

A Study on Industrial Eye Injuries

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ABSTRACT

Background: Eye injuries have been known since ancient times. Although nature has provided a protective bony wall and lids to cover the eye to protect it from injury, it is still exposed to all types of trauma. Trauma is the leading cause of patient presentation to the eye clinic, accounting for 52% of the patient load. Occupational eye injuries are more common in younger men and comprise 70% of all the ocular injuries.

Aim of the Study: To determine the various aetiological factors which are responsible for ocular injuries in various industrial environments and to assess the types of injuries and their outcomes in various types of occupations.

Material and Methods: This study included 65 cases with a history of trauma, which was sustained while working, who presented directly or were referred to the Aravind Eye Hospital, Coimbatore, during the study period from May 2003 to December

2004. In all the cases, a thorough history was obtained, with particular emphasis on the type of industry, the nature of work, the hours of work daily, the exact nature of the event which led to the injury and the object which caused the injury. The patient's symptoms following the injury were enquired about in detail. A relevant past ocular and general medical history was obtained for risk assessment in the present ocular injury. The history of prior treatment for the injury was recorded. All the patients were subjected to a complete ophthalmic examination. Their visual outcomes were considered.

Results: The males were commonly injured. The commonest age group which was affected was the 21-30 years age group. Mechanical injuries were the most common type of injury.

Conclusion: An attempt was made to find out the various aetiological factors for ocular injuries and their visual outcomes.

Key Words: Eye Injury, Industry, Visual outcome

KEY MESSAGE

- Potential eye hazards are found in nearly every industry and 90% of them are preventable.
- Mechanical injuries were the most common type of injury.
- Activities should be undertaken to create awareness about the risks of injuries that may be sustained and also plans should be drawn up to avoid them.

INTRODUCTION

The incidence of ocular injuries is constantly on the rise. It is difficult to accurately measure or even estimate the incidence of eye injuries. Worldwide, there are approximately 1.6 million people who have become blind, 2.3 million who have become bilaterally visually impaired and 19 million with unilateral visual loss due to eye injuries. Trauma is the commonest cause of unilateral blindness today. From the international perspective, an estimated 5,00,000 blinding eye injuries occur annually worldwide [1].

In an Indian survey, injuries were found to be the cause of blindness in 11.8% of the total blind subjects (A pilot survey from Jaipur, Rajasthan). The lifetime prevalence of ocular injuries in the USA is estimated at over 1400/100,000 population. The annual rate of eye injuries is 13.2/1000 population [2].

The importance of injuries has been highlighted by studies on occupational injuries. The toll of the industrial ocular injuries extends

beyond the pain and visual limitation of the injured. The direct cost of medical and surgical treatment and hospitalization and the indirect cost of the loss of productive work hours are shared by the society. In USA, the direct and indirect costs of all the injuries combined together have been estimated at 75 to 100 million dollars [3].

Occupational eye injuries are more common in younger men and comprise 70% of all the ocular injuries. Males have a 2.2 to 5.5 times higher risk of sustaining eye injuries than females [4, 5].

Automotive industry workers had the highest incidence of open globe injuries [6].

In most of the cases of ocular injuries, it is the anterior segment of the eye including the conjunctiva, the cornea, the iris, the lens and the angle of the anterior chamber, which bears the burden of the direct and indirect force of the injuries. Blunt injuries account for 49.7% of all the ocular injuries [4, 5].

The ultimate goal is to prevent secondary complications and to maximize the patients' visual prognosis, so as to enable the patients to carry on their normal activities and occupations.

MATERIALS AND METHODS

This was a prospective study which was conducted during the period from May 2003 to December 2004. A total of 65 cases were included, with a history of trauma which was sustained while working, who presented directly or were referred to Aravind Eye Hospital, Coimbatore. The age group of the patients ranged from 18-58 years. Ethical clearance was obtained for this study from the ethical committee. Consent was obtained from all the subjects who were involved in this study.

