A CLINICAL EVALUATION OF OUTCOME WITH REGARD TO CORNEAL INJURIES IN TERTIARY CARE HOSPITAL

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CERTIFICATE

This is to certify that this dissertation entitled "A **CLINICAL EVALUATION OF OUTCOME WITH REGARD TO CORNEAL INJURIES IN TERTIARY CARE HOSPITAL"** is a bonafide record of work done by **Dr.K. JAMUNA**, under my guidance and supervision in the Department of Ophthalmology, Government Raja Mirasdhar Hospital, Thanjavur Medical College, Thanjavur during her Post Graduate study for the degree of M.S.Ophthalmology from May 2018 - May 2021.

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DECLARATION

I, **Dr.K.JAMUNA** solemnly declare that this dissertation entitled "A **CLINICAL EVALUATION OF OUTCOME WITH REGARD TO CORNEAL INJURIES IN TERTIARY CARE HOSPITAL"** is a bonafide record of work done by me in the Department of Ophthalmology, Government Raja Mirasdhar Hospital, Thanjavur Medical College, Thanjavur under the guidance and Supervision of my Professor **Dr.J.Gnanaselvan M.S.,D.O.,** the Head of the Department, Department of Ophthalmology, Thanjavur Medical college, Thanjavur between May 2018 – May 2021.

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CONTENTS

Part I

Introduction

1. INTRODUCTION

Vision is the most precious sense and it is most cared for function of the human. This is possible only with healthy eyes. Ocular injury is a major health problem in India. Corneal involvement in injuries being one of the important cause of ocular morbidity and blindness.

The cornea is the most anterior structure of the eye and it is exposed to numerous hazards ranging from airborne debris to blunt trauma of sufficient force to disrupt the globe itself. As a result, corneal injury may assume multiple forms and clinical presentations. Because the cornea is the major refracting surface of the eye, even minor changes in its contour result in significant visual problems [(1).]

Blindness is the one of the most public health problem in most developing countries. Corneal opacification, as a cause of blindness, is second only to cataract in magnitude[(2)]. In corneal blindness, corneal injuries are the One of the most important preventable and avoidable cause. By understanding the different types of injuries to which the cornea is exposed, the practitioner may more capably manage these injuries and minimise the structural and visual sequelae of corneal injury.

Ocular trauma and corneal ulceration are serious public health problems that are occurring in epidemic proportions [3] . Corneal opacification often leads to unilateral blindness, as exemplified by trauma, which is the leading cause of unilateral blindness in the world with a prevalence of 2% [4].

During childhood, the most frequent cause of corneal blindness in at least one eye include keratitis , and during aduldhood trauma keratitis are the most frequent cause. Nearly 95% of all corneal blindness was avoidable[5].

Corneal, corneoscleral perforation and subsequent scarring due to ocular trauma may result in a variable amount of blindness[6]. Corneal abrasions (removal of part or all of the corneal epithelium) are one of the most common ocular injuries[7]. Second to corneal abrasions, corneal foreign bodies are the most common form of ocular trauma[8].

The industrialized world and in urban areas, chemical injuries, accidents at the workplace, and automobile injuries are common. In rural areas of developing countries, minor trauma due to hazardous practices in agriculture, cottage industries, and other work places, as well as sports accidents, are responsible for a large proportion of corneal blindness.

In addition, use of hazardous objects such as bows and arrows and lack of implementation of industrial safety regulations increase corneal morbidity from trauma[4]. It appears that early treatment can restore good vision and use of eye protective glass while working will be the preventable measure.

Diligence in diagnosis, patience and perseverance with regard to treatment goes a long way to alleviate the ocular morbidity. Hence this study is an attempt to study the clinical patterns, diagnosis, management and visual outcome of corneal injuries and also to educate the patient for better follow up during the course of treatment.

Review of Literature

2. REVIEW OF LITERATURE

The history of ocular injuries began when one primitive man fought with another person. When he first walked through forest and chipped a flint to make his primitive tool. At a much later date, that is about the year 1200 BC. One artist painted a picture of removal of foreign body from the eye of a workman on a tomb.

Sir. William Tindall Lister (1868 – 1944) has contributed most richly to the knowledge of ocular injuries.

The earliest statistics of the incidence of Ocular trauma of all types among ophthalmic patients were correlated by Zander and Geissler [10] (1864) they found the estimate to vary from 1.8 to 9% of all eye diseases.

In subsequent studies the figure have varied Weidman [11] (1888) among 30,000 ophthalmic patients he found total incidence of 4.89%. According to Arnold Sorsby [12] (1972) the incidence is 10% in non Industrial areas and 30 to 50 % in the Industrial Areas.

With regard to age, the highest incidence is in adult life because of growing Industrialization. But children are also in special danger because

they are less aware of the hazards and the child's eye is relatively less well protected because of the smaller orbit.

Regarding sex incidence, because of growing Industrialization, where males are the main employees it is more common in males. In 1017 cases seen in Industrial town of wolver Harpton, lambah [13](1968) found that there were 94.3% males and 5.7% females.

M.P.Upadhayay, P.C. Karmacharya, S.Koirala et al., studied a defined population of 34 902 individuals closely followed prospectively for 2 years by 81 primary eye care workers who referred all cases of ocular trauma and / or infection to one of the three local secondary eye study centres in Bhaktapur for examination , treatment, and follow up by an ophthalmologist.

Over the 2 year period there were 1248 cases of ocular trauma reported in the population of 34 902 (1788/100 000 annual incidence) and 551 cases of corneal abrasion (789 /100 000 annual incidence). The number of clinically documented corneal ulcers was 558 (799/100 000 annual incidence)[3].

R.Dandona and L.Dandona studied A total of 11 786 people of all ages from 94 clusters representative of the population of the Indian state of

Andhra Pradesh were sampled using a stratified, random, cluster, systematic sampling strategy. These participants underwent a detailed interview and eye examination including measurement of visual acuity with snellen charts, refraction, slit lamp biomicroscopy, applanation tonometry, gonioscopy and stereoscopic dilated fundus evaluation.

Of those sampled, 10 293 (87.3%) people participated in the study. Corneal blindness in at least one eye was present in 86 participants, an age, sex and urban – rural distribution adjusted prevalence of 0.66% (95% confidence interval 0.49 to 0.86), which included 0.10% prevalence of corneal blindness in both eyes and 0.56% in one eye .

The most frequent causes of corneal blindness in at least one eye included keratitis during childhood (36.7%), trauma (28.6%) and keratitis during adulthood (17.7%). Nearly 95% of all corneal blindness was avoidable[(5)].

S.K.Khatry, A.E.Lewis, O.D.Schein and et al studied reports of ocular trauma collected from 1995 through 2000 from patients presenting to the only eye care clinic in Sarlahi district, Nepal. Patients were given a standard free eye examination and interviewed about the context of their injury. Follow up examination was performed 2- 4 months after the initial

injury. 525 cases of incident ocular injury were reported, with a mean age of 28 years.

Using census data, the incidence was 0.65 per 1000 males per year, and 0.38 per 1000 females per year. The most common types of injury were lacerating and blunt, with the majority occurring at home or in the fields[14]. Interstitial edema due to blunt injury was described by Slingsby J.G., SL[35](1981). Blood staining of the cornea described by Beyer TL, Hirst LW[36] (1995). Folding of Bowman's Membrane described by Casper (1903) and Von graefe[37] (1866). Corneal lacerations described by Daniel L. Sambursky, Dimitri T.Azar[34] (1995).

Rajesh Sinha, Namrata Sinha and Rasik B.Vajpayee studied that in India, there are approximately 6.8 million people who have corneal blindness with vision less than 6/60 in at least one eye and of these, about 1 million have bilateral corneal blindness[15].

If the present trend continues, it is expected that the number of corneally blind individuals in India will increase to 8.4 million in 2010 and 10.6 million by 2020[16]. Ocular trauma and corneal ulceration are also significant causes of corneal blindness and may be responsible for 1.5 to 2.0 million new cases of uniocular blindness every year[17].

Ocular trauma has been reported to be the most important cause of the unilateral loss of vision in developing countries, and up to 5% of all bilateral blindness has been attributed to direct ocular trauma. Corneal and corneoscleral perforation and subsequent scarring due to ocular trauma may result in a variable amount of blindness[18]. Which was also described by Mac Cumber MW[39] (1998).

Gullapallin. Rao studied that Ocular trauma is responsible for 1% to 10% of corneal blindness. The geographic location, pattern of injury, causative agent and age are some of the factors that determine the degree of damage[19].

In urban areas and in the industrialized world, chemical injuries, accidents at the workplace and automobile injuries are common. In rural areas of developing countries, minor trauma due to hazardous practices in agriculture, cottage industries and other work places, as well as sports accidents, are responsible for a large proportion of corneal blindness[20].

According to Boshoff and Joki [27] (1948) Favory and Sedan[28] (1951) the injuries due to travel and sport can be soft tissue lacerations and occasionally fracture of orbit. Forsius and Nikupaavo [29](1964) found that

11.4% of Ocular injuries occurred among agricultural workers , injuries commonly are due to twigs, animal horn, tail, whiplash.

Corneal abrasions (removal of part of the corneal epithelium) are one of the most common ophthalmic injuries. Corneal abrasions were the cause of 10% of new patient visits to the ophthalmic emergency room [(21)]. The common causative agents include fingernails, paper, mascara brushes and plants. Corneal abrasions which described by Daniel L Sambursky, Dimitri.T.Azar[(34)] (1995).

Important non contact sources of epithelial injury include chemicals, radiations and heat. Second to corneal abrasions, corneal foreign bodies are the most common forms of ophthalmic trauma. In a recent study in northern Sweden the incidence of eye injuries was estimate to be 8.1 per 1000 population with corneal and conjunctival foreign bodies comprising 40% of these [(8)]. Mukherjee P.K Extra Ocular foreign bodies[(38)] (2005) described surrounding infiltration or even frank ulceration due to extra ocular foreign bodies.

Traditionally, acid injuries of the eye are for the most part, thought to be somewhat less destructive than exposure to alkaline compounds. Depending upon the concentration, strength and duration of contact acids

cause a wide spectrum of injury from mild keratoconjunctivitis to devastating bilateral blindness[22] which was also described by Mc Culley JP. Chemical injuries[41] (1987).

The entire anterior segment of the eye is seriously jeopardized by exposure to alkali. Non perforating ocular injuries of this type results in destruction of cellular components, denaturation and degradation of collagenous tissues and release of inflammatory mediators by alkaline hydrolysis of a broad range of intracellular and extracellular proteins as well as invading cells[23]. Alkali burns are twice as common as acid burns which was described by Arffa R. Chemical injuries [40] .(1991) .

Corneal Injuries: An Overview

3. CORNEA: AN OVERVIEW

Cornea is a transparent avascular structure. It forms 1/6 th of the outer fibrous coat of the eye ball. Cornea have a protective role. It is responsible for about three-quarter of the optical power of the eye. Normal cornea is free of blood vessels. Nutrients are supplied and metabolic products removed mainly via the aqueous humour posteriorly and tears anteriorly[24].

Cornea has the following two surfaces:

	Anterior cornea surface	**Posterior cornea surface**
Shape	Elliptical	Circular
Radius of curvature	7.8 mm	6.5 mm
Refractive power	+48 D	-5D
Vertical Diameter	10.6 mm	11.7 mm
Horizontal Diameter	11.7 mm	11.7 mm

- Total refractive power of cornea is +43 D (3/4 of the total refractive power of eye).
- Cornea is steep at birth (+53 D) and becomes flatter with age(+43 D by 2 years).
- Refractive index of cornea is 1.376.

- Central corneal thickness is about 540 microns. Cornea is thicker in periphery about 670 microns.
- Corneal size – horizontal diameter of cornea at birth is about 10 mm and reaches adult size of about 11.7 mm by 2 years of age.

Structure

The cornea consist of the following layers,

❖ Epithelium (50-90 µm)

- Non-keratinized Stratified squamous epithelium and consists of 5 - 6 layers of cells.
- A single layer of columnar cells forms the basal cell layer. These cells are capable of mitosis.
- Wing or Umbrella cells are 2-3 layers of polyhedral shaped cell. Squamous flattened cells are two most superficial cell layers contains microvilli, it helps in tear film stability.
- Completes turnover occurs in 6 – 8 days. It replaced by growth from its basal cells.

❖ Bowman's Membrane (8 - 14µm)

It is not a true membrane so its not PAS positive. It does not regenerate as it is an acellular layer consisting of collagen fibrils, thus heals by scarring leading to permanent loss of vision.

❖ Stroma (Substantia Propria)(0.49 mm)

It constitutes 90% of corneal thickness. It contains mostly Type 1 collagen and few Type 5 collagen. Most common ground substance is keratin sulphate. Contains keratocytes, macrophages, histiocytes and a few lymphocytes.

❖ Dua's layer(6.5 – 13.9 µm)

It has been recently identified. It lies between stroma and descemet's membrane (Pre-Descemet membrane). It is the toughest layer.(Previously, Descemet's membrane was considered as toughest layer).

❖ Descemet's Membrane (10- 12µm)

Its thickness varies with age (3 microns at birth and 10-12 microns in adults). It is secreted by endothelial cells throughout life. It can regenerate. In the periphery, it ends at the anterior limit of trabecular meshwork known as Schwalbe's line.

❖ Endothelium (5µm)

It consists of single layer of flat polygonal cells. Most metabolically active layer, contains an 'active-pump' mechanism (Na+ K+ AT Pase) to maintain corneal dehydration.

Nerve supply of cornea

The corneal nerves, are derived from the long and short cilliary nerves, branches of the ophthalmic divisions of trigeminal nerve. They form the pericorneal plexus just outside the limbus, and then pass onto the cornea as 60-70 trunks. They loose their myelin sheaths after a millimeter or two, and reach the cornea. Cornea does not have proprioceptive sensation.

Blood supply

Cornea is avascular, but the limbus is supplied by the anterior conjunctival branches of anterior ciliary arteries and form a perilimbal plexus of blood vessels.

Factors responsible for maintenance of corneal transparency [25]:

- Pre-corneal tear film and homogeneity of refractive index throughout the epithelium.
- Avascularity of cornea.
- Uniform arrangement of stromal lamellar collagen fibrils in a regular lattice,
    - Collagen fibers are highly uniform in diameter (25-35 nm).
    - The distance between two corneal fibers is also highly uniform (41.5 nm), which is less than half of wavelength of light and

thus, helps to maintain transparency by destructive interference.

- ❖ Relative state of corneal dehydration maintained by Endothelial pumps
- ❖ Normal intraocular pressure(IOP).
- ❖ Corneal crystallins (Soluble proteins present in stromal keratocytes) reduce backscatter of light.

Any interference with these factors affects the corneal transparency. Thus the cornea becomes hazy in corneal edema, ulcer, scars, xerosis, vascularization, mucopolysaccharidosis (MPS), acute attack of angle-closure glaucoma, absolute glaucoma, etc.

Opacity

For development of a corneal opacity at least the Bowman's membrane must have to be damaged.

Grades of opacity

- ❖ Nebula: Only Bowman's membrane is involved.
- ❖ Macular: Bowman's membrane and part of the anterior stroma are involved.
- ❖ Leucoma: Full thickness cornea is involved.

- ❖ Adherent leucoma: A full thickness corneal opacity with iris inclusion. It indicates corneal perforation or a penetrating injury in the past.
- ❖ In case of corneal opacity look for:
    - It density (grade).
    - Situations and extent in relation to the pupillary axis and limbus.
    - Any pigmentation.
    - Any vascularization – superficial or deep .
    - Adherent or not.
    - Its sensation.

Types of Ocular Injuries

From the aetiological point of view, Ocular injuries are difficult to classify since they occur from innumerable causes in every circumstance of life.

Duke – Elder [(26)] has classified injuries in following ways:

A. Aetiological Classification:

1. Intrauterine Injuries
2. Birth Injuries.
3. Domestic Injuries.

4. Injuries due to Travel and Sports.

5. Agricultural Injuries.

6. Industrial Injuries.

7. War Injuries.

B. Classification II

(a) Mechanical Injuries

The mechanical injuries to the eye can be classified as

- Closed globe injury
  - Contusion
  - Lamellar laceration
- Open globe injury
  - Rupture
  - Laceration
- Penetrating
- IOFB
- Perforating.

(b) Non Mechanical Injuries

1. Thermal Injuries
2. Ultrasonic Injuries
3. Electrical Injuries

4. Radiational Injuries

5. Chemical Injuries

6. Stress Injuries

1. Intrauterine Injuries

Development deformities due to mechanical trauma can be in the form of dissection, Constriction or Mechanical agitation of embryo. Amniotic bands may be responsible for variety of mutilations.

2. Birth Injuries

Occur at the time of birth in prolonged labour or Instrumental delivery. Injuries to the globe are caused by pressure either directly on the eye ball or the eye ball being forced against one of the Orbital walls. The two most common sequelae are intra ocular hemorrhages and corneal opacities. Other injuries like injuries to the lids and conjunctiva, rarely rupture of tenon's capsule with herniation of the orbital fat into the tissue of the eye. Lid injuries occur to the extra Ocular muscles due to compression of the orbit, producing tear of their sheaths and hemorrhage into the muscle substance with development of fibrosis may occur. Subluxation of the globe outside the palpebral fissure is rare and is in most cases are due to application of forceps.

