8% & scleral – 5.6%). Posterior segment damage including vitreous hemorrhaage and retinal detachment were minor accounting for 0.8% & 3.6 % respectively.

Khodam Rostomian et al[22] studied 50 children with open globe injuries. The cornea was involved in 92 % of cases and 32 eyes required only primary repair. 5 eyes were enucleated.

As per as visual dysfunction was concerned, the penetrating injuries had poor visual acuity presentation and so the poor final visual outcomes compare to closed globe injury and adnexal soft tissue injury. The factors which were prognosticate the outcomes were found to be presenting visual acuity, severity of damage, infection and retinal detachment. Khodam et al in his study, visual acuity of 20/40 or better was obtained in 45% of cases. The factors related to unfavorable visual outcome were retinal detachment, RAPD, vitreous hemorrhage and hyphema.

Sternberg et al[29] in his study of 159 patients 110 (69%) achieved final vision of 5/200 or better, and 77 patients (48%) achieved final visual acuity of 20/50 or better. The prognosis after a penetrating injury is strongly influenced by the nature of the injury and the extent of initial damage. Several factors were found to correlate with an unfavorable visual outcome, including: (1) initial preoperative visual acuity of worse than 5/200, (2) injuries due to blunt trauma, (3) wounds involving the sclera, (4) double penetrating injuries, (5) dense vitreous hemorrhage, and (6) wounds associated with an intraocular "BB" pellet.

In our study all the cases with penetrating surgery were needed primary repair consists of corneal/scleral tear repair. The posterior segment complications were handled as primary or secondary procedures depending on severity of injury and infection status.

CHEMICAL INJURIES

5.2% of patients had succumbed chemical injuries and majority of them had both eye involvement. In all cases globe was intact but cornea, limbus and anterior segment structures were damaged along with outer soft tissue damage.

It is known fact that acid injuries tend to be less severe, as they remain confined to the ocular surface. Mild burns result in loss of the corneal and conjunctival epithelium, which is usually fully recoverable. In our study, those who succumbed acid burns had failry good visual acuity at presentation and final visual acuity.

Majority of the injuries are due to lime as it is more often used as household ingredient in many things. Similar observation has been made by many other studies where lime was major culprit of chemical injury.

Correlation of risk factors with final visual outcomes

1. Correlation between gender and final visual outcomes.

Gender VS Visual acuity	FINAL_VA
Mann-Whitney U	4944.500
Wilcoxon W	6429.500
Z	-.996
Asymp. Sig. (2-tailed)	.319

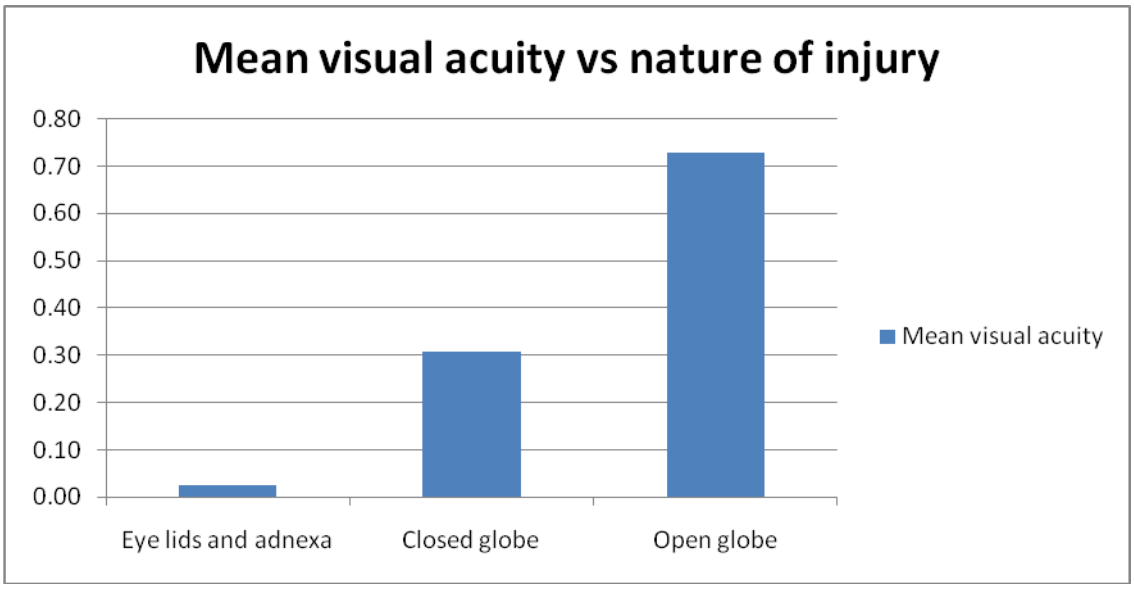
2. Correlation between age group and final visual acuity outcomes.

Age VS Visual acuity			AGE_years	FINAL_VA
Spearman's rho	AGE_years	Correlation Coefficient	1.000	-.046
		Sig. (2-tailed)	.	.473
		N	250	250
	FINAL_VA	Correlation Coefficient	-.046	1.000
		Sig. (2-tailed)	.473	.
		N	250	250

3. Correlation between Time gap between injury & management VS final visual outcomes.

Time gap and final visual acuity presentation			FINAL_VA	TIME_GAP
Spearman's rho	FINAL_VA	Correlation Coefficient	1.000	-.027
		Sig. (2-tailed)	.	.670
		N	250	248
	TIME_GAP	Correlation Coefficient	-.027	1.000
		Sig. (2-tailed)	.670	.
		N	248	248

4. Correlation between nature of injury and mean visual outcomes.



The "r" value calculated with online spearman's rho calculation R = 0.51816 with p value 0.00121. By normal standards, the association between the two variables would be considered statistically significant

Overall risk factor assessment shows that nature of injury is the most strongly associated risk factor for final visual acuity. This holds good in present study because of spectrum off injury is quite different compared to other studies where age and gender had role to play in prognosis. The road traffic accidents related injuries are very high grade and has mostly poor visual potentials irrespective of age and gender. On the other side, occupation related injuries constituted 2nd major cause of ocular trauma and they had poor visual acuity to begin with compare to domestic related injuries.