In all the cases, a thorough history was obtained, with particular emphasis on the type of industry, the nature of work, the hours of work daily, the exact nature of the event which led to the injury and the object which caused the injury. Any eye afflictions and a history of poor vision in the eyes, previous eye check-ups and the use of power glasses, protective glasses, shields, helmets and face protectors was asked. Any associated systemic diseases and alcohol and any drug intake at the time of the injury was noted. The activity at the time of the injury was classified as follows: hammering metals or stones, handling machinery for drilling, welding, grinding or polishing, handling chemicals or molten metals, working on power looms or others. A proforma was drawn up and the details were recorded for each patient. A relevant past ocular and general medical history was obtained for risk assessment in the present ocular injury. The history of prior treatment for the injury was recorded.

The patients' symptoms following the injury like pain, watering, photophobia, diminished vision, loss of vision, floaters, redness, bleeding, etc., were enquired about in detail.

All the patients were subjected to a complete ophthalmic examination, which included: visual acuity assessment by using the standard Snellens chart in literates and the 'E' chart in illiterates, slit-lamp biomicroscopy and fundus examination by using direct and indirect ophthalmoscopy. Tonometry with applanation, tonopen or a non-contact tonometer, gonioscopy with a 4-mirror lens and refraction by using tropicamide and phenylephrine were done to assess the posterior segment in appropriate cases. All the ocular findings were recorded by using diagrams wherever necessary and the important fundus findings were also documented by colour photography by using a fundus camera and slit lamp photography.

RESULTS

A survey on 65 cases (71 eyes), with a history of injury which was sustained at work in various industries, who presented to the Aravind eye Hospital, Coimbatore, directly or by referrals, was conducted during the study period and the clinical data which was collected, analyzed and compiled. Comparison of the categorical variables was done by using the Pearson's Chi Square test for association. A "p" value which was less than 0.05 was considered to be significant.

The injured were aged 30.5+/-9.8 years and were as young as 18 years, the oldest being 58 years.

Most of the injuries were in the age group of 21-30 years. There was only one (1.5%) female in the study sample.

The object of the injury was flying particles in 66.7% of the cases. Splashing of dangerous chemicals was the cause of injury in 23.1% of the cases.

Mechanical injuries were the most common type of injury in a large proportion of patients as compared to the non-mechanical injuries.

The injuries which occurred due to machines or mechanical forces formed the major proportion (62%); followed by 50.7% due to open globe, 11.3% due to closed globe 31% due to chemicals and 7% due to thermal causes.

Overall, 16.9% of the eyes presented with rupture and 33.8% with perforating injuries and 11.3% required foreign body removal. Almost one third (32.3%) of the injuries were thermal or chemical in nature.

DISCUSSION

Age and Sex Distribution of the Sample [Table/Fig-1]

A majority of the injuries were found in the 21 to 30 years age group. Probably the cases were under training in their respective areas and hence were more exposed to the injuries due to ignorance or inexperience. There appeared to be a very less proportion of women who reported with an injury. This could be due to reasons such as (1) less number of women in the industries, (2) women being employed in less dangerous departments or (3) women being very careful in their work and adhering to the safety measures. This finding was similar to that of other studies by Lambah, Malik and Shukla, who reported that a high number of males were affected as compared to the females varying from 80-90% [7, 8, 9].

A majority (75.4%) of the cases were from the Coimbatore district itself, followed by 13.8% from the Erode district and 4 cases from the neighbouring state of Kerala. The number of injuries indicated that the magnitude could be very high, as Coimbatore was an industrial city and there were only few numbers of tertiary eye care centers. Hence, the number of affected cases (though not a prevalence rate) can be an under estimate of the real situation.

Occupationwise Distribution of the Sample

Occupation [Table/Fig-2]: Machine tool operators or mechanics constituted a major (32.3%) part of the patients in the study. Labourers from various industries reported 23.1% of the injuries. 9.2% of the quarry workers were injured. Chemical handlers also were prone (7.7%) to the eye injuries.

Other studies; Shukla, Koval, Dannenberg and Malik reported (29.2%), (28.2%), (22%), and (19.7%) of the cases as those with occupational injuries [10-13].