3. Domestic Injuries

These comprise the multitude of accidents that occur in everyday life, outside the place of work. Injury by a blunt object such as sustained in failing or being hit by fist, piece of chopped wood, a stone. Corneal Foreign body trauma causes corneal abrasions, blunt traumas to perforating injuries. The objects are usually knife, scissors, finger nail, needle, etc., can be of serious and severe in nature. These injuries varies from lacerations of the lids and abrasions of the cornea, to wounds or rupture of sclera, Intra ocular hemorrhages dislocation of the lens and detachment of the retina. Children and women are the victims of a high percentage of domestic injuries animal blows (Bullgore) fire crackers injury during festivals.

4. Injuries due to Travel and Sport

Accidents involving injury to eyes and adnexa, while traveling are common irrespective of the type of vehicle whether in Trains, Aero planes or Cars etc., the injury tends to be severe which may be a contusion leading to fracture of the orbit and concussion or rupture of the globe which may be associated with craneo facial injuries.

Sports injuries are usually severe contusion of the globe from the impact of the blunt object from ball, stick, fist, foot, racquet these are common in Foot ball, Cricket , Hockey, Tennis, Golf, Boxing, Wrestling, Swimming[28].

5. Agricultural Injuries

The commonest agricultural injuries are abrasions or even perforation of eye, A Severe type of trauma can be from a blow, from an animal head, horn or hoof or a swish from its tail.

Frequently the corneal abrasions become infected developing into hypopyon ulcers, thus, many of the injuries sustained in rural set up result in serious visual loss, partly because of the gross nature of injury and increased prevalence of super imposed infection and difficulty in obtaining adequate and timely treatment[29].

6. Industrial Hazards / Industrial Injuries:

No industry is entirely immune from ocular hazards. Industrial workers are prone to injury with metals, like steel and Iron .In miners and Quarry men contusion injuries occurs following large pieces of coal or blast injuries resulting in intra ocular damage and lacerations and penetration of cornea particularly use of chisel and hammer.

7. War Injuries

The Ocular injuries sustained in war vary in succeeding wars as the techniques, strategy of attack go on changing the injuries were by hand

weapons in the past. Now bullet injuries and explosions injuries are common.

Many of the war injuries can cause concussions and contusion requiring excision of the eye, they may cause traumatic cataract, keratitis, intra ocular hemorrhage, retinal detachment, lid and orbital injuries.

Ocular trauma classification system is based on Birmingham Eye Trauma Terminology (BETT) [30]. It can be categorized by four parameters[31][32].

- Type
- Grade
- Presence / absence of RAPD
- Extent or zone of injury.

Open Globe Injuries

Open globe injuries may be of the following types

Type

A. Rupture

B. Penetrating

C. Intraocualr foreign body(IOFB)

D. Perforating

E. Mixed

Grade (Visual Acuity)

A. ≥ 20/40

B. 20/50 to 20/100

C. 19/100 to 5/200

D. 4/200 to light perception

E. No light perception (NLP)

Pupil

A. Positive, relative afferent papillary defect (APD) in injured eye.

B. Negative, relative APD in injured eye.

Zone

I. Injuries involve the cornea and limbus.

II. Injuries involve the anterior 5 mm of the sclera.

III. Injuries involve full – thickness defects whose most anterior aspect is at least 5 mm posterior to the limbus.

In perforating injury, the most posterior defect usually the exit site, is used to judge the zone of involvement.

Closed Globe Injuries

Closed globe injuries are of the following types

A. Contusion

B. Lamellar laceration

C. Superficial foreign body

D. Mixed

Grade (Visual Acuity)

A. ≥ 20/40

B. 20/50 to 20/100

C. 19/100 to 5/200

D. 4/200 to light perception

E. No light perception (NLP)

Pupil

A. Positive, relative APD in injured eye.

B. Negative, relative APD in injured eye.

Zone

I. External (superficial injuries limited to bulbar conjunctiva, sclera, cornea)

II. Anterior segment (includes structures of the anterior segment and the pars plicata , including the lens apparatus)

III. Posterior segment (all internal structures posterior to the posterior lens capsule including the retina, vitreous, uvea and optic nerve).

New Classification[30]

A New classification has been endorsed by the Board of Directors of the international society of Ocular trauma, the United States of Eye injury registry the Vitreous society, the Retina society and American Academy of Ophthalmology.

Closed Globe Injury

The eye wall does not have a full thickness wound.

Open Globe Injury

The Eye wall has a full thickness wound a through and through injury.

Ruptures

Full thickness wound caused by blunt impact and an inside out mechanism.

Laceration

Full thickness wound by sharp objects.

Penetrating Injury

Single Laceration, usually by a sharp object.

Perforating Injury

Two full thickness lacerations (Entrance and exist) usually caused by sharp object or missile.

Corneal Injury

1. Blunt Injury

Ocular injuries by blunt instruments vary in severity, from simple subconjunctival hemorrhage to rupture of the globe. Every part of the globe may be so injured by contusion, that may seriously cause diminished vision. Moreover, in some cases the effects are progressive or delayed[33]. So in all cases of contusions, a guarded prognosis should be given.

A Mechanism of ocular tissue damage are

- Direct effect of injury.
- Indirect effect against bony orbit, and
- Contrecoup effect due to propogation of wave of thrust, to and fro within the globe.

Injuries to Cornea

- Injuries to the cornea may be primary or secondary.
- Primary damage to the corneal epithelium corneal ring tears Descemet's membrane and corneal rupture.

- Secondary: Corneal edema blood staining of the cornea, folds of Bowman's membrane and Descemets membrane folds.

1.1. Abrasions

Minor trauma of the cornea results in Mechanical debridement of Corneal Epithehal cells[34]. An abrasion usually heals without any further changes.

1.2. Interstitial Edema

Following a severe trauma interstitial edema occur[35]. There is a temporary disturbance of the cells of the corneal endothelium the permeability of the endothelium is altered and the aqueous gains entrance into the cornea.

The interstitial portion of the cornea is hazy and edematous, more so in deeper layers the corneal lamellae are swollen and the edematous area shows a criss-cross straitated appearance. When the edema is accentuated by the folds in the Bowman's layer the lesion is known as "Lattice like opacities of Casper" when the edema is accentuated by the folds in the descemets membrane it is known as thread or "Lattice like opacities of Schimer".

There may be minimal epithelial bedewing rarely, when healing is delayed bullous keratopathy may develop there is associated ciliary congestion, the patient complains of diminished vision and irritation.

1.3. Blood Staining of the Cornea

Following a severe blunt trauma, when there is massive hyphema and raised intra ocular pressure, there may be absorption of decomposition products of blood pigments from the anterior chamber[36] . As a rule to produce this effect, the anterior chamber must be completely filled with blood. The route of entry into the cornea is not clear. It can be either through the damaged Endothelium (Most important route) or from the periphery.

Entire cornea is involved leaving a clear ring around the periphery initially the affected area is densely stained and appears rusty brown or greenish black. Gradually the colour changes to greenish yellow or grey. It occupies the entire thickness of the corneal stroma and it disappears over a period of two years or more. Although the peripheral cornea may become vascularized the tissues eventually clear. Probably due to scavenging action of phagocytic cells. Visual recovery however is unusual owing to damage to other structures of the eye, the important thing is to prevent its occurance by evacuating the blood and by control of tension.

1.4. Folding of Corneal Tissue

a) Folds of Bowman's Membrane

Following a blunt injury when a force impinges directly on the cornea but rarely seen following concussion injury, seen particularly when hypotony and inflammatory changes supervene, they appear as grey ridges with a double optical contour also called lattice like opacities of casper.

b) Folds in Descemets membrane they are more common they occur in hypotony following blunt injuries, they appear as delicate gray striae with a double optical contour. These may produce a lattice like pattern or a diffuse opacity. Also called "Traumatic Striate Keratopathy"[37].

On focal illumination, they appear as double contoured bright lines formed by two parallel linear reflexes at the sides of the fold, which join at their extremity on retro illumination, they appear as dark slender bands.

1.5 Corneal Lacerations

There can be a complete or partial corneal laceration[34] .

When a sudden force hits the cornea directly, the cornea is forcibly indented and lacerations of the corneal tissue occur which may be partial or total because of the elasticity, the Bowmans membrane may not be involved. The patient complains of pain, photophobia, lacriamtion. There is associated ciliary congestion, Miosis and often intra ocular damage.

Initially the lesions may be hidden by the corneal edema they leave behind permanent opacities on healing.

1.6 Tears in the Descemets Membrane

These lesions are due to compression of the eye following birth injuries. When there is a blunt force the cornea is forcibly indented. Since the Descemets membrane is not very elastic, it easily gives way.

The tears are long, sinuous and crescentric, may be circular at times the tear is broader in the middle and tapers at the ends. At times one end of the tear may separate itself from the cornea and the free end curls upon itself hanging freely in the anterior chamber there may be single or multiple tears.

On slit lamp examination, they appear as bright double contoured streaks with a dark space between them. On ophthalmoscopic examination these tears appears as dark double contrasted lines with a red space between them.

Descemets tears rarely heal. But the underlying endothelium grows over the bare areas and sometimes the endothelium may secrete a new membrane to cover the bare areas. Rarely the endothelium grows across the angle of the anterior chamber into the Iris. Healing may also occur by the formation of Fibrous tissue, which leave behind a permanent opacity.

1.7 Corneal Rupture

Corneal rupture is an uncommon complication of blunt trauma[34]. When the cornea is hit directly with a sudden severe force an expansive pressure occurs with in the eye stretching the globe outwards. Since the corneoscleral junction is a weak area it gives way, producing a rupture at that site, this is further enhanced by the presence of an old cicatrix. Such a severe force can be generated by injuries with the horn of a cow, blow from a fist, air gun or blast injuries commonly produce the linear rupture. It is associated with Iris prolapse and if it is a large rupture the lens, vitreous and a varying amount of uveal tissue is extruded.

If the damage is not extensive, prognosis is good.

2. Penetrating Injury / Perforating Injury

They are caused by sharp objects or foreign bodies. Perforating injuries are potentially serious, and the patient should be urgently admitted and treated promptly.

Penetrating injuries by definition penetrate into the eye but not through and through; there is no exit wound. Perforating injuries have both entry and exit wounds (a through and through injury).

The seriousness arises from the immediate effects of trauma, the introduction of infection, sympathetic ophthalmitis.

Wounds of the Cornea

These may be linear or lacerated. The margins soon swell up after the injury, and become cloudy, due to imbibitions of fluid. Adhesion of the iris or its prolapsed is almost certain[39].

3. Extra Ocular Foreign Bodies

Small foreign bodies like coal, dust, sand, iron particles, eyelash, wood piece, husks of seeds, wings of insect etc, may pitch upon the conjunctiva or the cornea.

A history of injury and the probable character of the foreign body help in its detection and removal.

The symptoms vary from mild or no discomforts to severe pain, and watering. There may be associated photophobia and redness.

Patient cannot localize a foreign body on the cornea, as there is no kinesthetic sensation in the cornea. Instead, it is very often referred to the tarsal conjunctiva of the upper lid against which the foreign body rubs.

The particle is usually embedded in the epithelium or in the anterior stroma.

Foreign body is best localized by careful inspection of the cornea, aided by magnification with loupe or slit-lamp.

A fluorescein stain is also very helpful.

When the removal is delayed, there may be surrounding infiltration or even frank ulceration of the cornea will occur[38].

4. Chemical Injuries

Chemical injuries (e.g. with household detergents and cleaning agents) of the eye are relatively minor, and are easily treated. . But occasionally, alkaline and acidic substances may cause severe ocular damage and permanent loss of vision.

The majority are accidental but a few are due to assault. Two-thirds of accidental burns occurs at work and the remainder are at the home. Alkali burns are much more dangerous than acid burns because, alkalis tends to more deeply than acids, as the latter coagulate surface proteins , forming a protective barrier.

The most commonly involved alkalis are ammonia, sodium hydroxide and lime[41] .Ammonia and sodium hydroxide characteristically produce severe damage because of rapid penetration. Hydrofluoric acid used in glass etching and cleaning also tends to rapidly penetrate the ocular

tissues, whilst sulphuric acid may be complicated by thermal effects and high velocity impacts associated with car battery explosions.

Chemical Injury Grading is performed on the basis of corneal and severity of limbal ischaemia which was described by **Roper – Hall system**[42]**.**

- **Grade 1** is characterized by a clear cornea (epithelial damage only) and no limbal ischaemia (excellent prognosis).
- **Grade 2** shows hazy cornea but with visible iris detail and less than one-third of the limbus being ischaemic (good prognosis)
- **Grade 3** manifests total loss of corneal epithelium , stromal haze obscuring iris detail and between one-third and half limbal ischaemia (guarded prognosis)
- **Grade 4** manifests with an opaque cornea and more than 50% of the limbus showing ischaemia (poor prognosis).

Evaluation of Corneal Injuries

4. EVALUATION OF CORNEAL INJURY

Evaluation of corneal injury [43]

1. History a detailed history and the aetiology of the injury should be noted.
2. Visual acuity – recording visual acuity using Snellen's chart for the patients with ocular trauma should be done.
3. Anterior segment examination – examination of anterior segment should be done in detail with special emphasis on corneal involvement with the help of a slit lamp biomicroscope after instilling topical anaesthetizing drop proparacaine 0.5 % and the pattern of corneal injury should be noted in detail and the management should be done according to the type of injuries.
4. Fluorescein staining should be done to note the layers of the cornea involved in injury.
5. Fundus examination.
6. B-scan should be done to see for the posterior segment involvement.
7. Lacrimal sac syringing
8. Routine laboratory investigations:
    a. Complete hemogram
    b. Random Blood Sugar

c. Urine – sugar, microscopy and albumin

d. HIV, HBsAg

9. Microbiological investigations as and when required should be done as follows

The sample for microbiological investigations should be obtained by corneal scrapping. The cornea will be anaesthetized using 0.5% proparacaine solution and scrapping should be done using sterile No.15 Bard Parker blade from the margins of the corneal ulcer.

The following microbiological investigations should be done immediately if needed

a Gram's stain

b 10% KOH preparation

c Bacterial culture using blood agar and chocolate agar. Sensitivity should be done using disc diffusion method if organisms are isolated.

d Fungal culture should be done using Sabouraud's dextrose agar medium. Culture reports should be collected at the end of 14 days.

10. Radiology investigations- X-ray orbit and CT orbit

Treatment of Corneal Injuries

5. TREATMENT OF CORNEAL INJURIES

1. Corneal Abrasions

- The eye should be patched after instilling topical lubricating eye drops, topical antibiotic eye drops, topical cycloplegics eye drops[44] .
- The eye patch should be removed after 24 hours to look for the healing. If not healed, patching should continued next 2- 3 days until the cornea gets fluorescein stain negative.
- After removal of patch, antibiotic, lubricating and cycloplegic eye drops should continued for next 3 days or as required depending upon the injury.
- Oral analgesics should be given to reduce pain.
- If corneal ulcer develops, it should be managed as infective keratitis.

2. Corneal Foreign Body

- Smaller objects should be removed simply with a direct stream of sterile irrigating solution.
- More tenaciously stuck corneal foreign body should be removed with moistened cotton-tipped applicator.

- More deeply embedded objects should be removed with a 26-gauge bent needle tip under the application of topical proparacaine 0.5% eye drops [45].
- Any remaining cellular debris or rust, as well as any ragged or non-viable epithelial tissue surrounding the wound should be removed.
- If perforation suspected, Seidel's test should be performed and treatment for corneal perforation should be done.
- Eyelids and adnexa should be carefully examined for any other foreign body and it should be removed.
- Subsequent management and follow up after removal of foreign body are same as corneal abrasion as above.
- X-ray or B scan should be done to eliminate intraocular foreign body.
- Oral analgesics should be given to reduce pain.

3. Blunt Trauma

- If no corneal abrasions found, other layers of cornea should be inspected [46].
- In case of DM detachment conservative treatment with antibiotics and lubricating eye drops should be given and if striae or any signs of raised intra ocular pressure noted then topical antiglaucoma

medications like timolol maleate eye drops 0.5% and acetazolamide 250mg tab should be given with usage of topical cycloplegics.

4. Chemical Injury

Irrespective of the nature of chemical involved in the injury the following treatment should be given on an emergency basis

- Critical step in the assessment is thorough examination of ocular surface for the presence of any particulate chemical matter by double eversion of the upper eyelid using an eyelid retractor [(48)].
- Copious irrigation of the eyes, preferably with saline or ringer's lactate solution, for at least 30 minutes should be performed. An eyelid speculum should be inserted along with topical anesthetic before the irrigation.
- The lower eyelid should be pulled down and the upper eyelid should be everted to irrigate the fornices [(49)].
- Five to ten minutes after ceasing irrigation, litmus paper should be touched to the inferior cul-de –sac. Irrigation should be continued until neutral pH reached (i.e.,7.0).
- Any loose bits such as lime should be removed from the conjunctival fornices and the fornices should be swept with moistened cotton tipped applicator to prevent formation of symblepharon.