Play and recreational injuries have constitutes bulk of western studies in contrast, Indian subcontinent studies and present studies have only minor share. This is particularly because less exposed is the children for recreational purposes in this rural-urban transition zone and hence less frequency is the trauma

In a five year retrospective study including 298 eyes by Salvatore Cillino et al,[13] author concluded that cause of injury differed significantly by gender ($p = 0.001$) and urban vs. rural location ($p = 0.009$). Initial visual acuity was found to be correlated with final visual acuity. Sternberg P Jr, de Juan E Jr, Michels RG, Auer C, studied factors predicting visual outcome in 281 eyes that underwent primary repair of penetrating ocular injury, and found that in patients with initial visual acuities worse than 20/800, a laceration limited to the cornea was the best predictor of good visual outcome.[29]

A similar study done by David Leonardo Cruvinel Isaac et al analysed the prognostic factors in open globe injuries and showed that length of laceration, elapsed time between trauma and surgery, presence or absence of vitreous loss, cataract, hyphema and retinal detachment were important factors related to poor post operative visual acuity.[33]

To conclude the risk of having poor visual outcomes are multifactorial and to name few, nature and severity of injury has maximum impact in present study. The initial and final visual acuities from better to worse are associated with peri-ocular soft tissue injury – Orbital injury - Closed globe injury and worse with open globe injury. This trend was attributed in our study wherein penetrating trauma had resulted in poor visual outcomes, the reason being infection, posterior segment intervention, presence of IOFB and non-salvageable globes.

CONCLUSION

Majority of the cases were seen in the age group 21 to 30 years (43%) with a male predominance (78.4%) and 21.6% were females. RTA accounted for majority of cases in our study 39.2%,followed by occupational hazard 23.2% motor vehicle accidents were the commonest cause for road traffic accidents. Most common object was foreign body and stone 6.8% in assault cases, stick 5.6%,chemical injuries and fall accounted for 5.2% of cases and injury at work places was mostly due to improper safety measures.

These injuries can be prevented by use of safety goggles and helmets to avoid RTA and head and face Protectors can be particularly given to workers doing welding and sandblasting.

Age and gender was not found to be risk factor but it is the nature and severity of injury which has highest imppact on final visual outcomes, among which penetrating injuries had poor visual prognosis. Comparison of visual acuity at the time of presentation and after management showed statistically improved visual acuity in majority of cases. This suggests that with meticulous management, visual outcome of ocular trauma is favourable.

Adequate follow-up and awareness about need for timely surgical intervention is a must for better visual outcome. With meticulous management and prevention measures, the cause for monocular blindness can be limited

SUMMARY

This is a prospective study conducted from November 2013 to march 2015 consisting of 250 cases of ocular trauma. In our study, we considered demographic analysis, occupation at time of trauma, time of presentation, modes of management, visual outcomes, prognostic indicators and causes of visual disability.

In this study there was male predominance because men are exposed to ocular trauma because of their occupation and they formed wage earning group in rural area. Majority presented 1-3 days after injury. Right eye was involved in 48% cases and left eye in 47% and both eyes in 5% cases.

Majority of the subjects were students comprising 36.4% followed by business 15.2% and agriculturist in 10.8%. Road traffic accidents were the commonest cause of trauma in 39.2% followed by occupational hazard in 23.2% and during household work in 16.8%. Cause and nature of injury was analyzed. Motor vehicle accidents accounted for 40% cases, injury by stone and foreign body in 6.8% followed by self fall and chemicals in 5.2%.

Majority of the patients had lid injury as common mode of presentation (85.6%) .In overall trauma cases, 55.6% had blunt trauma like lid contusion, black eye and 30% had lacerated soft tissue injuries like partial thickness/ full thickness injuries. Half of the closed group injury patients had conjuncival involvement along with corneal involvement. Second most common presentation was lens injury in the form of traumatic cataract, subluxation, dislocation which accounted for 8.8% of closed globe injury.

Among 23.2% open globe injuries, 6.8% haas corneal laceration and 5.6% had scleral tear. About 3.6 % of patients had fundus changes like retinal detachment, retinal tear, retinal incarceration and 6.4% had combined anterior and posterior segment injuries.

Majority of patients (76.4%) had attained visual outcomes of 6/18 or better and on the other side 5 patient lost their vision completely with NO PERCEPTION of light. Persons with severely visual impaired and blind accounted for nearly 7.2%.

Statistically significant difference was noted between the groups in terms of change in visual acuity before and after active intervention. (p value 0.000)

The above analytical observations have paid way to understand the spectrum of ocular trauma and its implications in causation of visual dysfunction and its management in our setting. The risk factor analysis has showed vulnarable checkpoints which can be targeted for better managementof ocular trauma.

BIBLIOGRAPHY

1. Thylefors B: Epidemiologic patterns of ocular trauma. Aust N Z J Ophthalmol 20:95, 1992.
2. Negrel AD, Massembo-Yako B, Botaka E et al: Prevalence et causes de la cecite ou Congo. Bull WHO 68:237, 1990.
3. Dana MR, Tielsch JM, Enger C et al: Visual impairment in a rural Appalachian community. JAMA 264:2400, 1990
4. Ahmed E: Quoted From The Report Of Working Group On Control Of Blindness: Ministry Of Health: GOI: 1993; 3.
5. Gupta AK, Moraos O. Ocular injuries due to accidental explosion of carbonated beverage bottles. Indian J Ophthalmol 1982; 30:47-50. .
6. Dada VK, Kalra VK, Angra SK. Changing pattern of blindness in blind school residents in India. Indian J Ophthalmol 1984; 32: 161-163.
7. Dannenberg A L: Parver LM, Fowler CJ the national eye trauma system registry: Arch Ophthalmology 1992 : 110 :949-57.
8. .Liggett PE, Pince KJ, Barlow W et al: Ocular trauma in an urban population. Ophthalmology 97:581, 1990
9. Schein OD, Hibberd PL, Shingleton BJ et al: The spectrum and burden of ocular injury. Ophthalmology 95:300, 1988
10. MacEwen CJ: Eye injuries: A prospective survey of 5671 cases. Br J Ophthalmol 73:888, 1989.
11. S. Vats, MD, G V S Murthy, M Chandra, S K Gupta, P Vashist, and M Gogoi,: Epidemiological study of ocular trauma in an urban slum population in Delhi Indian J Ophthalmol. 2008 Jul-Aug; 56(4): 313–316.