Activity during the injury [Table/Fig-3]: A majority (38.5%) of the injuries occurred when the subject was hammering, followed by the handling of chemicals or acids (23%). The injury occurred while handling hot metals in 5(7.7%) cases. Three persons (4.6%) were bystanders when the injury occurred. Patients who were working

Age group (in yrs)	n	%
<=20	07	10.7
21-30	34	52.3
31-40	13	20.0
41-50	07	10.7
>50	04	6.15
Total	65	100

[Table/Fig-1]: Age and sex distribution of the sample: (n = number of subjects; % = percentage)

Occupation	n	%
Machine tool operators	9	13.8
Assembly workers	4	6.2
Mechanics	12	18.5
Chemical handlers	5	7.7
Furnace operators	4	6.2
Weavers	1	1.5
Quarry workers	6	9.2
Innocent bystanders	1	1.5
Supervisors	2	3.1
Labourer	15	23.1
Fitter	2	3.1
Electrician	2	3.1
Spinning mill worker	2	3.1
Total	65	100

[Table/Fig-2]: Occupationwise Distribution Of Sample

Activity	n	%
Hammering	25	38.5
Handling chemicals	15	23.0
Welding	2	3.1
Handling hot metal	5	7.7
Sewing	4	6.2
Bystander	1	1.5
Machine operation	9	13.8
Grinding	1	1.5
Supervision	2	3.1
Weaving	1	1.5
Total	65	100

[Table/Fig-3]: Analysis of history of activity during injury

in other industries apart from the chemical industry were also exposed to chemicals at work. For example, chemicals such as bleach, caustic soda and other acids are used in the textile industry during the processing of yarn and during the dyeing and finishing of the garments. Similarly, various chemicals are used in the tools and during the stages of cleaning, treatment and polishing.

Industrywise distribution of the sample [Table/Fig-4]: The place of work at which the injuries occurred was mostly workshops (53.8%), followed by textile mills where nearly one fifth (18.5%) of the injuries were caused and foundries where 10.8% of the injuries were caused. The chemical factory was the place of injury in 4.6% of the cases. All the cases reported that there was adequate illumination in their work place. However, 4 (6.2%) cases said that there was not enough ventilation.

Object of the injury (Table/Fig-5): The object of the injury was flying particles in 67.7% of the cases. The splashing of dangerous chemicals was the cause of injury in 23.1% of the cases.

This was similar to reports by others. Roper-Hall reported 30.4% injuries which were caused due to hammering [13]. Rubsamen reported that chisels and hammers were responsible for 49% of the injuries [14]. Malik reported that the use of hammers was the cause in 46.3% of the eye injuries [8].

Jain reported the incidence of flame burns to be 1.3% [15]. Shukla and Verma reported chemical injuries to constitute 3% of the total injuries [16], as also Jain who reported 3% chemical eye injuries [15].

Time taken for the presentation: The presentation to the clinic was early in a majority of the cases. This shows that eye injuries are real ophthalmic emergencies which demand prompt and early attention. The presentation to the hospital is influenced by the type and severity of the injury.

Experience: Only 8 (12.3%) cases were new to the industry/department, with an experience of less than one year. A majority (50.8%) of the cases who presented with eye injuries had an experience of more than five years. Injuries can occur at any point of time, irrespective of the experience in the field. Probably the workers with less experience were still trainees in the field. There could have been neglect and lethargy in using protection in the latter group.

Awareness and the usage of protective gear: Forty-four (67.7%) cases were not aware that there was a possibility of eye injuries. The rest (21 cases) who were aware of the possibility of an injury, knew that they had to use protective gear at their workplace.

The provision of protective gears for the eyes was not available in a major proportion (76.9%) of the cases. Of the 15 cases that had the provision, 9 (13.85%) wore it 'regularly' and 6 (9.2%) wore it 'occasionally'.

Most (87.7%) of the cases were not wearing protective gear at the time of the injury. Eight persons (12.3%) had an injury in spite of wearing protection at the time of the injury.

Previous ocular eye examination: Only 9 (13.8%) cases had their eyes examined prior to the injury. The reason for the eye examination was glass penetration in 5 (55.6%) cases and a routine check up in 4 cases. One patient was one-eyed. Presbyopia was the predominant (12.3%) problem which was reported before the injury. Uncorrected refractive error was reported by 3 (4.6%) cases. There was one squint eyed and one hyperopic case in the study sample.