- Necrotic tissue should be removed to prevent epithelial healing and tonometry should be performed.
- Topical antibiotics should be started to prevent infection.
- Oral NSAIDS along with topical cycloplegics should be given for pain relief.
- Anti – glaucoma medication either systemic or topical should be prescribed. Topical agents such as beta blockers or oral agents such as Acetazolamide 250 mg bid-qid should be given according to IOP.
- Topical corticosteroids should be started in case of alkaline burns for the first 7-10 days, but should be tapered quickly within 2-3 weeks. Either low dose Topical cortico steroid or high dose prednisolone 1% can be given according to severity of burns.
- Additional topical agents include 10% sodium citrate and ascorbate can be employed to decrease the incidence of corneal ulceration and perforation. Oral ascorbic acid (tab. Vit-C, 500 mg qid) and oral doxycycline (100 mg bid) can be used to promote wound healing and to prevent stromal ulceration.
- Topical tear substitutes such as eye drops and eye ointment can be prescribed. Eye drops should be advised hourly and eye ointment should be advised twice a day.

- On subsequent visits, glass rod rotation with antibiotic eye ointment should be performed each time to prevent symblepharon formation

5. Corneal Penetrating / Perforating Injuries

- After diagnosing perforating injury, the patient should be started on systematic antibiotics and Tetanus toxoid prophylaxis should be given [47].
- X-ray orbit should be taken for medico legal aspects.
- A B-scan was done to look for the posterior segment involvement.
- Under peribulbar anesthesia with 2% lignocaine and adrenaline the iris tissue in the wound should be removed and suturing of the iridodialysis should be performed through the wound. The iris lens diaphragm should be maintained without any posterior segment disturbances. The side port entry should be made and thorough anterior chamber wash should be given.
- Throughout the procedure anterior chamber should be maintained with viscoelastic substance.
- The corneal laceration can be closed with 10-0 ethylon interrupted sutures and the knots should be buried in the stroma away from the central cornea and trimmed.

- After wound closure the anterior chamber should be formed and excessive viscoelastic should be washed away. Care should be taken to note any wound gaping.
- The patient should be continued on oral antibiotics and analgesics for a week.
- Post operatively patient should be started on topical antibiotics hourly, tear substitute hourly, topical prednisolone 1% hourly, topical NSAIDS, topical cycloplegics, anti-glaucoma medication should be given according to IOP.
- On every visit wound leak should be checked by performing a seidel's test.
- Steroids, antibiotic and cycloplegics should be tapered over a period of 2 months.
- Sutures should be removed after 3 months after wound fibrosis under topical anesthesia and topical antibiotics should be continued for one week and then should be stopped.

6. Infective Keratitis following Vegetative Matter Injury

Bacterial Keratitis

- Gram staining and culture should be done [50]. Organism should be identified.

- If the reports come positive, the patients should be started with fortified antibiotics eye drops hourly for the first 5 days followed by 4-6 times for the next 9 days.
- Oral antibiotics in the combination of cefixime 200 mg with ofloxacin 400mg should be given bid for a week .
- Topical cycloplegic like atropine 1% eye ointment should be used bid for 5 days then switched over to topical 2% homatropine for next 1 week.
- Anti-glaucoma medications like timolol maleate 0.5% eye drops and acetazolamide 250mg tablets should be prescribed after tonometry and wherever required.
- Topical tear substitutes should be advised.
- Supportive treatment like Vitamin A capsules (5000 IU per day) and oral Vitamin C 500mg tid should be prescribed .
- Oral analgesics to reduce pain.

Fungal Keratitis

- 10% KOH preparation should be done. If reports come positive topical anti-fungal drugs like natamycin 5% eye suspension should be advised hourly for the first 48 hours and then decreased to 2nd hourly. Initially only natamycin suspension should be advised if the

smear shows presence of septate hyphae. Topical therapy should be continued at least 3rd hourly for at least 2 weeks after healing of ulcer.

- Topical cycloplegic like atropine 1% eye ointment should be used bd for 5 days then switched over to topical 2% homatropine for the next 1 week.
- Anti-glaucoma medications like timolol maleate 0.5% eye drops and acetazolamide 250mg tablets should be prescribed after IOP monitor and wherever required.
- Topical antibiotics eye drops should be used hourly.
- Topical tear substitutes should be used hourly.
- Supportive treatment like vitamin A capsules (5000 IU per day) and oral vitamin C 500mg tid should be given.
- Oral analgesics to reduce pain.

7. Surgical Treatment for Corneal Injury

- Surgical debridement of ulcer should be performed under topical anesthesia on a slit lamp with a Bard Parker blade No.15. This should be done daily to help penetration of drugs until the ulcer shows decrease in infiltration.

- Optical keratoplasty should be done for leucomatous corneal opacity involving central cornea. After that antibiotic with steroid eye drops, lubricating eye drops should be given. It should be given for one week.

The patients should be examined on day 1, 3, followed by first week, fourth week, 2nd month and 3rd month depending upon the type of injury and the rate of healing. At each follow up the wound details including fluorescein staining and visual acuity should be recorded. At the end of 3rd month visual acuity should be noted. If corneal opacity develops it should also be noted.

Part II

Aims and Objectives

6. AIMS AND OBJECTIVES

To study the various patterns of corneal injuries and its outcome among patients of ocular trauma attending our tertiary care hospital.

Inclusion Criteria

- Patients of any age
- Both sexes
- Primary Corneal injuries
- Any type of injury – Mechanical, RTA, Assault, Accidental trauma.

Exclusion Criteria

- Patients with old corneal opacity
- Ocular trauma in which cornea is uninvolved
- Old corneal surgeries
- Previous Posterior segment involvement
- Corneal degeneration
- Corneal dystrophy

Materials and Methods

7. MATERIALS AND METHODS

The study was conducted on patients who attended the Cornea clinic at Department of Ophthalmology, Government Raja Mirasdhar Hospital, Thanjavur Medical College, Thanjavur during the period from December 2018 to May 2020.

This is an observational and analytical study done on 133 patients with corneal injuries who fulfilled the exclusion and inclusion criteria.

Ethical Considerations

The Institutional ethical committee clearance was obtained for the study. Written consent from the participants were obtained after providing complete explanation of the study and confidentiality of the patients were maintained.

Detailed history was taken and complete clinical evaluation of patients were done and datas were collected according to proforma. The following details were recorded for each patient: age, sex, occupation, ocular history including history of trauma, mode of injury, time of injury.

Methodology

All patients of ocular trauma of either sex have been subjected to slit lamp examination to ensure corneal involvement. When the cornea is involved the aetiology of the injury would be noted. Then the pattern of the corneal injury would be studied under the slit lamp examination.

After initial examination the cornea would be stained with 2% fluoroscein strip paper and examined under the slit lamp with blue light to note the type of corneal injury in the form of abrasions of epithelium, stroma and others.

After establishing a diagnosis the patient would be subjected to Visual acuity , direct ophthalmoscopy, indirect ophthalmoscopy, B scan, routine blood investigations RBS, FBS, PPBS, HIV, HBSAG, urine routine examination , X-ray orbit and CT – orbit.

After noting all the details, the patient has been given treatment as needed for the specific type of corneal injury.

The patient has been followed on day 1, day 3, week 1, week 4, week 8, week 12. They would be examined under the slit lamp and staining would be done if required. The improvement of vision and the opacification if any developed has been noted.

Observation and Results

8. OBSERVATIONS AND RESULTS

The collected data were analysed with IBM. SPSS statistics software 23.0 Version. To describe about the data descriptive statistics frequency analysis, percentage analysis were used for categorical variables and the mean & S.D were used for continuous variables. To find the significance in categorical data Chi-Square test was used. In the above statistical tools the probability value .05 is considered as significant level.

Table 1: Age Distribution

Age Distribution		
	Frequency	**Percent**
Upto 10 years	11	8.3
11 - 20 years	15	11.3
21 - 30 years	25	18.8
31 - 40 years	20	15.0
41 - 50 years	15	11.3
51 - 60 years	15	11.3
61 - 70 years	18	13.5
71 - 80 years	8	6.0
Above 80 years	6	4.5
Total	133	100.0

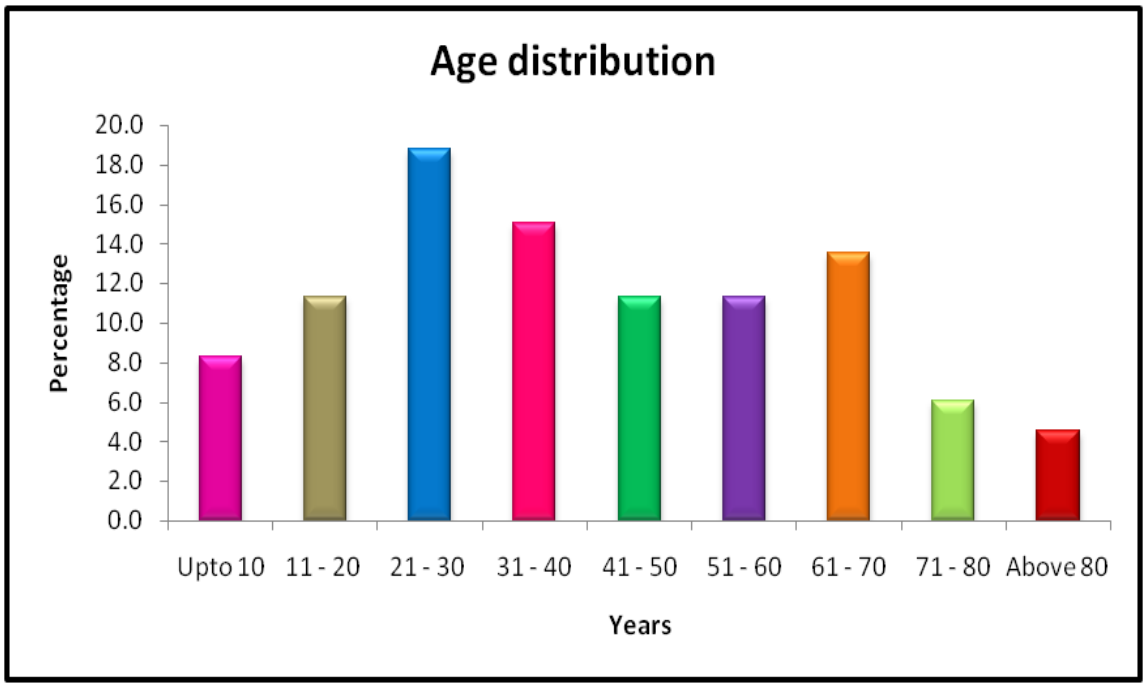

Figure 1

Table No:1 shows the age distribution of corneal injuries. The incidence below 10 years of age was 8.3%, among 11-20 years was 11.3%, among 21-30 years was 18.8%, among 31-40 years was 15%, among 41-50 years was 11.3%, among 51-60 years was 11.3%, among 61-70 years was 13.5%, among 71-80 years was 6% and above 80 years of age was 4.5%.

Table 2: Descriptive Statistics-Age

Descriptive Statistics					
	N	Minimum	Maximum	Mean	S.D
Age	133	3	91	41	23

Table No: 2 shows descriptive statistics of Age. The mean age for the occurrence of injury was 41 years.

Table 3: Gender distribution

Gender distribution		
	Frequency	**Percent**
Female	48	36.1
Male	85	63.9
Total	133	100.0

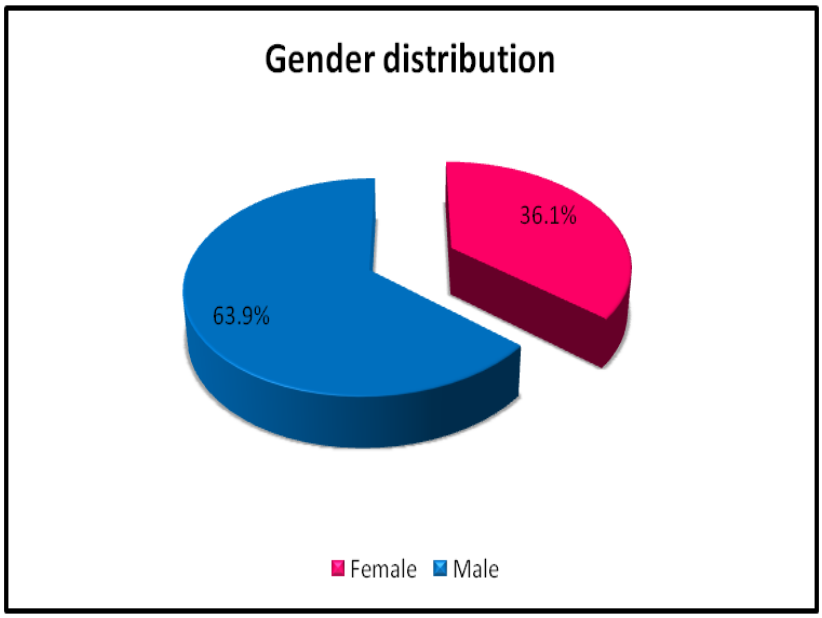

Figure 2

Table No: 3 shows Gender distribution of the corneal injuries. Among the victims 36.1% were Female and 63.9% were Male.

Table 4: Time of Consultation

Time of consultation		
	Frequency	Percent
Within 24 hours	115	86.5
24 - 48 hours	12	9.0
> 48 hours	6	4.5
Total	133	100.0

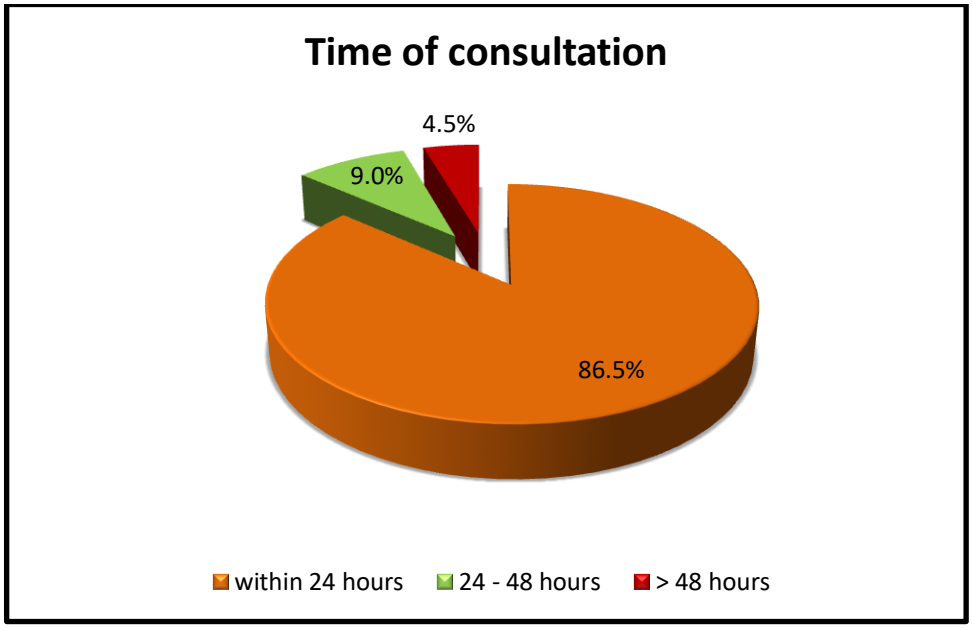

Figure 3

Table No: 4 shows time of consultation of the patients to the hospital following the injury. Around 86.5% of the patients reached within 24 hours, 9.0% reached in 24-48 hours and 4.5% after 48 hrs of injury.

Table 5: Occupation distribution

Occupation		
	Frequency	**Percent**
Farmer	19	14.3
Home maker	27	20.3
Student	26	19.5
Worker	61	45.9
Total	133	100.0

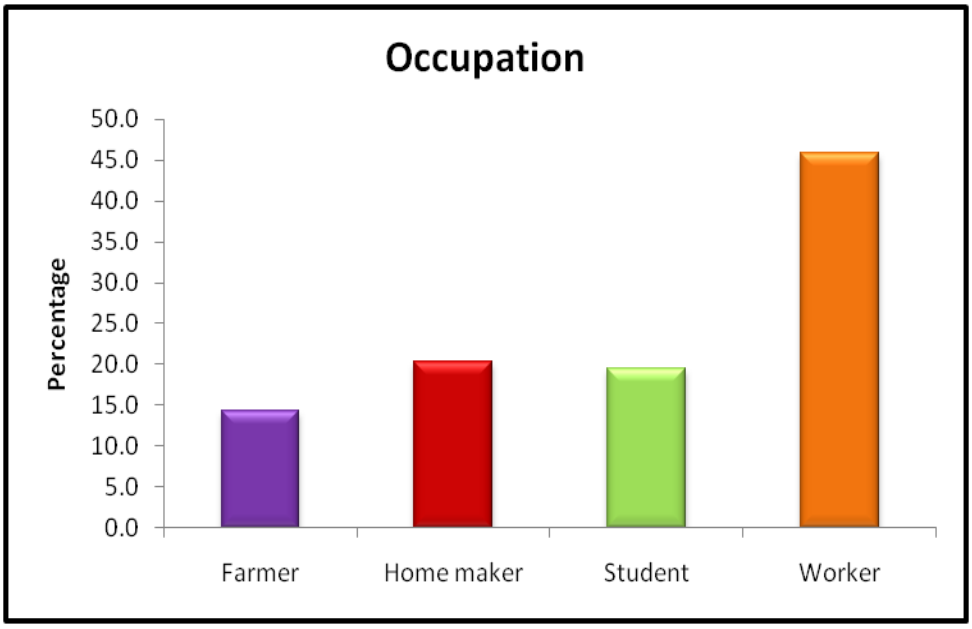

Figure 4

Table No: 5 shows Occupation distribution among the injured patients. Among the patients 45.9% were workers, 20.3% were Home makers, 19.5% were Students, 14.3% were farmers.