12. Kadappu S, Silveira S, Martin F:Aetiology and outcome of open and closed globe eye injuries in children: Clin Experiment Ophthalmol. 2013 Jul; 41(5):427-34.
13. Salvatore Cillino, Alessandra Casuccio, Francesco Di Pace, Francesco Pillitteri, and Giovanni Cillino: A five-year retrospective study of the epidemiological characteristics and visual outcomes of patients hospitalized for ocular trauma in a Mediterranean area : BMC Ophthalmol. 2008; 8: 6.
14. Ocular trauma in a rural South Indian Population- The Aravind Comaprehensive Eye Survey: Ophthalmology Vol 111, issue 9, pages 1778-1781
15. Dondana L, Dondana. R Shrinivasan M et al, Ocular trauma in an urban population in Southern India: The Andhra Pradesh eye disease study – Clinical and Experimental Ophthalmology 2000: 28:350-58
16. D.V. Singh, Yog Raj Sharma, R.V. Azad, Dinesh Talwar, Rajpal: Profile of Ocular trauma at Tertiary Eye Centre. JK Science: Vol. 7 No. 1, Jan-Mar 2005.
17. Gilbert CM, Soong HK, Hirst LW: A two year prospective study of penetrating ocular trauma at the Wilmer Ophthalmological Institute; Ann Ophthalmolo.1987 Mar; 19(3): 104-6.
18. Kyle J Alliman, William E Smiddy, James Banta: Ocular trauma and visual outcome secondary to paintball projectiles: Am J of Oph: Vol 147, Issue @, Feb 2009,239-242.e1
19. V K Gothwal Bopt, S Adolph Dopt, S Jalali Ms & TJ Naduvilath Msc, L V Prasad Eye Institute, Hyderabad: “Demography and prognostic factors of ocular injuries in South India”; Australian and New Zealand Journal of Ophthalmology, Vol 27 Issue 5, Pages 318-325

20. Fasina Oluyemi; Epidemiology of penetrating eye injury in Ibada:A 10 year hospital bases review. Middle Eastern Journal of Ophthalmol.2011, Vol18 (2).159-163.
21. Jalali, Subhadra ; Das, Taraprasad; Majji, Ajit Babu. Hyposermic Needles: A new source of penetrating ocular trauma in Indian children. Retina; Mar 1999, Vol 19(3). .
22. Khodam Rostomian, Allen B.Thach, Amir Isfahani. Open globe injuries in children. Journal of American association for Pediatric Ophthalmology and Strabismus. Aug 19
23. Charles C Wykoff, Harry W Flynn Jr, Darlene Miller, Ingrid U Scott, Eduardo C Alfonso: "Exogenous Fungal Endophthalmitis: Microbiology and clinical outcome" Ophthalmology vol 115, no 9, Sept 2008
24. Imtiaz A. Choudhry; Farrukh A Shamsi; Abdulwahab Al-Theeb; Incidence and Visual Outcome of Endophthalmitis Associated with intraocular foreign bodies; Graefe's Arch for Clinical and Exp Ophthalmology; Vol 246, No 2, Feb 2008.
25. Reynolds DS, Flynn HW Jr.Endophthalmitis after penetrating ocular trauma; Curr Opin Ophthalmol,1997 Jun;8(3): 32-8
26. Thompson WS, Rubsamen P E. Endophthalmitis after penetrating trauma : risk factors and visual acuity outcomes; Ophthalmology, 1995, Vol 102(11); 1696-1701.
27. Cristopher A Girkin, Gerald McGwin Jr, Robert Morris, Ferenc Kuhn "Glaucoma following penetrating ocular trauma : A cohort study of the United States Eye Injury Registry" American Journal of Ophthalmology, 23 Aug 2004

28. Sharma T, Agarwal P, Gopal L, Badrinath SS, Murugesan R. Vision Research Foundation: "Penetrating ocular trauma in children by broomstick bows and arrows", Ophthalmic Surgery 1994 Mar, 25 (3): 175-9.
29. Sternberg,Paul Jr; De Juan, Eugene; Michaels Ronald. Penetrating ocular injuries in young patients: Initial injuries and visual results. Retina, 1984, Vol 4(1)
30. Lamkin JC, AZar DT, Mead MD, Volpe NJ. Simultaneous corneal laceration repair, cataract removal and posterior chamber intraocular lens implantation. Am J Ophthalmol. 1992 Jun 15; 113 (6): 626-31.
31. Steqmann R, Miller D. Use of sodium hyaluronate in severe penetrating ocular trauma. Ann Ophthalmol, 1986 Jan; 18(1): 9-13
32. Esmaeli B, Elner S G, Schork M A, University Michigan school of medicine in " Visual outcome and ocular survival after penetrating ocular trauma : a clinicopathological study".
33. David Leonardo Cruvinel Isaac, Vinicius Coral Ghanem. Prognostic factors in Open Globe Injuries; Ophthalmologica 2003;217: 431-435
34. Duanes Clinical Ophthalmology : Mechanism of blunt ocular injury: Chap Pg:
35. Courville B: 1942 Coup Contre coup mechanism of craniocerebral injuries Arch surg 45:19-43.
36. Arlt: Contusion effects on the choroid : cited by Nature and incidence of ocular injuries cited by Duke-Elder system of Ophthalmology Henry Kimpton part I 14: 151.
37. Concussions and contusions cited by the nature & incidence of ocular injuries cited by Duke – Elder system of Ophthalmology Henry Kimpton part I 14:67
38. Ogilive F M 1900: Holes of the macula:Transactions of the Ophthalmic society of UK 20:202.