Laterality: Six (9.2%) cases had injuries in both eyes as a result of chemical splashing. Among the unilateral injuries, the eye which was involved was the right eye in a majority (60%) of the cases and the left eye in 20 (30.8%) cases.

This indicates that chemical injuries were the most common cause of the bilateral eye injuries.

Industry	n	%
Workshop	35	53.8
Textile industry	12	18.5
Chemical factory	3	4.6
Quarry	6	9.2
Motor factory	7	10.8
Others	2	3.1
Total	65	100

[Table/Fig-4]: Industry wise distribution of samples

Cause	n	%
Blunt injury	14	21.53
Sharp object	30	46.15
Acid burns	9	13.84
Alkali burns	7	10.76
Hot metal fall	5	7.69

[Table/Fig-5]: Offending agent of injury

Type of injury [Table/Fig-6]: Mechanical injuries are broadly classified as open globe and closed globe injuries. Open globe injuries [Table/Fig-7] include IOFB (Intraocular Foreign Body), rupture, penetrating, and perforating injuries. Closed globe injuries include contusion, lamellar laceration and superficial foreign body [17].

The injuries which were caused by machines or mechanical forces formed the major proportion (62%) of the injuries – 50.7% were open globe and 11.3% were closed globe injuries, followed by those which were caused by chemicals (31%) and thermal causes (7%).

Mechanical injuries: A majority of the cases had an injury in the structures in the anterior segment, while the posterior segment injuries were less. This was similar to the findings of other authors who have reported a higher incidence in the anterior segment of the eye than in the posterior segment.

Thermal and Chemical injuries: There were thermal injuries [Table/Fig-8] in 5 eyes and chemical injuries (acid or alkali burns) in 22 eyes. Chemical injuries were the most common (6 cases) causes of the bilateral eye injuries.

Jain reported the incidence of flame burns to be 1.3% [15]. Shukla and Verma reported chemical injuries to comprise 3% of the total injuries [16], as also Jain who reported 3% chemical eye injuries.

Structurewise involvement of the eye in the injury [Table/Fig-9]:

The highest involvement was of the anterior segment structures. The cornea was the most commonly involved site, followed by the conjunctiva and the eyelids. In the cornea, the most commonly involved site was the tear film. Conjunctival burns and lid burns were common. Shallowing of the anterior chamber and hyphema [Table/Fig-10] were common changes following the injury. Iris prolapse was the most common change. Cataract was the most common lens change following the trauma. Retinal oedema and tear were the common posterior segment changes.

Malik reported that the highest incidence of injuries was in the cornea (55.8%), followed by the iris (44.1%) and the eyelids (33.2%)

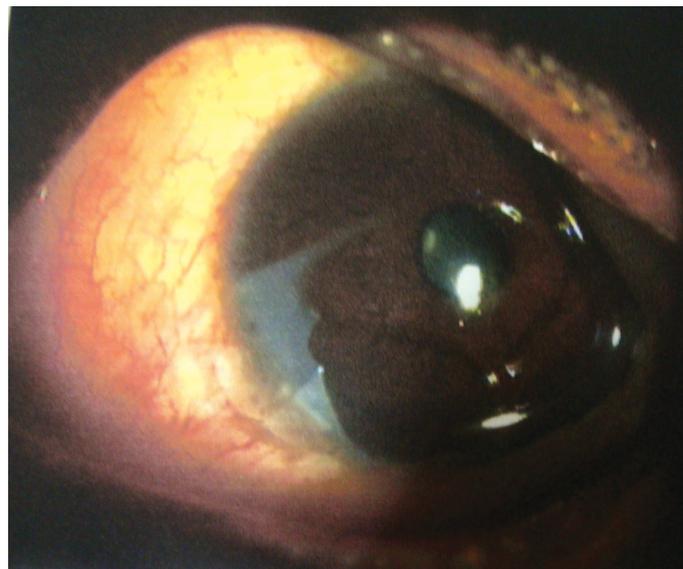
Type	Open globe		Closed globe	
	n	%	n	%
Rupture	8	22.2	4	50
Perforation	20	55.6	4	50
IOFB	8	22.2	–	–
Total	36	100	8	100