Table 6: Source of Injury Distribution

Source of Injury		
	Frequency	**Percent**
Agriculture	19	14.3
Assault	3	2.3
Construction	3	2.3
Domestic	39	29.3
Industry	46	34.5
RTA	3	2.3
Sports	20	15.1
Total	133	100.0

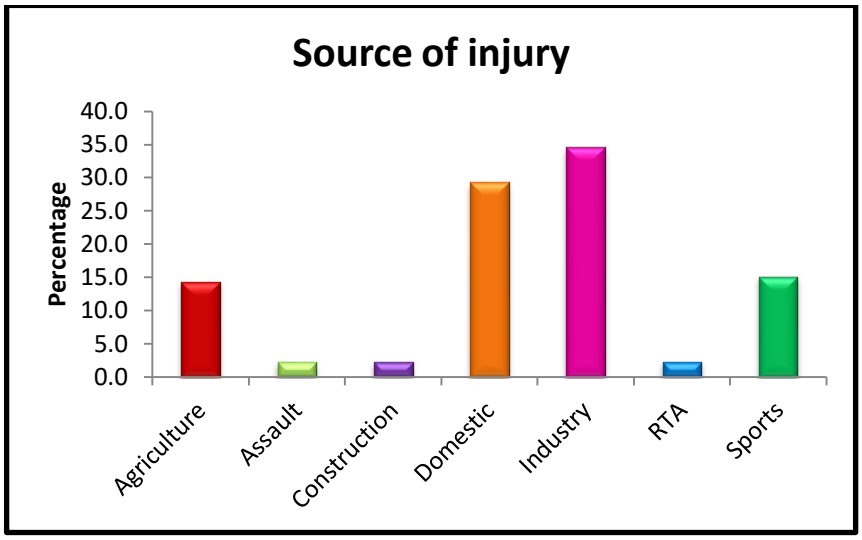

Figure 5

Table No: 6 shows the distribution of source of injury. The most common injuries were those occurring in the industries. It was around 34.5%. The second most common was Domestic injuries with incidence of about 29%. The incidence of sports injuries was 15.1%.14.3% were Agricultural injuries. The incidence of other injuries were 2.3% each. These includes assault, RTA and construction site injuries.

Table 7: Mode of injury distribution

Mode of Injury		
	Frequency	**Percent**
Blunt injury	32	24.1
Chemical injury	20	15.0
External foreign body	58	43.6
Penetrating injury	23	17.3
Total	133	100.0

** Chemical Injury Alkali Injury 15 (75%), acid injury 5 (25%)

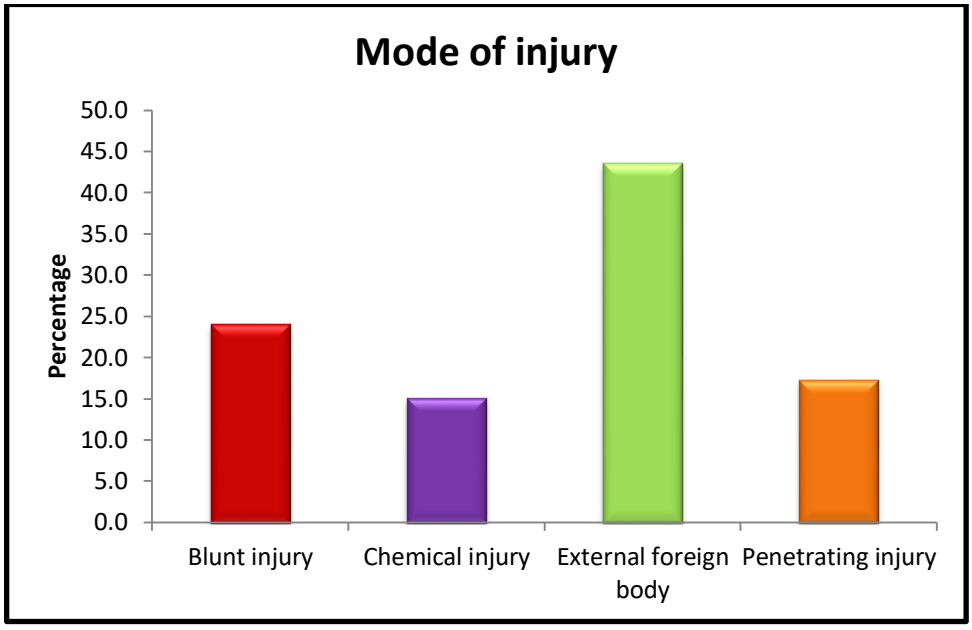

Figure 6

Table: 7 shows distribution of Mode of injury. The commonest injury was the external foreign body. The incidence of external foreign body was 43.6%. The incidence of blunt injuries was 24.1%, 17.3% was penetrating injury, 15.0% was Chemical injury. In chemical injury 75% was alkali injury and 25% was acid injury.

Table 8: Eye Involved Distribution

Eye involved		
	Frequency	**Percent**
Left eye	67	50.4
Right eye	66	49.6
Total	133	100.0

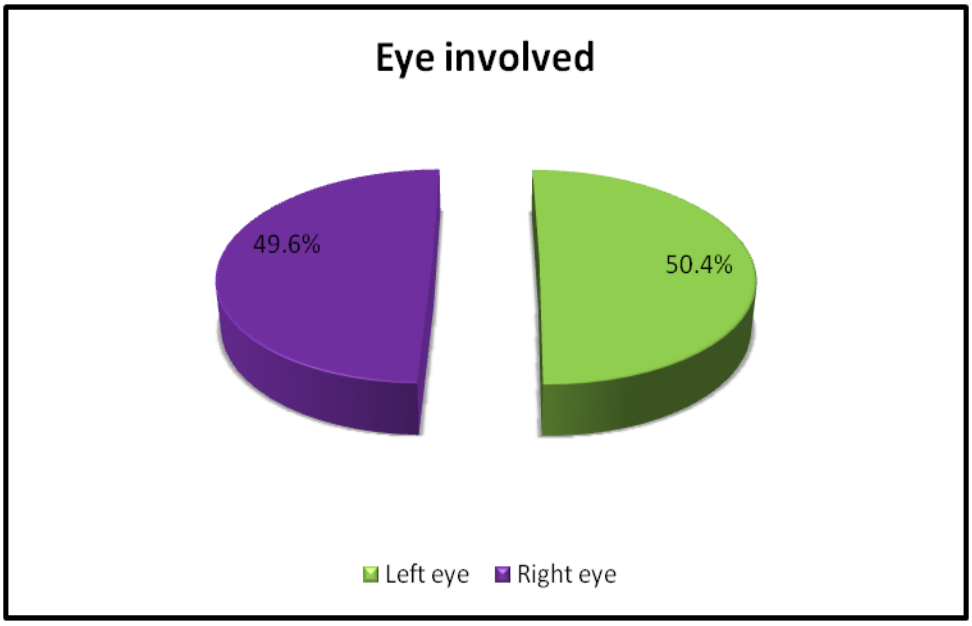

Figure 7

Table No: 8 shows the incidence of injury in the left eye was 50.4% and right eye was 9.6%.

Table 9: Depth of Cornea Distribution

Depth of Cornea		
	Frequency	**Percent**
Epithelium	74	55.6
Anterior stroma	20	15.0
Mid stroma	14	10.5
Full thickness	25	18.8
Total	133	100.0

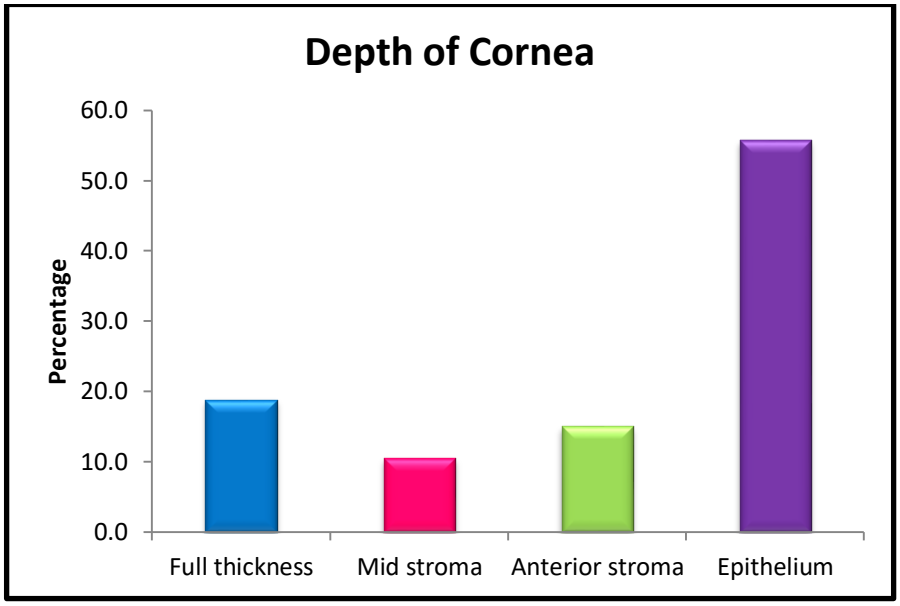

Figure 8

Table No : 9 shows the distribution of depth of corneal involvement in the injuries. The commonest level of injury was limited to the epithelium. The incidence was 55.6%. 18.8% were full thickness injuries. The anterior stroma was involved in about 15% and the Mid stroma was 10.5% of the patients.

Table 10: Central Cornea Involvement Distribution

Central Cornea involvement		
	Frequency	**Percent**
No	62	46.6
Yes	71	53.4
Total	133	100.0

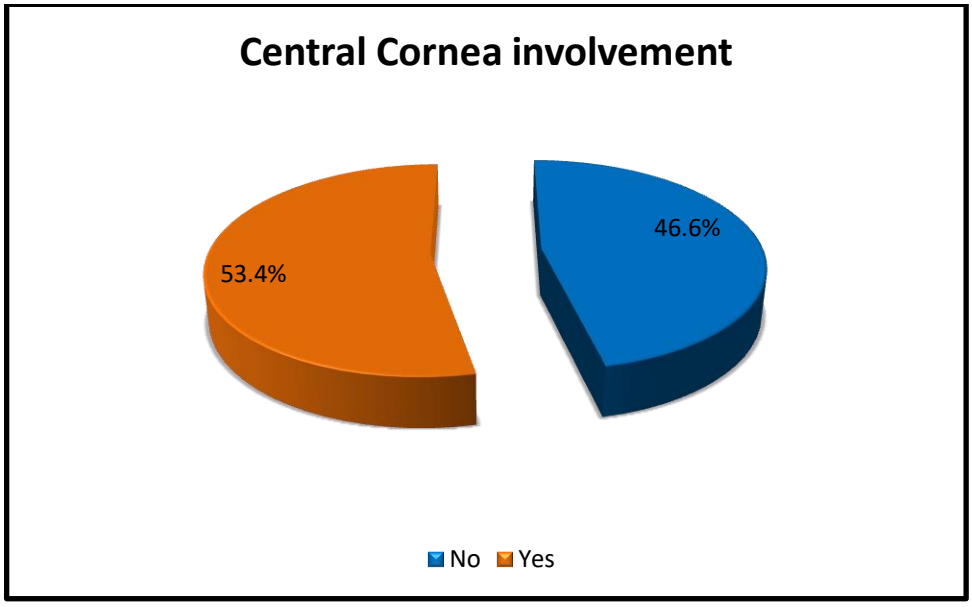

Figure 9

Table No:10 shows that Central cornea involvement was present in about 53.4% of the patients. Among 46.6% Central cornea was not involved.

Table 11: Management Distribution

Management		
	Frequency	**Percent**
Medical Management	110	82.7
Surgical Management	23	17.3
Total	133	100.0

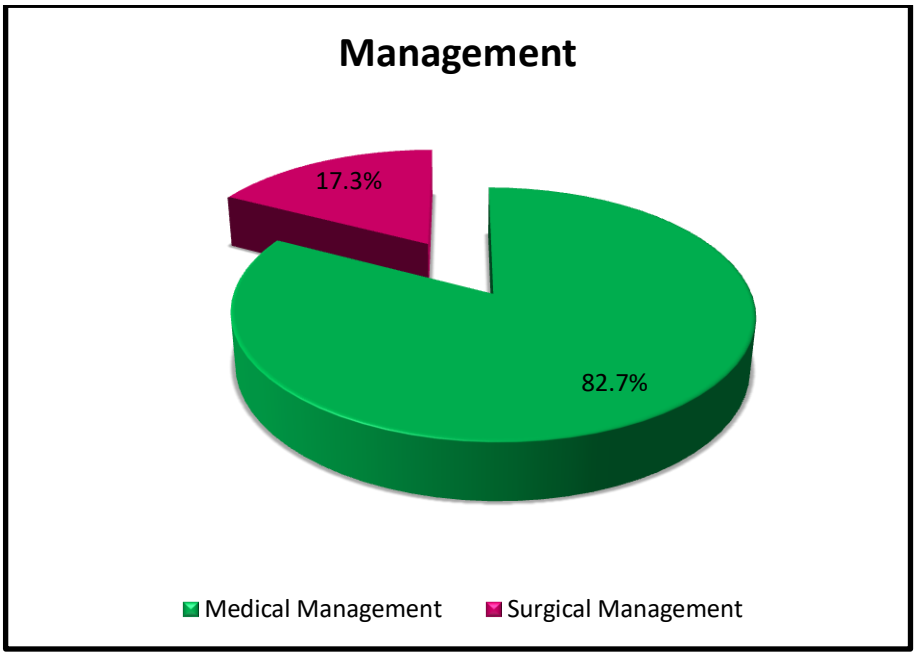

Figure 10

Table No :11 shows distribution of management of the injuries. Among the injuries 82.7% was medically managed. The remaining 17.3% was surgically managed.

Table 12: State of Cornea Distribution

State of Cornea		
	Frequency	**Percent**
Clear	80	60.2
Nebular Opacity	27	20.3
Macular Opacity	22	16.5
Leucomatous Opacity	4	3.0
Total	133	100.0

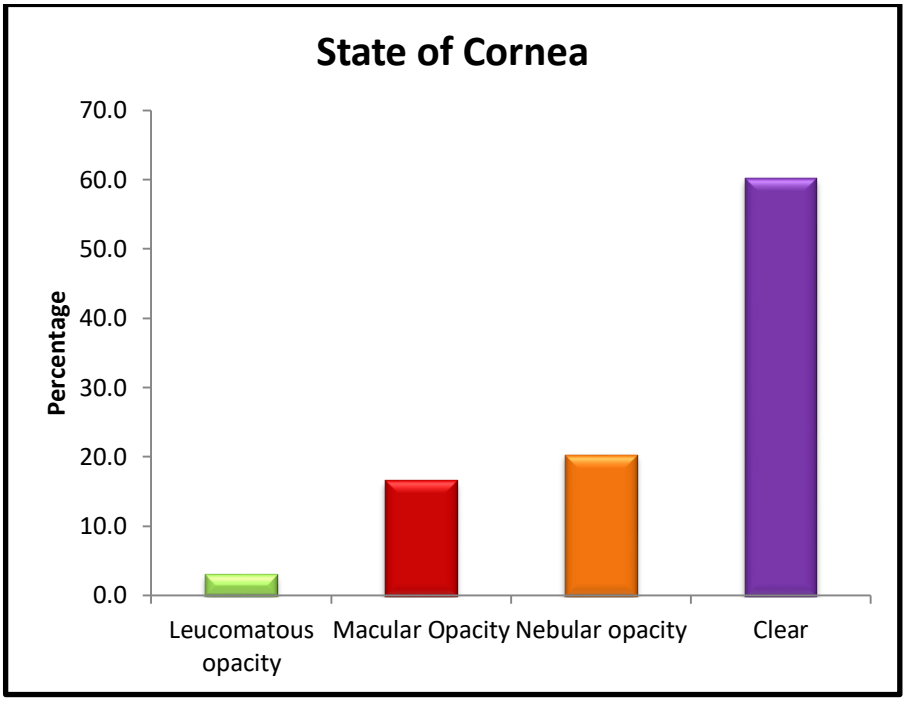

Figure 11

Table No: 12 shows the state of the cornea following treatment. Most of the treated patients had clear corneas. There were 60.2% of the patients with clear corneas. The incidence of nebular opacity was 20.3%, macular opacity was 16.5% and 3.0% had Leucomatous opacity.