39. Coup Contre coup mechanisms of ocular injuries: American Journal Of Ophthalmology – 56 :785-796
40. Kuhn and Pieramici : Ocular trauma: Priniciples & practice:Ed 2012:Chap 2.
41. Cherry P M 1978 : Indirect traumatic rupture of globe :Arch ophthalmology 96 (2) :252-6
42. VonGraefe 1854 : Contusion effects of choroid cited by nature and incidence of ocular injuries cited by Duke – Elder system of Ophthalmology Henry Kimpton part I 14:151-1972
43. Beyer TL, Hirst LW (1985): Corneal blood staining at low pressures: Arch ophthalmol 103 (5) 150-153
44. Daniel L Sambursky and Dimitri T Azar (1995) : Corneal And Anterior Segment And Reconstruction Issues In Ocular Trauma In Ophthalmology Clinics Of North America, WB Sanunders, Philadelphia 8 (4) :609-631
45. Cibis GW, Weingeist TA, Krachmer JH: Traumatic corneal endothelial rings: Arch Ophthalmol. 1978;96: 485–488. 44.
46. Maloney WF, Colvard M, Bourne WM, et al: Specular microscopy of traumatic posterior annular keratopathy. Arch Ophthalmol. 1979;97:1647–1650.
47. Löwenstein A. Überlegungen zu einem Fall von traumatischer Hornhautquellung nebst Bemerkungen überdie Bedeutung des Hornhautendothels: Graefes Arch Clin Ophthalmol. 1931;127:598–605.41.
48. Payrau P, Raynaud G: Lésions de la cornée par souggle: corps étrangers perforants microscopiques; anneaux veloutés postérieurs. Ann Ocul. 1965;198:1057–1074.
49. Forstot SL, Gasset AR: Transient traumatic posterior annular keratopathy of Payrau:Arch Ophthalmol. 1974; 92:527–528

50. Datan S oliver M (1982) : Anterior chamber and uveal effusion after non-perforating trauma to the eye: Am J Ophthalmol 94 (6) 782-4
51. Mendel DC (2000) Ophthalmic emergencies:Clinic Tech ,small Annu pract 15 (2) 94 -100 ,127
52. Kumar S et al (1990) :Contusion effects on the choriod cited by the nature and incidence of ocular injuries cited by Duke Elder system of ophthalmology Henry kimpton part I 142-151 (1972) quantitative animal model of traumatic iridodialysis "Acta ophthalmol (copenh) 68 (5) ; 591-6
53. Spoor TC etal (1990) traumatic hyphema in a an urban population Am.Jr. ophthalmol 109(1) 23-27
54. Volpe NJ, Larrison WI, Hersh PT, Kim T, Shingleton BJ. Secondary hemorrhage in traumatic hyphema. Am J Ophthalmol. 1991;112:507–513.
55. Deutsch TA, Feller DB. Paton and Goldberg's Management of Ocular Injuries. 2nd ed. Philadelphia: WB Saunders;1985.
56. Eagling EM. Ocular damage after blunt trauma to the eye: its relationship to the nature of the injury. Br J Ophthalmol. 1974; 58:126–140
57. Ajaman PC (1933) traumatic cataract optima clin 3 (2) : 49-56
58. Dean Eliott and Robert L Avery (1985) non penetrating posterior segment trauma issues in ocular trauma and ophthalmology clinics of North America ; WB Saunders Philadelphia 8 (4) ;569-587
59. Goffstein R Burton TC (1982) differentiating in traumatic from non traumatic retinal detachment ophthalmology 89 (4) : 361-368
60. Knapp (1869) and Noyer (1871) macular holes and cysts cited by Duke elder system of ophthalmology Henry kimpton part I 14 : 169 1972

61. Kaufer G; Zimmer man LE (1996) Direct rupture of choroid Arch ophthalmo l75 (3) 384-5
62. Michael P Joseph (1985) traumatic optic neropathy issues in ocular hyphema ophthalmology clinics of north America WB Saunders Philadelphia 8 (4) 693-708
63. Duke Elder S, Macfaul PA. Injuries Part-I: Mechanical Injuries. System of Ophthalmology, Vol. XIV, St. Louis, C.V.Mosby, 121-148; 1972.
64. Lane SS, Koppeitz LA, Lindquist TD et al. Treatment of Phacolytic glaucoma with ECCE, Ophthal, 1998; 95: 749-53.
65. Joseph Horwitz, Norman.J. "Lens alterations in trauma" vol.3, Lens and Cataract, Page 8:15 Phelps Brown "etiological classification of cataract". Lens disorders, Page 201.
66. Phelps Brown "etiological classification of cataract". Lens disorders, Page 201.
67. Craig Lemley,William Wirostko. Intraocular foreign bodies. Albert & Jakobiec's Principles and practice of Ophthalmology. Vol 4 ,Ed 3(377), 5137-44.
68. Steinberg P, Dezmon E et al. Multivariate analysis of prognostic factors In penetrating ocular injuries. AMJ Ophthalmol, 1984; 98-46 7-72.
69. Rand Allingham, Karim Damji, Sharon Freedman, Soyoko Moroi, Douglas Rhee. Glaucomas associated with ocular trauma.Shiel'd textbook of glaucoma, Ed 6 (25),361-3.
70. Melsaether, CN, Rosenm, CL. "Burns, Ocular." EMedicine: The Continually Updated Clinical Reference. 1 Nov. 2007. 07 May 2009
71. Burns FR, Paterson CA. Prompt irrigation of chemical eye injuries may avert severe damage. Occup Health Safety. 1989; 58: 33–36.

72. Socransky SJ. Ocular burn management and eye irrigation. In: Reichman, Eric, and Robert R. Simon. Emergency Medicine Procedures. New York: McGraw-Hill Professional, 2003.

73. Wagoner MD. Chemical injuries of the eye: current concepts in pathophysiology and therapy. Surv Ophthalmol. 1997; 41(4):275–313.