Table 13: Visual Outcome Distribution

WHO categories for vision	Initial day 1	Day 3	1st Week	4th Week	8th Week	12th Week
Normal vision (6/6 - 6/18)	39.1	46.6	51.9	60.9	66.9	79.7
Low vision (6/18 – FC 3meter)	48.9	43.6	39.1	30.8	27.8	17.3
Blindness (FC 3meter – no PL/PR)	12.0	9.8	9.0	8.3	5.3	3.0

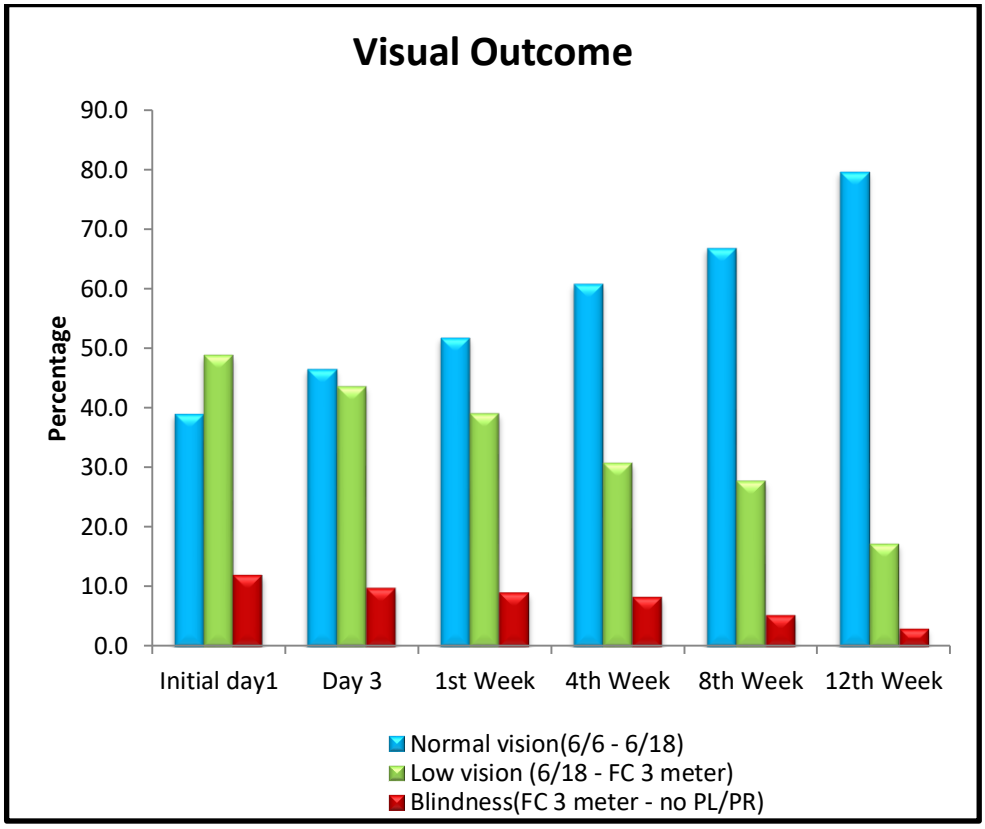

Figure 12

Table No: 13 shows the distribution of visual outcome following the treatment. According to WHO categories for vision on day 1 48.9% had low vision, 39.1% had normal vision, Blindness was 12.0%. The Visual Outcome on day 3 was 46.6% had normal vision, 43.6% had low vision, 9.8% were blind. At the end of 1st week 51.9% had normal vision, 39.1% had low vision, 9.0% were blind. At the end of 4th week 60.9% had normal vision, 30.8% had low vision, 8.3% were blind. At the end of 8th week 66.9% had normal vision, 27.8% had low vision, 5.3% were blind. The Visual Outcome at 12th week 79.7% had normal vision, 17.3% had low vision, 3.0% were blind.

Table 14: Visual Outcome Distribution at 12th Week

Visual Outcome at 12th week		
	Frequency	**Percent**
Normal vision	106	79.7
Low vision	23	17.3
Blindness	4	3.0
Total	133	100.0

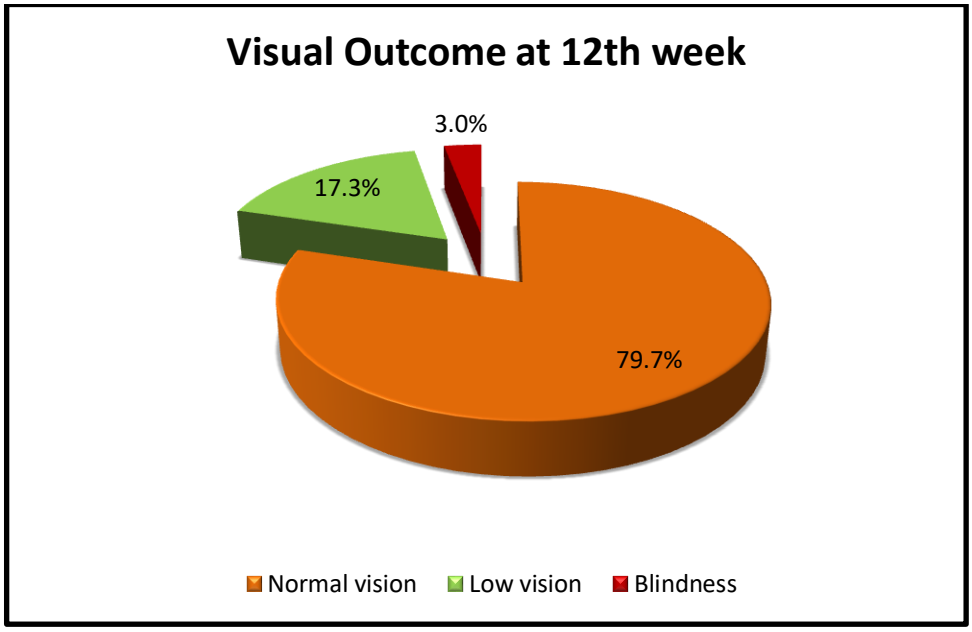

Figure 13

Table No: 14 shows Vision Outcome distribution. Among the treated patients 79.7% had Normal vision, 17.3% had Low vision, 3.0% were blind.

Table 15: Comparison of Visual Acuity at Day 1 and at 12th week

			Visual Outcome at 12th Week			Total	χ^2 - value	p-value
			Normal vision	Low vision	Blindness			
Visual acuity at day 1	Normal vision	Count	52	0	0	52	69.181	0.0005 **
		% of Total	39.1%	0.0%	0.0%	39.1%		
	Low vision	Count	52	13	0	65		
		% of Total	39.1%	9.8%	0.0%	48.9%		
	Blindness	Count	2	10	4	16		
		% of Total	1.5%	7.5%	3.0%	12.0%		
Total		Count	106	23	4	133		
		% of Total	79.7%	17.3%	3.0%	100.0%		
** Highly Statistical Significance at $p < 0.01$ level								

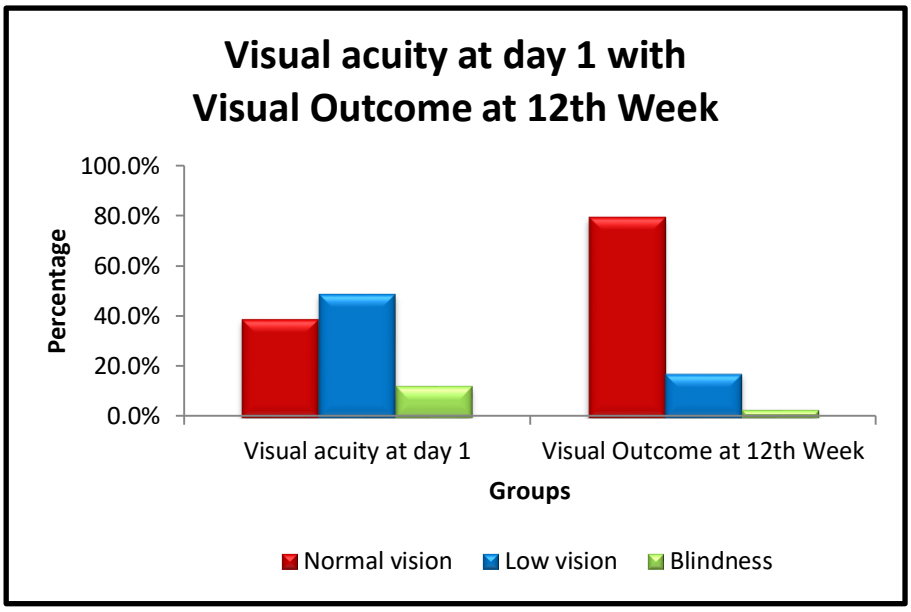

Figure 14

Table No : 15 shows comparison between Visual acuity on day 1 with Visual Outcome at 12th Week by Pearson's chi-squared test were χ^2=69.181, p=0.0005<0.01 which shows highly statistical significant association between Vision Outcome at initial day 1 and Visual Outcome at 12th Week. This shows that there was gradual improvement in the vision of the patients with proper treatment and follow up.

Table 16: Comparison between Time of Consultation with Visual Outcome at 12th Week

			Visual Outcome at 12th week			Total	χ 2 - value	p-value
			Normal vision	Low vision	Blindness			
Time of consultation	Within 24 hours	Count	102	12	1	115	47.784	0.0005 **
		%	88.7%	10.4%	0.9%	100.0%		
	24 - 48 hours	Count	4	6	2	12		
		%	33.3%	50.0%	16.7%	100.0%		
	> 48 hours	Count	0	5	1	6		
		%	0.0%	83.3%	16.7%	100.0%		
Total		Count	106	23	4	133		
		%	79.7%	17.3%	3.0%	100.0%		
** Highly Statistical Significance at p < 0.01 level								

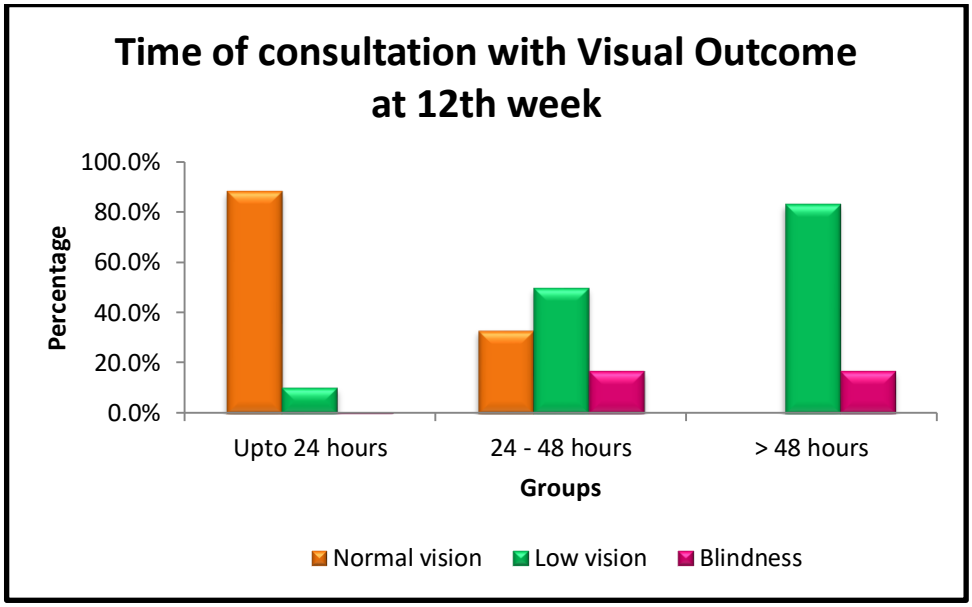

Figure 15

Table No :16 shows comparison between Time of consultation with Visual Outcome by Pearson's chi-squared test were χ^2=47.784, p=0.0005<0.01 which shows highly statistical significant association between Time of consultation and Visual Outcome.

Table 17: Comparison between Mode of Injury with Visual Outcome at 12th Week

			Visual Outcome at 12th Week			Total	χ 2 - value	p-value
			Normal vision	Low vision	Blindness			
Mode of injury	Blunt injury	Count	26	5	1	32	17.966	0.006 **
		%	81.3%	15.6%	3.1%	100.0%		
	Chemical injury	Count	18	2	0	20		
		%	90.0%	10.0%	0.0%	100.0%		
	External foreign body	Count	50	8	0	58		
		%	86.2%	13.8%	0.0%	100.0%		
	Penetrating injury	Count	12	8	3	23		
		%	52.2%	34.8%	13.0%	100.0%		
Total		Count	106	23	4	133		
		%	79.7%	17.3%	3.0%	100.0%		

** Highly Statistical Significance at p < 0.01 level

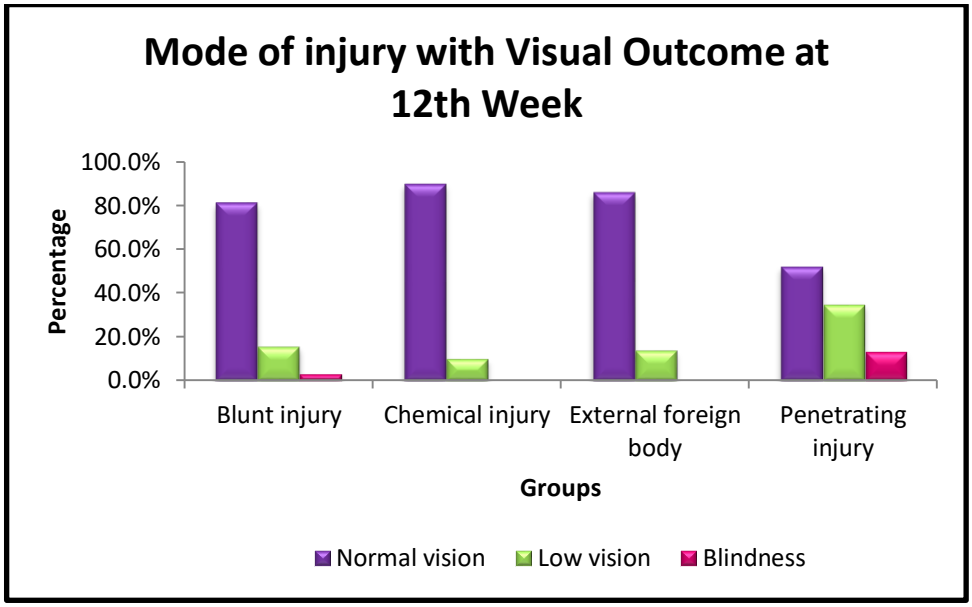

Figure 16

Table No :17 shows comparison between Mode of injury with Visual Outcome by Pearson's chi-squared test were χ^2=17.966 , p=0.006<0.01 which shows highly statistical significant association between Mode of injury and Visual Outcome. The visual outcome depends on the type of the injury. Around 90% of the chemical injury patients had very good vision following treatment. Around 80% of the patients with external foreign body had greater vision. The victims of penetrating injury had very low vision.