74. Kuckelkorn R, Kottek A, Schrage N & Reim M. Poor prognosis of severe chemical and thermal burns. The need for adequate emergency care and primary prevention. Int Arch Occup Environ Health 1995; 67:281–284.

75. Smith AR, O'Hagan SB, Gole GA (2006) Epidemiology of open and closedglobe trauma Presenting to Cairns Base Hospital, Queensland. Clin Experiment Ophthalmol 34: 252–259.

76. McCarty CA, Fu CL, Taylor HR (2006) Epidemiology of ocular trauma in Australia. Ophthalmology 106: 1847–1852

77 . Wu M, Ye J. Hospitalized eye injury in a Chinese urban population: a 7-year retrospective analysis. Int J Ophthalmol. 2010;3(2):179-81.

ANNEXURE I: PROFORMA

Hospital No. :

Date :

HISTORY

(1) Particulars of the patient :

- ✶ Name : Age: Sex:
- ✶ Address : Occupation :

(2) Time of injury : Time of reporting:

(3) Chief complaints with duration:.

(4) History related to injury

- Bilateral/Unilateral Eye protection Yes/No
- Place of incident :
  a) Farm / home/work place/School/ recreation/sports Road side
  b) Bystander c) Unknown/Others
- Mode of injury:
  a) Accidental/unintentional b) Assault/Self-inflicted c) Unknown
- Source of Injury :

  Hammers/metal/Sharp object/blunt object/ Nail/thorn

Chemicals/Detergents/Animal bite/impact with horns

Pellet/gun shot/Vehicular accident /Explosives/ Others

(5) Medication / treatment taken outside :Inj. TT/Topical/ Systemic

(6) Any relevant past history(ocular /nonocular): DM/HTN

(7) Immunization history:specially against Tetanus

EXAMINATION OF THE PATIENT

(A) General and systemic examination

Limb/facial/CNS/other injuries

(B) Examination of the eye Right eye(OD) Left eye(OS)

(a) Vision

(b) Pupil (RAPD +/-)

(c) Diffuse illumination

(d) Slitlamp examination

(i) Lids

(ii) Conjunctiva

(iii) Cornea

(iv) A/C – Depth/ cells , flare

Other contents (pus, hyphaema, FB, lens matter, vitreous)

(v) Iris

(vi) Lens

(e) Ophthalmoscopic examination

(a) Direct

(b) Indirect

(D) Intra-ocular pressure (method) Right eye(OD) Left eye(OS)

(E) Any other investigations:

(gonioscopy, syringing etc..)

(F) Investigations

(a) Routine investigations:

- Blood for RE and RBS
- Urine for RE

(b) Special investigations :

- X-ray orbit : CT-Scan/ MRI :

- USG orbit : A-Scan

B-Scan

PROVISIONAL DIAGNOSIS

MANAGEMENT

(a) Supportive medical treatment :

- Inj. T.T./Antibiotics/Antifungal
- Atropine/Cyclopentolate (Mydriatics/Cycloplegics)

(b) Operative:

Follow-up :

TIME	**Vision**	**complications**	**IOP**	**Fundus**	**Refractive status**	**Other**
1st DAY						
At 1 week						
At 1 month						
At 3 months						
At 6 months						

ANNEXURE II: CONSENT TO PARTICIPATE

I, the undersigned, agree to participate in this study and authorize the collection and disclosure of my personal information as outlined in this consent form.

I have read or had read to me and understand the purpose of this study, the procedures that will be used, the risks and benefits associated with my involvement in the study and the confidential nature of the information that will be collected and disclosed during the study.

I have had the opportunity to ask questions regarding the various aspects of this study and my questions have been answered to my satisfaction.

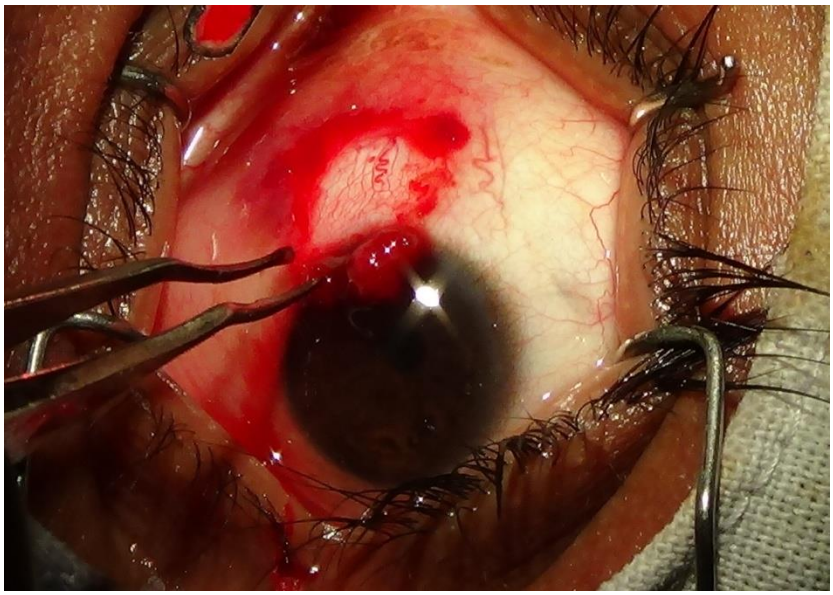
I understand that I remain free to withdraw from this study at any time and this will not change my future care.