Table 18: Comparison between Depth of Cornea with Visual Outcome at 12th week

			Visual Outcome			Total	χ 2 - value	p-value
			Normal vision	Low vision	Blindness			
Depth of Cornea	Epithelium	Count	72	2	0	74	40.518	0.0005 **
		%	97.3%	2.7%	0.0%	100.0%		
	Anterior stroma	Count	15	5	0	20		
		%	75.0%	25.0%	0.0%	100.0%		
	Mid stroma	Count	7	6	1	14		
		%	50.0%	42.9%	7.1%	100.0%		
	Full thickness	Count	12	10	3	25		
		%	48.0%	40.0%	12.0%	100.0%		
Total		Count	106	23	4	133		
		%	79.7%	17.3%	3.0%	100.0%		
** Highly Statistical Significance at p < 0.01 level								

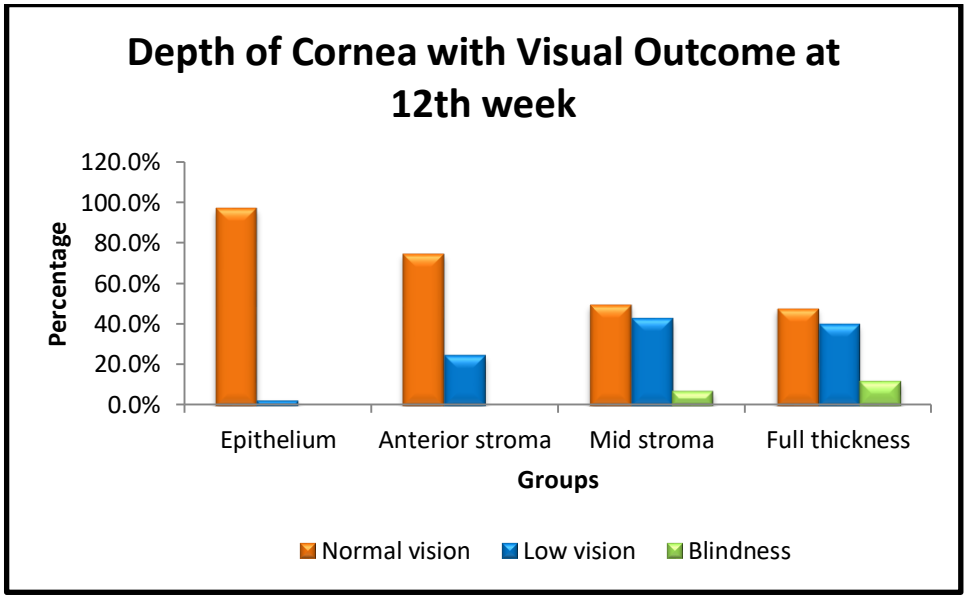

Figure 17

Table No:18 shows comparison between Depth of Cornea with Visual Outcome by Pearson's chi-squared test were χ^2=40.518, p=0.0005<0.01 which shows highly statistical significant association between Depth of Cornea and Visual Outcome. This table shows that the level of corneal injury had greater impact on the visual outcome. Around 90% of the patients with epithelial involvement had normal vision. The involvement of stroma had low vision. Around 20% of patients with full thickness injury was blind.

Table 19: Comparison between Central Cornea Involvement with Visual Outcome at 12th Week

			Visual Outcome at 12th Week			Total	χ 2 - value	p-value
			Normal vision	Low vision	Blindness			
Central Cornea involvement	No	Count	55	7	0	62	7.096	0.029 *
		%	88.7%	11.3%	0.0%	100.0%		
	Yes	Count	51	16	4	71		
		%	71.8%	22.5%	5.6%	100.0%		
Total		Count	106	23	4	133		
		%	79.7%	17.3%	3.0%	100.0%		

* Statistical Significance at $p < 0.05$ level

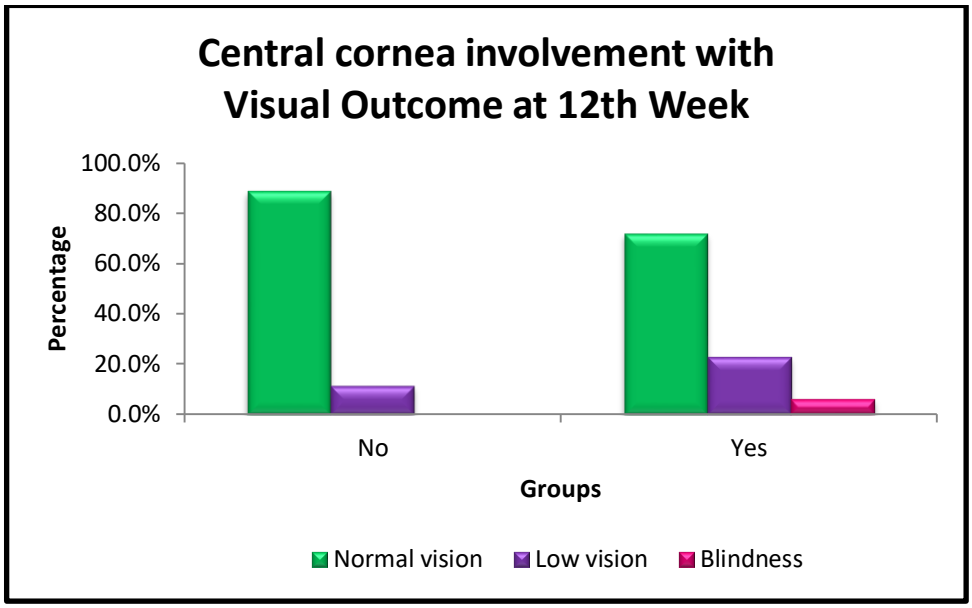

Figure 18

Table No :19 shows comparison between Central cornea involvement with Visual Outcome by Pearson's chi-squared test were χ^2=7.096, p=0.029<0.05 which shows statistical significant association between Central cornea involvement and Visual Outcome. This shows that involvement of Central cornea results in decrease in the final visual outcome.

Table 20: Comparison between State of Cornea with Visual Outcome at 12th Week

			Visual Outcome at 12th week			Total	χ 2 - value	p-value
			Normal vision	Low vision	Blindness			
State of Cornea	Clear	Count	79	1	0	80	74.56	0.0005 **
		%	98.8%	1.2%	0.0%	100.0%		
	Nebular opacity	Count	21	6	0	27		
		%	77.8%	22.2%	0.0%	100.0%		
	Macular Opacity	Count	6	13	3	22		
		%	27.3%	59.1%	13.6%	100.0%		
	Leucomatous opacity	Count	0	3	1	4		
		%	0.0%	75.0%	25.0%	100.0%		
Total		Count	106	23	4	133		
		%	79.7%	17.3%	3.0%	100.0%		
** Highly Statistical Significance at p < 0.01 level								

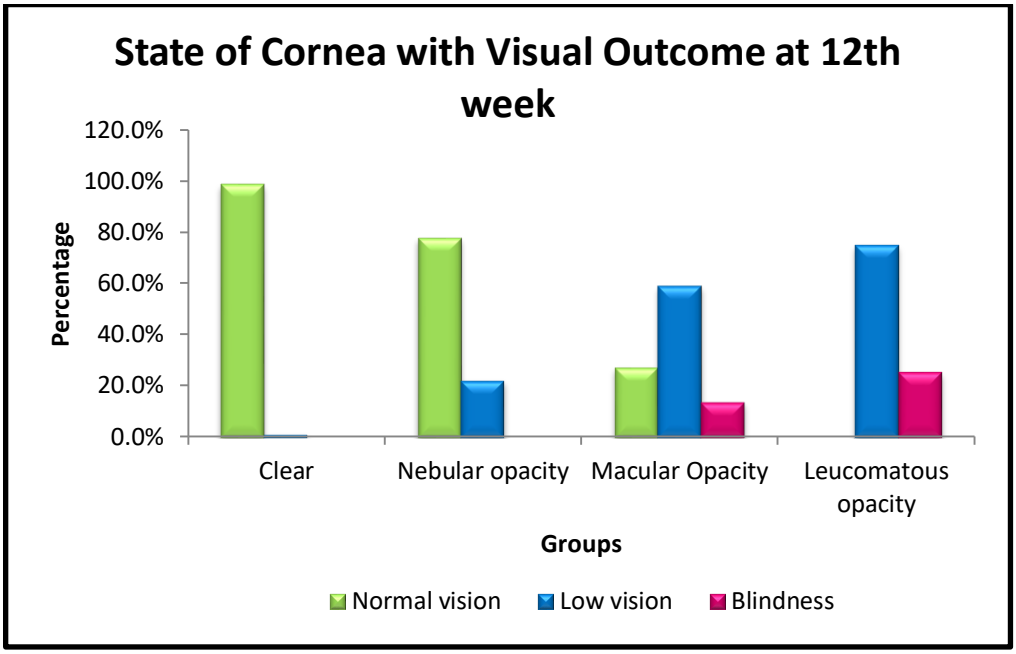

Figure 19

Table No: 20 shows comparison between State of Cornea with Visual Outcome by Pearson's chi-squared test were χ^2=74.56, p=0.0005<0.01 which shows highly statistical significant association between State of Cornea and Visual Outcome. The patients with clear cornea at 12th Week had good visual acuity. Around 60% of the patients with leucomatous opacity had low vision and 40% were blind. Around 80% with nebula opacity had normal vision and 20% had low vision. Around 20% with macular opacity had normal vision and 60% with low vision.

Table 21: Comparison between Depth of Cornea with State of Cornea

			State of Cornea				Total	χ 2 - value	p-value
			Epithelium	Anterior stroma	Mid stroma	Full thickness			
Depth of Cornea	Clear	Count	73	5	2	0	80	136.888	0.0005 **
		%	98.6%	25.0%	14.3%	0.0%	60.2%		
	Nebular opacity	Count	1	13	5	8	27		
		%	1.4%	65.0%	35.7%	32.0%	20.3%		
	Macular Opacity	Count	0	2	7	13	22		
		%	0.0%	10.0%	50.0%	52.0%	16.5%		
	Leucomatous opacity	Count	0	0	0	4	4		
		%	0.0%	0.0%	0.0%	16.0%	3.0%		
Total		Count	74	20	14	25	133		
		%	100.0%	100.0%	100.0%	100.0%	100.0%		
** Highly Statistical Significance at p < 0.01 level									

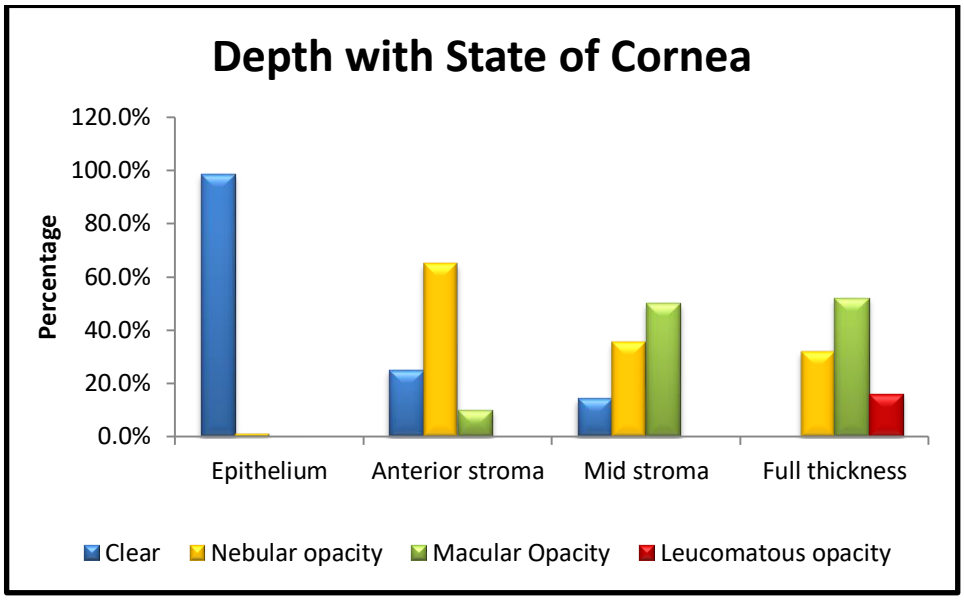

Figure 20

Table No:21 shows comparison between Depth of Cornea with State of Cornea by Pearson's chi-squared test were χ^2=136.888, p=0.0005<0.01 which shows highly statistically significant association between Depth of Cornea and State of Cornea. This shows that the formation of opacity greatly influenced by the level of the corneal involvement. Around 90% of the epithelial injuries had normal vision. Around 60% of the patients with anterior stromal involvement had nebular opacity and 20% had normal vision. Around 50% of the patients with mid stromal involvement had macular opacity. Around 20% of patients with full thickness injury developed leucomatous opacity.

Table 22: Comparison between 12th week Visual outcome with Management

			Management		Total	χ 2 - value	p-value
			Medical	Surgical			
12th Week Visual Outcome	Normal vision	Count	96	10	106	24.917	0.0005 **
		%	87.3%	43.5%	79.7%		
	Low vision	Count	13	10	23		
		%	11.8%	43.5%	17.3%		
	Blindness	Count	1	3	4		
		%	0.9%	13.0%	3.0%		
Total		Count	110	23	133		
		%	100.0%	100.0%	100.0%		
** Highly Statistical Significance at p < 0.01 level							

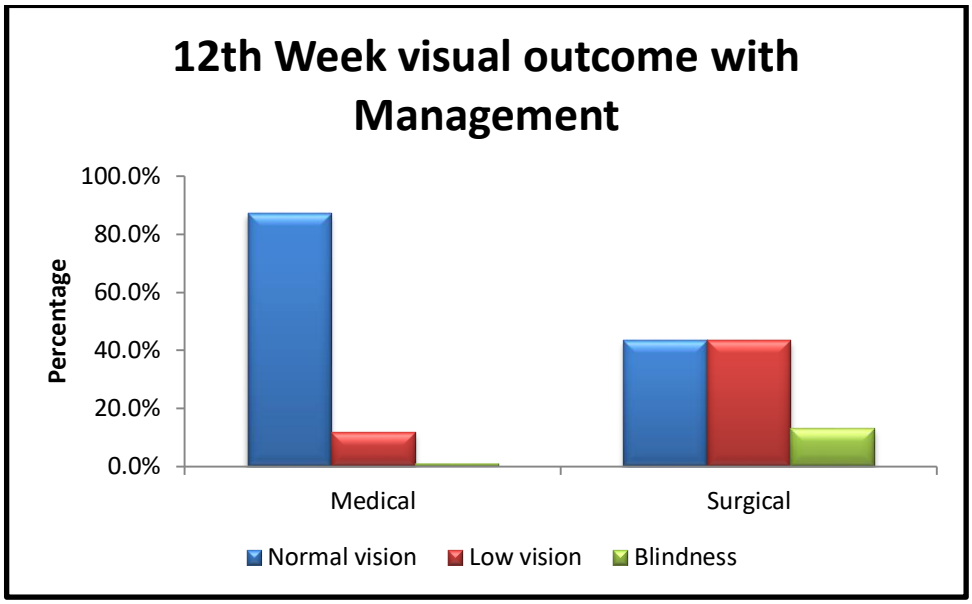

Figure 21

Table No: 22 shows comparison between 12th week visual outcome with Management by Pearson's chi-squared test were χ^2=24.917, p=0.0005<0.01 which shows highly statistical significant association between 12th week visual outcome and Management. Around 80% of the patients had normal vision with medical management. Around 40% of the patients had normal vision with surgical management.

Discussion

9. DISCUSSION

133 patients with corneal injury who attended the outpatient Department of Ophthalmology, Government Raja Mirasdhar Hospital, Thanjavur Medical College, Thanjavur during the period from December 2018 to May 2020 were taken up for the observational and analytical study**.**

Age Distribution

In our study the occurrence of the injuries shows the following distribution. It shows that highest incidence among 21- 30 years is 18.8% ,followed by 31-40 years is 15%, least one is above 80 years of age it is 4.5%.

The mean age for the occurrence of injury in this study is 41 years.

R.K. Adhikari's study, injuries were more in most active period of life 15-50 years of life. This has a considerable socioeconomic impact because people of this age group are bread winners of their family. This coincides with Rapti's study also.

Sex Distribution

In our study, among the victims 36.1% are female and 63.9% are male

This study coincides with the study conducted by Eagling EM.

Time of Consultation

In our study around 86.5% of the patients reached hospital within 24 hours, 9.0% reached in 24-48 hours and 4.5% after 48hrs of injury.

Our study explains that early reported cases had good results which was proved by Adhikari study also.

Occupation

This study showed varying distribution of the occupation of the injured patients. Among the patients 45.9% were workers, 20.3% are Home makers, 19.5% are Students, 14.3% are farmers.

In our study the most common injuries are those occurring in the industries. It was around 34.5%. The second most common was Domestic injuries with incidence of about 29%. The incidence of sports injuries was 15.1%. Around 14.3% were Agricultural injuries. The incidence of other injuries were 2.3% each. These include assault, RTA and construction site injuries.

Mode of Injury

In our study the commonest injury is the fall of foreign body. The commonest site of foreign body is the cornea. The incidence of external foreign body is 43.6%. The incidence of blunt injuries was 24.1%, 17.3% is penetrating injury, 15.0% was Chemical injury. In chemical injury 75% was alkali and 25% was acid injury.

Banerjee in a similar study found that corneal external foreign body was most common in new patient seen in an emergency room in England over a six months period .

According to similar study by kuckelkorn, et al. most of the chemical injuries were classified as mild which is also consistent with our present study.

In this study the incidence of injury in the left eye was 50.4% and right eye was 49.6%.

Depth of Corneal Involvement

In our study the depth of corneal involvement in the injuries was assessed. The commonest level of injury was limited to the epithelium of the cornea. The incidence was 55.6%. Around 18.8% were full thickness

injuries. The anterior stroma is involved in about 15% and the Mid stroma in 10.5% of the patients.

Our study showed that full thickness injuries have a devastating outcome which was also proved by khatrys studie.

Central Cornea Involvement

Among the injured victims Central cornea involvement was present in about 53.4% of the patients. In 46.6% of patients Central cornea is not involved.

Management

The injured patients were treated either medically or with surgery. Among the injuries 82.7% was medically managed. The remaining 17.3% was surgically managed.

Both Adhikary and caroline's studies proved that medical and conservative management was sufficient for superficial and non infective conditions.

State of Cornea

In our study the state of the cornea at the end of the study was assessed. Most of the treated patients had clear corneas. There were 60.2%

of the patients with clear corneas. The incidence of nebular opacity was 20.3%, macular opacity was 16.5% and 3.0% had Leucomatous opacity.