Subject's name and signature /thumb impression Date:

Name and signature of parent /guardian Date:

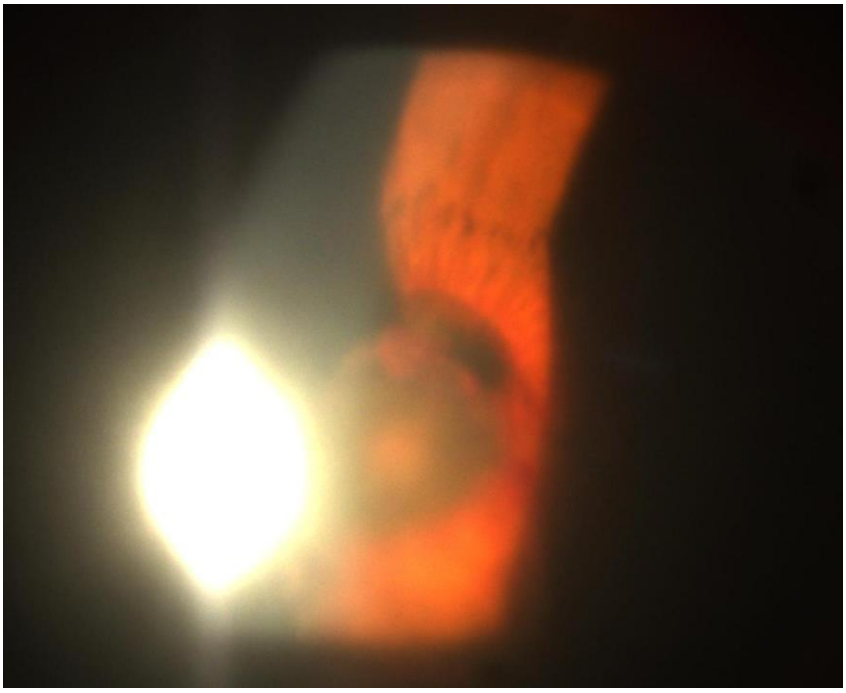
Name and signature of person obtaining consent Date:

ANNEXURE III: PHOTOGRAPHS

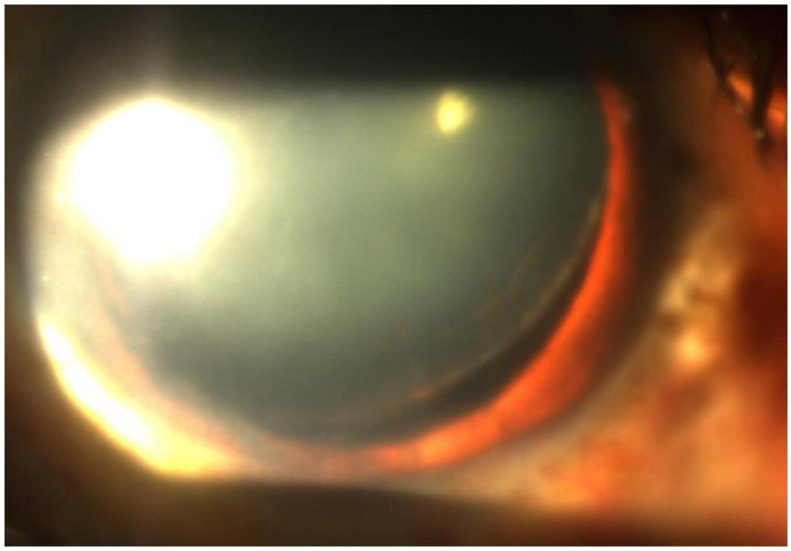


Photograph 1:Simple conjunctival laceraion by trauma with finger nails exposing bare sclera. (On table exploration and primary wound repair)

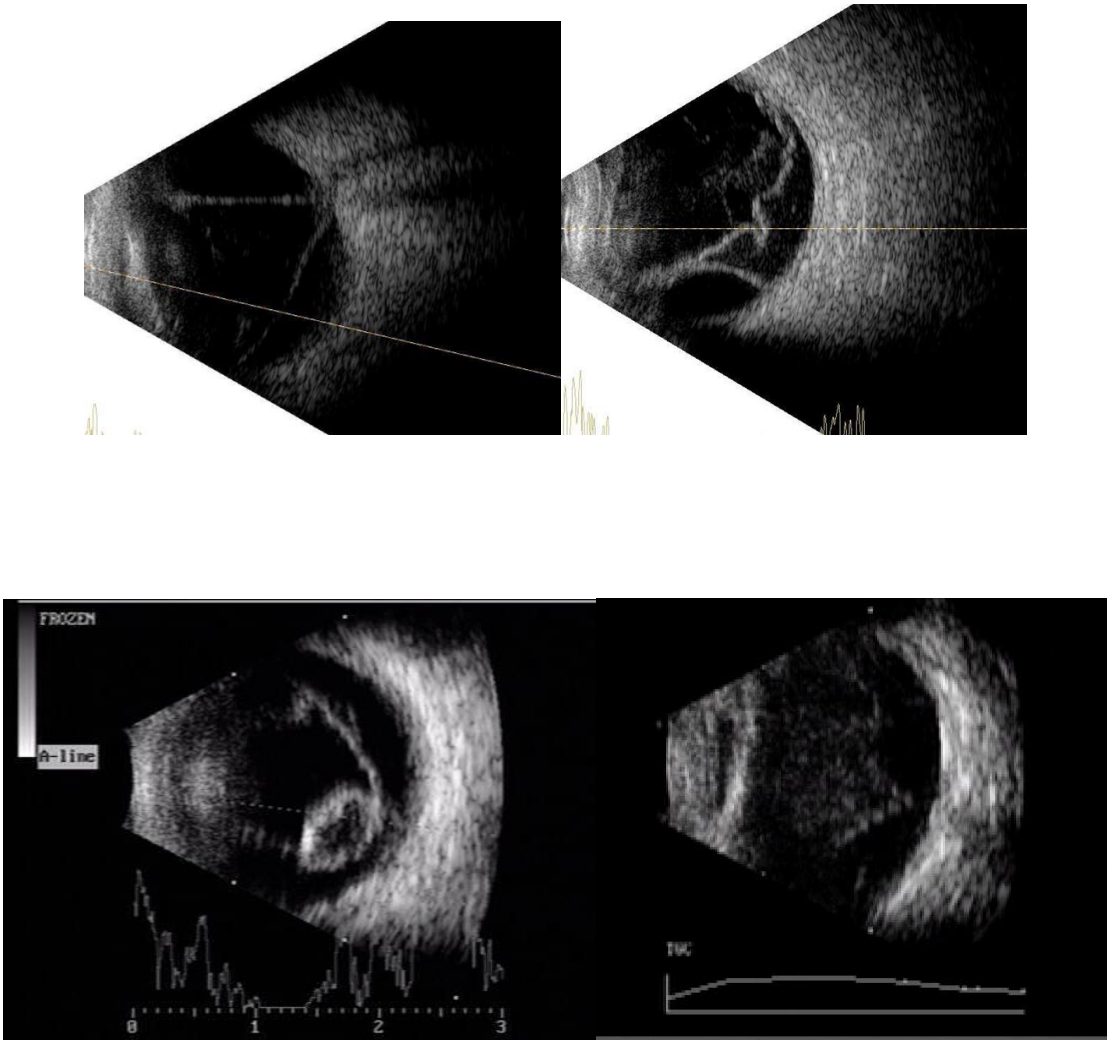
Photograph 2: Severe full thickness adnexal injuries involving both upper and lower lid, globe is intact. Primary lid repair was done.