Visual Outcome

In our study the visual acuity of the patients were recorded from day one to till 12th week. On day 1, 48.9% had low vision, 39.1% had normal vision, Blindness is 12.0%. The Visual Outcome at 12th week 79.7% had normal vision, 17.3% had low vision, 3.0% were blind. This was to assess the effectiveness of early management.

Among the treated patients 79.7% had Normal vision, 17.3% had Low vision, 3.0% were blind at the end of 12th week.

In our study the visual acuity of the patients on the follow up visits was recorded. It showed that there was gradual improvement in the vision of the patients with proper treatment and follow up.

In our study the time of consultation and Visual Outcome were compared. It showed the importance of approaching the hospital immediately following the injury. The timely intervention can save the vision of the patients. The patients who reached the hospital within 24 hrs had earlier and better visual rehabilitation.

In our study the mode of injury and visual outcome are compared. It showed that the visual outcome depends on the type of the injury. Most of the patients with mild chemical injury had very good vision following treatment. Around 80% of the patients with external foreign body had greater vision. The victims of penetrating injury had very low vision.

In our study the depth of Cornea involved in the injury was compared with the visual outcome. The results showed that the level of corneal injury had greater impact on the visual outcome. Around 90% of the patients with epithelial involvement had normal vision. The involvement of stroma had low vision. Around 20% of patients with full thickness injury was blind.

In our study significant association between Central cornea involvement and Visual Outcome was analysed. It showed that the involvement of Central cornea results in decrease in the final visual outcome.

In our study the State of Cornea and Visual Outcome are compared. The patients with clear cornea at the time of presentation had good visual acuity. Around 60% of the patients with leucomatous opacity had low vision and 40% were blind. Around 80% with nebular opacity had normal

vision and 20% had low vision. Around 20% with macular opacity had normal vision and 60% with low vision.

This study showed that the formation of corneal opacity was greatly influenced by the level of the corneal involvement.

In our study the Depth of Cornea and State of Cornea following the injury was analysed. The formation of opacity was greatly influenced by the level of the corneal involvement. Around 90% of the epithelial injuries had normal vision. Around 60% of the patients with anterior stromal involvement had nebular opacity and 20% had normal vision. Around 50% of the patients with mid stromal involvement had macular opacity. Around 20% of patients with full thickness injury developed leucomatous opacity.

This study analysed the visual outcome following management. Around 80% of the patients had normal vision with medical management. Around 40% of the patients had normal vision with surgical management.

Summary

10. SUMMARY

- The mean age for the occurrence of injury in this study was 41 years.
- In our study around 86.5% of the patients reached hospital within 24 hours.
- Among the patients 45.9% were workers, 20.3% were Homemakers, 19.5% were Students, 14.3% were farmers.
- Industries were the most common location for the injuries. Domestic injuries were the second most common.
- The commonest injury was extraocular foreign body. The incidence of external foreign body was 43.6%. The incidence of blunt injuries was 24.1%, 17.3% was penetrating injury, 15.0% was Chemical injury. In chemical injury 75% was alkali and 25% was acid injury.
- The left eye was more commonly injured than the right eye.
- In our study the depth of corneal involvement in the injuries was assessed. The commonest level of injury was limited to the epithelium of the cornea.
- The central cornea was commonly involved in most of the injuries.
- In our study most of the patients were treated with medical management.

- In our study the state of the cornea at the end of the study was assessed. Most of the treated patients had clear corneas with proper line of management.
- The patients with early intervention had good visual recovery at the end of the study. Timely intervention could save the vision of the patient.
- At the end of the study most patients had normal vision. The importance of early intervention is shown in this study.
- The patients who had proper follow up and compliance to treatment had very good vision at the end of the study.
- The study showed the importance of approaching the hospital immediately following the injury. The patients who reached the hospital within 24 hrs had earlier and better visual rehabilitation.
- The study showed a significant relationship between the mode of injury and the visual outcome. The patients with external foreign body and chemical injury had good visual recovery compared to full thickness injury who had low vision.
- The level of corneal involvement had greater impact on the visual outcome. Most of the patients with epithelial involvement had normal vision. The involvement of stroma had low vision. A few patients with full thickness injury was blind.

- The involvement of Central cornea resulted in decreases in the final visual outcome.
- The state of the cornea at the end of the study influenced the visual acuity. Most of the patients with clear cornea had good visual acuity. The patients who developed opacities had very poor vision. The occurrence of low vision was common with the patients with leucomatous opacity.
- This study showed that the formation of corneal opacity was greatly influenced by the level of the corneal involvement.
- Around 80% of the patients had normal vision with medical management, and 40% of the patients had normal vision with surgical management.

Conclusion

11. CONCLUSION

Corneal injuries are the most important cause of vision loss following trauma. The various demographic factors like age, sex and pattern of corneal injury was studied, which showed that the commonest affected population are the working male population of the society.

The primary prevention is always better than cure. So in all working places safety precautions should be followed. Industrial workers should be provided with protective equipment.

In our study most of the patients who reached hospital within 24 hrs had very good visual prognosis. So, it is inferred that earlier intervention has greater influence in visual recovery.

The use of antibiotic plays an important role.

Thus, use of preventive measures, earlier intervention, use of antibiotics and meticulous treatment of injury helps in restoring the vision to the patients.

Part III

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Proforma

PROFORMA

Name of the Patient :

Age /sex :

Date :

Hospital no :

Address :

Occupation :

Chief Complaints :

Ocular History :

H/o defective vision/pain/redness/irritation

H/o trauma and mode of injury

H/o previous ocular surgeries

Past History

H/o DM/SHTN/Chronic Immunosupressive Condition/Steroid Intake

General Examination

Cardiovascular System

Respiratory System

Per Abdomen

Central Nervous System

Systemic Examination

Ocular Examination : OD OS

Visual Acuity

Slit Lamp Examination

Lids

Conjunctiva

Cornea

Injury: Site

Size

Depth

Anterior Chamber

Iris

Pupil

Lens

Duct

Fundus Examination

Direct/ Indirect Ophthalmoscopy

Investigations

Treatment

Follow Up Period	**Findings**	**Improvement**	**Further Treatment if Required**
Day 1			
Day 3			
Day 7			
Week 4			
Week 8			
Week 12			

Key to Master Chart

KEY TO MASTER CHART

Abbreviation	Explanation
IRON.P	Iron Particle
MET.FB	Metallic Foreign Body
GLA.PIE	Glass Piece
FB+	Foreign Body+
EFB	External Foreign Body
BI	Blunt Injury
CI	Chemical Injury
PI	Penetrating Injury
EPI	Epithelium
ANT.STR	Anterior Stroma
MID.STR	Mid Stroma
FULL.THI	Full Thickness
EPI.ER	Epithelial Erosion
EPI.DEF	Epithelial Defect
STR.EDE	Stromal Edema
P.LAC	Partial Laceration
MM	Medical Management
SM	Surgical Management
NEB.OP	Nebular Opacity
MAC.OP	Macular Opacity
LEUC.OP	Leucomatous Opacity

Master Chart

MASTER CHART

S.NO	Name	Age	Sex	Time of Consultation	Occupation	Source of Injury	Mode of Injury	Cause Of Injury	EYE		Slit Lamp Finding	Depth of Cornea	Central Cornea Involvement	Management	State of Cornea	VISION					
									Right	Left						Initial(Day 1)	Day 3	Week 1	Week 4	Week 8	Week 12
1	Vinoth	28	M	2h	worker	Industry	EFB	iron.p		√	FB+	epi	Yes	MM	CLEAR	6/12.	6/6p.	6/6.	6/6.	6/6.	6/6.
2	Muniammal	58	F	1h	H.wife	Domestic	PI	Stick	√		lac	full.thi	no	SM	mac.op	5/60.	5/60.	6/60 P	6/60.	6/36.	6/36.
3	Karupaiyan	72	M	2d	Farmer	Agri	PI	Stick		√	lac	full.thi	no	SM	leu.op	CFCF	1/60p	1/60.	1/60.	2/60p	4/60.
4	Kunjammal	43	F	3h	H.wife	Domestic	BI	vessels	√		abr	epi	no	MM	CLEAR	6/60p	6/60.	6/36 P	6/24 P	6/24.	6/18.
5	Muniyandi	52	M	10h	worker	Factory	CI	Lime		√	epi.er	epi	yes	MM	CLEAR	6/36 P	6/36p	6/36.	6/18.	6/18.	6/12.
6	Karunya	12	F	3h	Student	sports	EFB	Sand	√		FB+	epi	yes	MM	CLEAR	6/9 P	6/9.	6/6.	6/6.	6/6.	6/6.
7	Harish	28	M	2h	worker	RTA	EFB	gla.pie	√		FB+	epi	no	MM	CLEAR	6/12.	6/9P	6/9.	6/6.	6/6.	6/6.
8	Krishna Kumar	32	M	4h	worker	Factory	BI	knob		√	abr	epi	yes	MM	CLEAR	6/24 P	6/24.	6/12.	6/9p	6/6P.	6/6p
9	Vivek	48	M	2h	worker	factory	CI	acid	√		epi.er	epi	yes	MM	CLEAR	6/24.	6/18p	6/18 P	6/6.	6/6.	6/6.
10	Shanmuga Priyan	18	M	3h	Student	sports	EFB	wood.p		√	FB+	epi	no	MM	CLEAR	6/6 P	6/6p.	6/6.	6/6.	6/6.	6/6.
11	Karuppayi	82	F	2d	H.wife	Domestic	PI	stick		√	lac	full.thi	yes	SM	leu.op	PL+	HM+	1/60p	1/60.	1/60.	1/60.
12	Mariamma	67	F	1d	H.wife	Domestic	EFB	wood.p	√		infil	ant.st	no	MM	neb.op	6/60.	6/60.	6/36 P	6/36.	6/36.	6/36.
13	Balan	6	M	2h	Student	sports	BI	ball		√	abr	epi	yes	MM	CLEAR	6/18.	6/12p	6/12.	6/6.	6/6.	6/6.

14	Marimuthu	26	M	10h	worker	Factory	CI	acid	√		str.ede	ant.st	no	MM	neb.op	6/60.	636p	6/36.	6/9 P	6/9 P	6/9p
15	Poovarasu	33	M	2h	worker	office	EFB	dust		√	FB+	epi	yes	MM	CLEAR	6/9 P	6/9p	6/6.	6/6.	6/6.	6/6.
16	Ramalingam	41	M	1d	worker	Industry	PI	nail	√		lac	full.thi	no	SM	mac.op	6/18 P	6/18p	6/18.	6/18.	6/12.	6/12.
17	Chandran	23	M	3h	worker	industry	EFB	iron.p		√	FB+	epi	no	MM	CLEAR	6/9 P	6/9p	6/6.	6/6.	6/6.	6/6.
18	Ramamoorthy	88	M	2d	Farmer	agri	BI	stone		√	stro.ede	mid.str	yes	MM	mac.op	3/60.	5/60p	6/60P.	6/60.	6/60.	6/60.
19	Radha	21	F	4h	H.wife	Domestic	EFB	leaf	√		FB+	epi	no	MM	CLEAR	6/18.	6/18p	6/12.	6/6 P	6/6 P	6/6.
20	Karthik	18	M	3h	Student	sports	EFB	sand		√	FB+	epi	no	MM	CLEAR	6/6 P	6/6p.	6/6.	6/6.	6/6.	6/6.
21	Feroze	15	M	1d	student	Domestic	EFB	iron.p	√		FB+	epi	Yes	MM	CLEAR	6/60.	6/36p	6/36.	6/12.	6/9P.	6/9p
22	Suber Basha	70	M	4h	farmer	Domestic	PI	stick	√		lac	full.thi	no	MM	mac.op	6/60.	6/36p	6/24.	6/24.	6/24.	6/18.
23	Nataraj	52	M	6h	Farmer	assault	BI	stone		√	stro.ede	mid.str	no	MM	neb.op	6/36.	6/24p	6/24.	6/18.	6/12p	6/12.
24	Pavithra	13	F	6h	student	play	EFB	Sand	√		abr	epi	no	MM	CLEAR	6/12P.	6/12.	6/9p	6/9p	6/6.	6/6.
25	Balaji	35	M	4h	worker	contruct	CI	lime	√		epi.er	epi	yes	MM	CLEAR	6/12.	6/9p.	6/6P.	6/6.	6/6.	6/6.
26	Christoper	62	M	2d	worker	Industry	PI	nail	√		lac	full.thi	no	SM	leu.op	PL+	HM+	1/60p	2/60p	6/60p.	6/60.
27	Nagesh	70	M	10h	Farmer	agri	BI	stone		√	rupture	full.thi	Yes	SM	leu.op	PL+	HM+	PL+	3/60.	5/60p	5/60.
28	Srinivas	36	M	5h	worker	Factory	EFB	iron.p	√		FB+	epi	no	MM	CLEAR	6/18P.	6/18.	6/6P.	6/6P.	6/6P.	6/6p
29	Priyanka	7	F	2h	Student	play	EFB	sand		√	abr	epi	Yes	MM	CLEAR	6/12P.	6/12.	6/9.	6/6P.	6/6.	6/6.
30	Sukumar	18	M	2h	Student	sports	PI	stick		√	lac	full.thi	no	SM	mac.op	6/60.	6/60.	6/36P.	6/18.	6/9P.	9/6.
31	Antony	68	M	2d	Farmer	agri	EFB	sand	√		ulcer	full.thi	No	SM	mac.op	PL+	PL+	1/60.	2/60.	4/60.	4/60.
32	Azeera	37	F	5h	H.wife	Domestic	EFB	leaf	√		FB+	epi	yes	MM	CLEAR	6/36.	6/9p	6/9.	6/6.	6/6.	6/6.
33	Gokul	45	M	1d	worker	Factory	EFB	Met.FB		√	FB+	epi	no	MM	CLEAR	6/9P.	6/9.	6/6.	6/6.	6/6.	6/6.

34	Roshan	3	M	1d	student	play	PI	bro.sti	√		lac	full.thi	no	SM	neb.op	3/60.	4/60.	6/60.	6/18.	6/12p	6/12.
35	Masilamani	45	M	1d	Farmer	domestic	PI	nail	√		lac	full.thi	no	SM	neb.op	4/60.	5/60.	6/60.	6/36.	6/36.	6/18.
36	Selvaraj	12	M	2h	Student	domestic	PI	stick		√	lac	full.thi	yes	SM	mac.op	HM	2/60.	6/60.	6/24.	6/24.	6/24.
37	Guna	22	F	3h	worker	Factory	CI	cleaner s	√		epi.def	epi	no	MM	CLEAR	6/12p.	6/9.	6/6.	6/6.	6/6.	6/6.
38	Gangatharan	53	M	1d	worker	Agri	BI	stone		√	str.ede	ant.st	yes	MM	CLEAR	6/18.	6/12p	6/12.	6/12.	6/12.	6/12.
39	Vasathi	70	F	4h	H.wife	Domestic	PI	Stick	√		lac	full.thi	yes	MM	mac.op	5/60.	6/60p	6/60.	6/60.	6/60.	6/60.
40	Maliga	48	F	2h	H.wife	Domestic	PI	Stick		√	lac	full.thi	no	SM	neb.op	6/60.	6/60.	6/36P.	6/18.	6/18.	6/18.
41	Tamil Selvan	62	M	2h	worker	Domestic	EFB	Sand	√		FB+	epi	yes	MM	CLEAR	6/24.	6/18p	6/18P.	6/12.	6/12.	6/9.
42	Mounika	5	F	1h	Student	Domestic	EFB	sand		√	abr	epi	yes	MM	CLEAR	6/12P.	6/9.	6/6.	6/6.	6/6.	6/6.
43	Rajaappa	77	M	1d	Farmer	agri	CI	pestici de	√		str.ede	mid.str	Yes	MM	neb.op	6/60.	6/36p	6/36.	6/24.	6/18p	6/18.
44	Somasundaram	63	M	4h	worker	Agri	PI	Stick	√		lac	full.thi	no	SM	neb.op	6/36P.	6/36.	6/36.	6/18.	6/9P.	6/9.
45	Hajimohamed	34	M	6h	worker	Factory	EFB	iron.p	√		FB+	epi	no	MM	CLEAR	6/18P.	6/18.	6/12.	6/12.	6/12.	6/9.
46	Devaraj	80	M	2d	gedia	domestic	PI	Stick		√	lac	full.thi	yes	SM	mac.op	HM+	PL+	PL+	1/60.	2/60p	2/60.
47	Kanya	9	F	4h	Student	sports	EFB	dust		√	FB+	epi	yes	MM	CLEAR	6/6P.	6/6.	6/6.	6/6.	6/6.	6/6.
48	Philomeena	12	F	1h	Student	Domestic	EFB	Met.F B	√		FB+	epi	no	MM	CLEAR	6/12.	6/9p	6/6P.	6/6.	6/6.	6/6.
49	Syedshoib	22	M	7h	worker	Factory	BI	handle		√	abr	epi	no	MM	CLEAR	6/6P.	6/6p.	6/6.	6/6.	6/6.	6/6.
50	Murugaiya	79	M	3d	Farmer	Agri	EFB	sand		√	ulcer	mid.str	no	SM	neb.op	HM+	CFCF	1/60P	1/60.	2/60.	3/60.
51	Krishanamuruth y	46	M	4d	Farmer	agri	BI	stone	√		ulcer	mid.str	yes	MM	mac.op	PL+	HM+	1/60P	1/60.	1/60.	1/60.
52	Latha	35	F	1d	worker	office	EFB	dust	√		abr	epi	no	MM	CLEAR	6/18.	6/12p	6/12P.	6/6.	6/6.	6/6.
53	Husnabegam	56	F	1d	H.wife	Domestic	PI	nail		√	lac	full.thi	no	MM	neb.op	6/60.	6/36p	6/18.	6/12.	6/12.	6/12.