Photograph 3: Slit-lamp photography of Acute blunt trauma – Closed globe injury presented with corneal edema, severe iritis with fibrinous exudates admixed with hyphaeme.

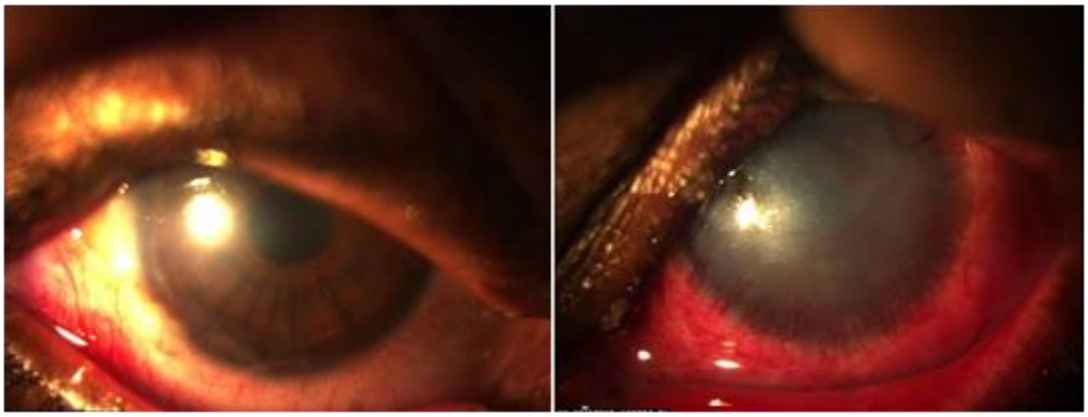


Photograph 4:Blunt injury causing subluxation of lens superotemporally with zonular dehiscence and prolapse of anterior vitreous into anterior chamber

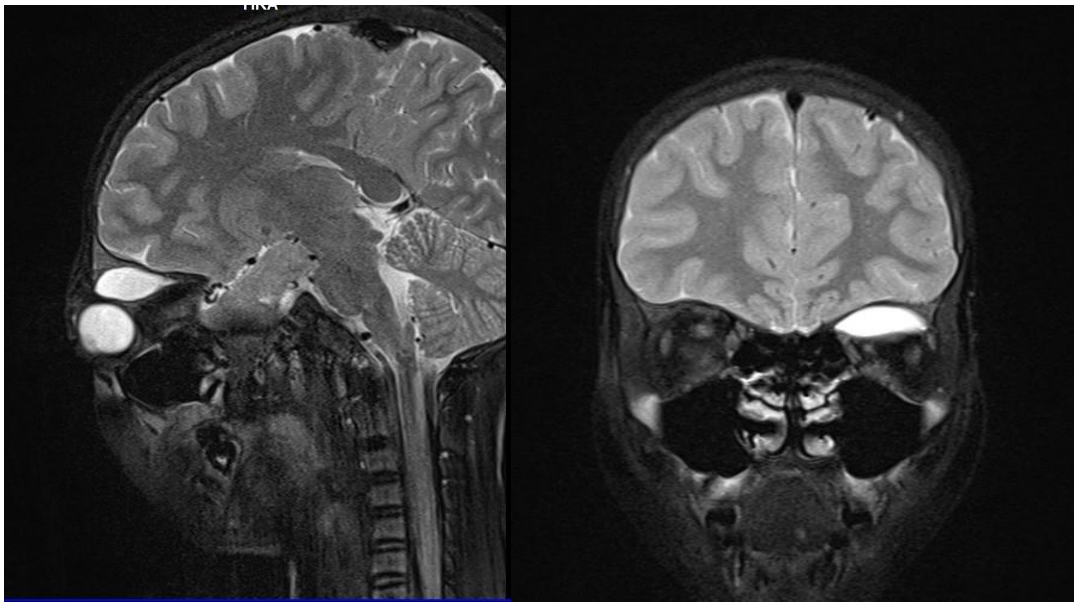


Photograph 5: Composite figure. Upper right – B scan ultrasonography picture showing incomplete PVD, NO RD. Upper right - picture showing post traumatic combined choroidal and retinal detachment. Lower left image showing dot echoes suggestive of vitreous hemorrhage with IPVD. Lower right image showing posteriorly dislocated lens with IPVD.

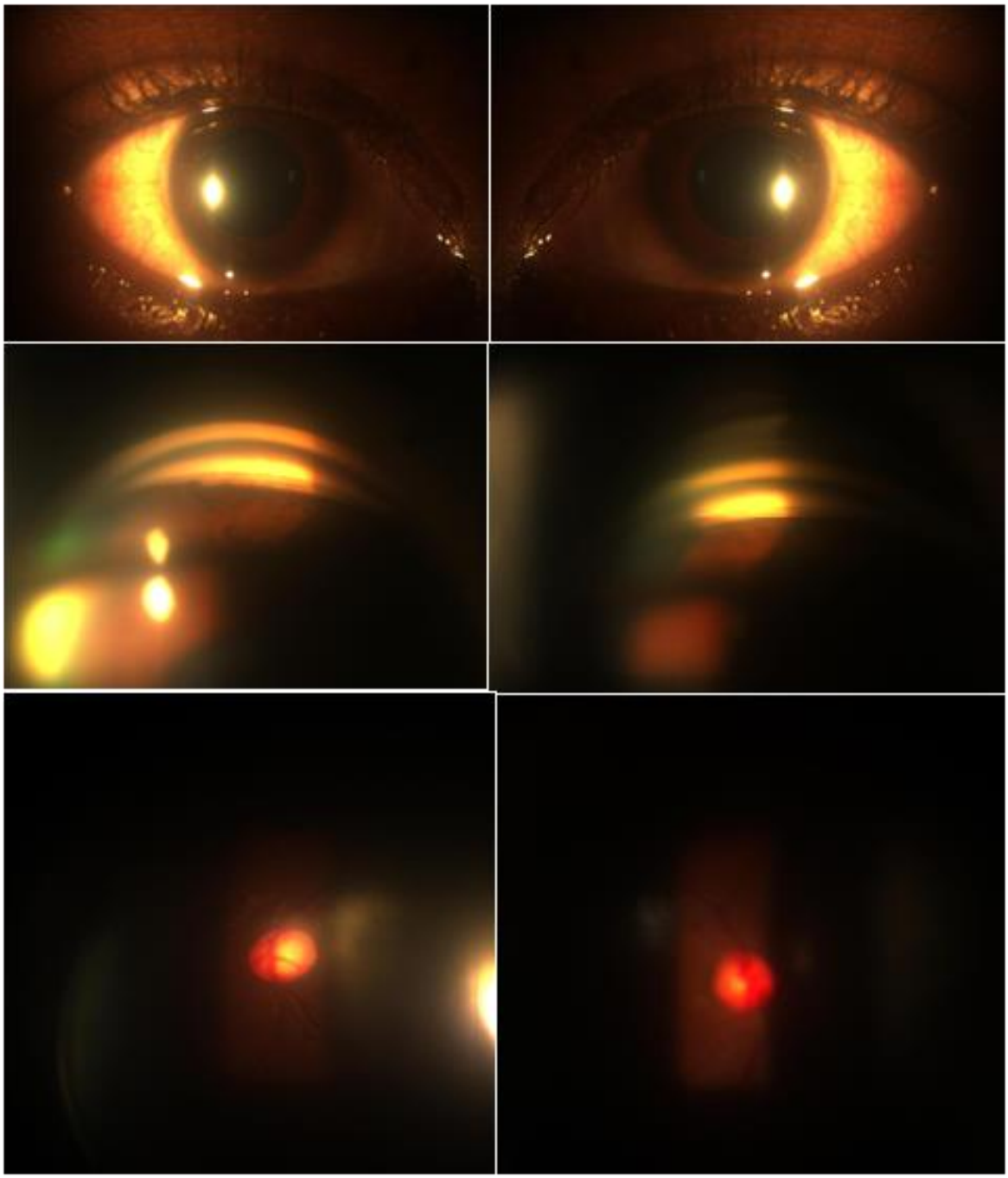
Photograph 6: Pictures showing acute chemical burn injury due to accidental lime spillage in both eyes causing corneal haze in right eye and epithelial defect with limbal whitening in left eye.



Photograph 7: Pictures are after treatment photogrphs of above mentiones case. Patient was managed conservtively . right eye has 6/6 vision. Left eye ended in complete limbal stem cell deficiency with 360 degree pannus.



Photograph 8: Post traumatic orbital hemetoma presented with left eye hypotropia with limitations of movements superiorly (Composite picture). Sagital and cornonal section of MRI showing space occupying lesion in the superior orbit pushing globe forward and inferiorly.



Photograph 9: Composie picture showing Post traumatic angle recession in the right eye with increases cup-disc ratio. Right column pictures are left eye normal findings for comparision.

Photograph 10: 1 week post traumatic lid laceration repair, showing good anatomical appoximation.

Photograph 11: Corneal uler with trace hypopyon. Had trauma with leafy vegetable 1 month back which was unaddressed.

KEY TO MASTER CHART

A	SEX	1= MALE 2=FEMALE
B	OCCUPATION	1 Teacher 2 Student 3 Agriculturist 4 Coolie 5 House Wife 6 Tailor 7 Business 8 Industrial worker 9 Engineering 10 Manual Laborers 11 Miscellaneous 12 Child
C	CAUSE AND NATURE	1 Road Traffic Accident 2 Foreign Body 3 Stone 4 Stick 5 Chemical 6 Fall 7 Thermal 8 Leaf 9 Ball 10 Miscellaneous
D	EYE	1 Right eye 2 Left eye 3 Both Eyes
E	CIRCUMSTANCES	1 RTA 2 Housing 3 Schooling and Recreations 4 Assault 5 Occupational Hazards 6 Others (Details not given)

F	Type of Injury	A Eyelid and adnexa B Closed globe C Open globe D Chemical Injury E Orbital Injury	1 A 2 B 3 C 4 A,B 5 A,C 6 A,E 7 B,E 8 A,B,D 9 A,B,D,E 10 A,B,E 11 A,C,D 12 A,C,E
G	Nature of Injury	EYELID ADNEXA 1=Yes,0=2 CLOSED GLOBE 1=Yes,0=2 OPEN GLOBE 1=Yes,0=2 CHEMICAL INJURY 1=Yes,0=2 ORBITAL INJURY 1=Yes,0=2	
H	EYELID ADNEXA	A=Contusion, B=Laceration	
I	CLOSED GLOBE	N NO INJURY A CONJUNCTIVAL INJURY B CORNEAL INJURY C LENS INJURY D VITREOUS CHANGES E FUNDUS DAMAGE	0 N 1 A 2 B 3 C 4 D 5 E 6 A,B 7 A,C 8 A,D 9 A,E 10 B,C 11 B,D 12 B,E

			13 C,D 14 A,B,C 15 A,B,D 16 A,B,E 17 B,C,D 18 A,B,C,D 19 A,B,C,E 20 B,C,D,E