54	Patchapayappa	66	M	4h	worker	Factory	BI	hammer	√		str.ede	ant.st	no	MM	neb.op	6/24.	6/18p	6/18.	6/18.	6/18.	6/12.
55	Thayalnayagi	55	F	4h	H.wife	Domestic	EFB	Met.FB		√	FB+	epi	yes	MM	CLEAR	6/12P.	6/12p	6/12.	6/6.	6/6.	6/6.
56	Roobiga	6	F	1d	Student	play	EFB	Met.FB		√	FB+	ant.st	yes	MM	neb.op	6/24.	6/12p	6/12.	6/12.	6/12.	6/9p
57	Rakesh	8	M	3h	Student	play	EFB	leaf	√		FB+	epi	yes	MM	CLEAR	6/9 P	6/9p	6/6.	6/6.	6/6.	6/6.
58	Nelson	16	M	3h	Student	play	CI	lime		√	epi.def	epi	yes	MM	CLEAR	6/12.	6/9p	6/6.	6/6.	6/6.	6/6.
59	Chinnappa	58	M	7h	worker	factory	EFB	iron.p		√	FB+	epi	no	MM	CLEAR	6/9 P	6/9.	6/6.	6/6.	6/6.	6/6.
60	Arjun	24	M	5h	worker	office	BI	knob	√		abr	epi	yes	MM	CLEAR	6/12.	6/9p	6/6.	6/6.	6/6.	6/6.
61	Lakshmi	67	F	1d	H.wife	Domestic	BI	iron.ro		√	abr	ant.st	yes	MM	neb.op	6/60.	6/36p	6/18.	6/18.	6/12p	6/12.
62	Kaviya	13	F	1h	student	play	CI	feviqu		√	epi.er	epi	yes	MM	CLEAR	6/18.	6/12p	6/9 P	6/6.	6/6.	6/6.
63	Kirankumar	43	M	7h	worker	Industry	BI	hammer	√		str.ede	ant.st	no	MM	CLEAR	6/24.	6/12.	6/9 P	6/9 P	6/9 P	6/9.
64	Yashodha	89	F	1d	H.wife	Domestic	EFB	wood.p		√	infil	ant.st	yes	MM	neb.op	4/60.	5/60.	6/60.	6/60.	6/60.	6/36 p
65	Eshwar	23	M	5h	worker	office	BI	iron.ro	√		abr	epi	yes	MM	CLEAR	6/9 P	6/9p	6/6.	6/6.	6/6.	6/6.
66	Nilavarnisha	28	F	1d	H.wife	Domestic	CI	cleaners		√	epi.def	epi	yes	MM	CLEAR	6/12 P	6/12.	6/12.	6/9.	6/9.	6/6p
67	Stephan	16	M	4h	Student	sports	BI	ball	√		abr	ant.st	no	MM	neb.op	6/18.	6/12.	6/9 P	6/9.	6/9.	6/6p
68	Raja	36	M	6h	worker	Industry	BI	handle	√		str.ede	mid.str	no	MM	CLEAR	6/24P.	6/18.	6/9.	6/6.	6/6.	6/6.
69	Manokar	76	F	4h	worker	Factory	EFB	iron.p		√	fb+	epi	yes	MM	CLEAR	5/60.	6/60p	6/60.	6/60.	6/60.	6/60.
70	Rukmani	34	F	2h	H.wife	Domestic	BI	vessels	√		abr	epi	no	MM	CLEAR	6/24.	6/18p	6/18 P	6/12.	6/12.	6/6p
71	Somu	56	M	8h	worker	assault	BI	stone	√		str.ede	ant.st	yes	MM	neb.op	6/36.	6/24p	6/24 P	6/18p	6/18p	6/18.
72	Mala	65	F	1d	H.wife	Domestic	PI	scisso		√	lac	full.thi	yes	SM	mac.op	6/60.	6/60p	6/36 P	6/36.	6/36.	6/36.

73	Vetri	27	M	5h	worker	RTA	EFB	gla.pie	√		FB+	epi	yes	MM	CLEAR	6/12.	6/9p	6/9 P	6/9.	6/6.	6/6.
74	Joseph	89	M	2d	Farmer	Domestic	CI	pestici de	√		str.ede	mid.str	yes	MM	CLEAR	6/36.	6/36.	6/24 P	6/24.	6/18p	6/18.
75	Ram	13	M	6h	student	Domestic	CI	lime		√	epi.def	epi	yes	MM	CLEAR	6/24.	6/18p	6/18 P	6/12.	6/12.	6/6p
76	Govindarajan	46	M	5h	Farmer	agri	BI	stone	√		epi.def	epi	no	MM	CLEAR	6/18 P	6/18.	6/12.	6/9 P	6/9.	6/6p
77	Sekar	62	M	2d	worker	Factory	BI	iron.ro		√	str.ede	ant.st	yes	MM	mac.op	6/36.	6/24p	6/24.	6/24.	6/24.	6/24.
78	Rahuman	24	M	6h	worker	Industry	EFB	iron.p		√	FB+	epi	yes	MM	CLEAR	6/9 P	6/6p.	6/6.	6/6.	6/6.	6/6.
79	Sampath	35	M	5h	worker	Industry	EFB	iron.p	√		FB+	epi	no	MM	CLEAR	6/12.	6/12p	6/6.	6/6.	6/6.	6/6.
80	Sakunthala	42	F	3h	worker	agri	PI	stick		√	lac	full.thi	no	SM	mac.op	5/60.	6/60p	6/36P.	6/36.	6/36.	6/36.
81	Sokkalingam	56	M	8h	worker	Factory	EFB	iron.p		√	FB+	epi	yes	MM	CLEAR	6/36.	6/36p	6/24 P	6/18.	6/18.	6/18.
82	Babu	36	M	1d	worker	constru	CI	lime	√		str.ede	ant.st	yes	MM	neb.op	6/24P.	6/24.	6/18.	6/18.	6/12p	6/12 p
83	Rasathi	23	F	1d	worker	office	EFB	Met.F B		√	FB+	epi	yes	MM	CLEAR	6/12.	6/9p	6/9.	6/6.	6/6.	6/6.
84	Manivannan	59	M	2d	worker	Industry	BI	hamme r		√	abr	epi	yes	MM	CLEAR	6/36.	6/24p	6/12.	6/12.	6/12.	6/9.
85	Gopinath	39	M	4h	worker	RTA	EFB	sand	√		abr	epi	yes	MM	CLEAR	6/12.	9/6.	6/6.	6/6.	6/6.	6/6.
86	Senthil	73	M	2d	Farmer	agri	CI	pestici de		√	str.ede	ant.st	yes	MM	mac.op	6/36.	6/36.	6/24 P	6/24.	6/24.	6/24.
87	Sembaruthi	10	F	1h	student	sports	BI	ball		√	abr	epi	no	MM	CLEAR	6/9 P	6/9.	6/9.	6/6.	6/6.	6/6.
88	Kasinathan	56	M	4h	Farmer	Agri	PI	scre.dr	√		lac	full.thi	no	SM	neb.op	6/36.	6/24p	6/24.	6/18p	6/18.	6/18.
89	Anjammal	77	F	1d	H.wife	Domestic	PI	stick		√	lac	full.thi	yes	SM	mac.op	PL +	HM+	1/60p	1/60.	1/60.	1/60.
90	Arun	22	M	5h	worker	office	EFB	iron.p		√	FB+	epi	no	MM	CLEAR	6/12 P	6/12.	6/12.	6/6.	6/6.	6/6.
91	Sahul Natchiya	29	F	3h	H.wife	Domestic	CI	cleaner s		√	epi.def	epi	no	MM	CLEAR	6/9 P	6/9.	6/6.	6/6.	6/6.	6/6.

92	Anthony Samy	33	M	1d	worker	Industry	EFB	Met.F B	√		FB+	ant.st	yes	MM	neb.op	6/12 P	6/12p	6/12.	6/12.	6/12.	6/9p
93	Cladis	25	M	6h	worker	Factory	CI	acid	√		epi.def	epi	no	MM	CLEAR	6/9 P	6/9.	6/9.	6/6.	6/6.	6/6.
94	Amarnath	38	M	3h	worker	Industry	BI	hamme r		√	epi.def	epi	yes	MM	CLEAR	6/12 P	6/9p	6/9.	6/9.	6/6 P	6/6p
95	Bhuveneshwari	28	F	8h	H.wife	Domestic	EFB	leaf		√	FB+	epi	no	MM	CLEAR	6/9 P	6/9p	6/9.	6/6.	6/6.	6/6.
96	Rahul	7	M	3h	student	play	EFB	Sand	√		FB+	epi	no	MM	CLEAR	6/12.	6/9p	6/6 P	6/6.	6/6.	6/6.
97	Akila	52	F	3h	worker	office	BI	knob	√		str.ede	ant.st	yes	MM	CLEAR	6/12p.	6/12.	6/9 P	6/9.	6/9.	6/9p
98	Janarthanan	44	M	1d	worker	Industry	EFB	iron.p		√	FB+	epi	no	MM	CLEAR	6/9 P	6/9.	6/6.	6/6.	6/6.	6/6.
99	Amalorpam	67	F	5h	H.wife	Domestic	PI	stick	√		lac	full.thi	no	SM	neb.op	6/36.p	6/36.	6/24.	6/24.	6/18p	6/18.
100	Sivesh	12	M	4h	student	play	PI	bro.sti		√	lac	full.thi	no	SM	neb.op	6/24 P	6/18p	6/18.	6/9.	6/9.	6/9.
101	Abdul Azeez	70	M	7h	Farmer	Agri	EFB	Sand	√		epi.er	epi	yes	MM	neb.op	5/60P	5/60.	5/60.	6/60.	6/60.	6/60.
102	Karupayi	86	F	3d	H.wife	Domestic	EFB	wood.p		√	infil	mid.str	yes	MM	mac.op	1/60.	2/60p	2/60.	2/60.	3/60.	6/60.
103	Poominathan	27	M	2h	worker	Factory	CI	cleaner s		√	epi.def	ant.st	no	MM	CLEAR	6/9P.	6/9p	6/9.	6/9.	6/9.	6/6.
104	Fathima Begum	34	F	6h	H.wife	Domestic	BI	fist	√		abr	epi	yes	MM	CLEAR	6/36P.	6/24p	6/24.	6/12.	6/12.	6/9p
105	Mahesh	26	M	5h	worker	Factory	EFB	dust	√		FB+	epi	yes	MM	CLEAR	6/12P.	6/12p	6/12.	6/9.	6/6.	6/6.
106	Jahir Hussain	21	M	8h	worker	constru	CI	lime		√	epi.def	epi	yes	MM	CLEAR	6/36.	6/24p	6/18.	6/9 P	6/9.	6/6.
107	Sarala	48	F	1d	H.wife	Domestic	EFB	Sand		√	epi.er	epi	no	MM	CLEAR	6/24P.	6/24p	6/24.	6/18.	6/18.	6/12.
108	Sadhana	9	F	5h	student	play	BI	toll	√		abr	epi	yes	MM	CLEAR	6/12P.	6/9p	6/9.	6/6.	6/6.	6/6.
109	Kandhan	31	M	8h	worker	Factory	EFB	iron.p	√		FB+	ant.st	no	MM	CLEAR	6/12p.	6/12.	6/9.	6/6P.	6/6P.	6/6.
110	Mugilan	13	M	4h	student	play	EFB	Met.F B		√	FB+	epi	yes	MM	CLEAR	6/12.	6/9p	6/6P.	6/6.	6/6.	6/6.
111	Vadivel	67	M	6h	Farmer	Agri	BI	stone		√	abr	epi	no	MM	CLEAR	6/36P.	6/36.	6/24p	6/24.	6/12.	6/9p

112	Deepa	33	F	3h	H.wife	Domestic	CI	cleaners	√		epi.def	epi	no	MM	CLEAR	6/18 P	6'18.	6/12.	6/9.	6/9.	6/6p
113	Vennila	56	F	1d	worker	Agri	EFB	wood.p	√		infil	mid.str	yes	MM	neb.op	6/36P.	6/36p	6/36.	6/24p	6/24.	6/18.
114	Utharapathi	69	M	10h	Farmer	Agri	EFB	Sand		√	FB+	epi	yes	MM	CLEAR	6/60.	6/36p	6/24p	6/18p	6/18.	6/18.
115	Aruna	25	F	2h	worker	office	BI	handle		√	abr	ant.st	no	MM	neb.op	6/24P.	6/24.	6/18.	6/6P.	6/6.	6/6.
116	Dhinakaran	41	M	4h	worker	Industry	PI	scisso	√		lac	full.thi	no	SM	mac.op	6/24.	6/24.	6/18P.	6/18.	6/18.	6/18.
117	Arivukarasi	23	F	6h	H.wife	Domestic	EFB	dust		√	epi.er	epi	yes	MM	CLEAR	6/12.	6/9p	6/9.	6/6P.	6/6P.	6/6.
118	Vadivu	52	F	2d	Farmer	Agri	EFB	wood.p	√		infil	ant.st	no	MM	neb.op	6/18P.	6/12p	6/12.	6/9.	6/9.	6/9.
119	Fernadaze	70	M	3d	worker	Factory	BI	hammer	√		ulcer	mid.str	yes	MM	mac.op	6/60p	6/60.	6/36 P	6/36.	6/36.	6/24p
120	Kiruba	18	M	1d	student	play	EFB	Met.FB	√		FB+	epi	yes	MM	CLEAR	6/12p.	6/9p	6/9.	6/9.	6/6.	6/6.
121	Midhila	8	F	5h	student	Domestic	EFB	dust	√		abr	epi	no	MM	CLEAR	6/12.	6/9p	6/9.	6/6.	6/6.	6/6.
122	Faizal	23	M	1d	worker	assault	BI	fist		√	abr	epi	yes	MM	CLEAR	6/12P.	6/12.	6/9.	6/6.	6/6.	6/6.
123	Sangeetha	40	F	3h	H.wife	Domestic	EFB	Met.FB		√	FB+	epi	yes	MM	CLEAR	6/12.	6/9p	6/9.	6/9.	6/9.	6/6.
124	Dhivakar	26	M	6h	worker	Industry	EFB	iron.p	√		FB+	epi	no	MM	CLEAR	6/9P.	6/6p.	6/6.	6/6.	6/6.	6/6.
125	Kanagaraj	61	M	4d	Farmer	agri	CI	pesticide	√		str.ede	mid.str	yes	MM	mac.op	5/60.	6/60p	6/60P.	6/60.	6/60.	6/60.
126	Muthulakshmi	59	F	3d	H.wife	Domestic	EFB	dust		√	epi.def	ant.st	yes	MM	neb.op	6/60.	6/36p	6/36.	6/36.	6/24p	6/24.
127	Kalaivani	37	F	2d	worker	Industry	EFB	iron.p	√		FB+	mid.str	no	MM	mac.op	6/12p.	6/12.	6/9p	6/6p.	6/6P.	6/6p
128	Edwin	50	M	3h	worker	Factory	BI	stone		√	str.ede	mid.str	no	MM	mac.op	6/60.	6/36p	6/36.	6/24p	6/24.	6/18.
129	Vigneshwaran	43	M	5h	worker	Industry	EFB	iron.p	√		FB+	epi	yes	MM	CLEAR	6/36P.	6/36.	6/24p	6/18.	6/12.	6/9p
130	Indhran	40	M	3h	worker	Industry	EFB	iron.p		√	FB+	epi	no	MM	CLEAR	6/12P.	6/12.	6/12.	6/9.	6/6.	6/6.

131	Mukkaiyi	91	F	1d	H.wife	Domestic	BI	fall	√		p.lac	mid.str	yes	MM	neb.op	PL+	HM+	1/60p	1/60.	2/60.	4/60.
132	Kanagavel	79	M	7h	worker	Domestic	PI	stick		√	lac	full.thi	yes	SM	mac.op	2/60.	3/60p	3/60.	5/60.	5/60.	6/60.
133	Kavin	25	M	4h	worker	Industry	CI	acid		√	epi.def	epi	yes	MM	CLEAR	6/12 P	6/12.	6/9.	6/6.	6/6.	6/6.