[Table/Fig-6]: Type of injury



[Table/Fig-7]: Open Globe Injury

[8]. Shukla and Verma reported the involvement of the conjunctiva in 92.5%, the cornea in 64% and the eyelids in 21.75% of the cases [16]. Koval reported that the cornea was involved in 81.2% of the cases [11]. Mukherjee also reported the cornea as the most



[Table/Fig-8]: Thermal burns

Structure	n	%
Lids	17	23.9
Conjunctiva	24	33.8
Cornea	52	73.2
Sclera	12	16.4
Iris	19	26.7
Anterior chamber	41	57.4
Lens	16	22.5
Vitreous	18	25.4
Retina	11	15.5
Choroid	04	5.6
EOM Damage	01	1.4
Orbital fracture	01	1.4

[Table/Fig-9]: Structurewise involvement in injury



[Table/Fig-10]: Hyphema

common site of perforation in 62.21%, as the corneoscleral in 29.26% and as the sclera in 8.5% of the cases [18].

Approximately 66% of the penetrating wounds were caused through the cornea, 10% were caused through the sclera and the remainder were caused through the limbus.

Most of the authors reported uveal prolapse and lenticular damage as the common sequelae following the perforation.

The presenting visual acuity (VA): The grading of the visual acuity is done as follows [17]:

Grade I	>20/40
Grade II	20/50 to 20/100
Grade III	20/100 to 5/200
Grade IV	4/200 to PL (Perception of Light)
Grade V	No PL

All injuries were graded for subjective visual acuity. There was no eye that presented with no light perception (Grade V). Most (38%) of the eyes presented with a visual acuity of 4/60-PL. One third (32.4%) of the eyes presented with a visual acuity of 6/12 or better.

Association of presenting Visual Acuity with predisposing factors: The presenting visual acuity of the injuries was associated with the type of injury, the experience of the work, the time of presentation and with the wearing of protective gear. There was no statistically significant association between the experience, the time of presentation and the wearing of the gear and the visual acuity at presentation.

However, the nature of the injury did influence the presenting visual acuity. The p value was less than 0.001 and so there was a significant association between the type of injury and the presenting visual acuity. Three fourth (75%) of the eyes that had closed injuries had a visual acuity of 6/36 or better as compared to 22.2% eyes among the open injuries. The open globe injuries mostly (61.1%) presented with a visual acuity of 4/60-PL.

CONCLUSION

Potential eye hazards are found in nearly every industry. Males were more commonly injured than the females. The commonest age group which was affected was the 21-30 years age group. The higher incidence among the youth causes visual disability and has a tremendous burden on the financial and social perspectives and on the quality of life of the individuals.

The number of injuries indicated that the magnitude could be very high, as Coimbatore was an industrial city and there were only few numbers of tertiary eye care centers. Hence, the number (though not a prevalence rate) could be an under estimate of the real situation.

Mechanical injuries were the most common type of injury and comprised a large proportion of the cases. Chemical injuries are the most common cause of bilateral eye injuries that cause serious functional disability and hence, special efforts should be made to prevent them. Thermal injuries were seen in foundry and steel industry workers, which were caused by molten metal.

Acids, alkalis, bleach and dyes are not only used in chemical industries, but are also used in textile manufacturing and processing.

Chemical splashing was the commonest mode of injury. Most of the chemical injuries were of grade I, but the severe injuries caused

ocular surface problems and needed prolonged rehabilitation measures with surface reconstructive procedures.

The commonest cause of thermal burns was the falling of hot metal. Eyelid and conjunctival burns were the most common lesions. If the burns were localized and deeper, they often necessitated procedures like AMG to avoid symblepharon and scarring.

Mechanical injuries were frequently found to occur in the workshops of various industries. Workers who were engaged in activities like hammering were the most frequently affected ones. Even persons in the supervisory cadre can get eye injuries. Machine operators were more prone to eye injuries.

Mechanical injuries are often caused by flying particles/splinters. They cause open globe injuries which commonly involve the anterior segment. IOFBs were seen in 11.3% of the cases and they needed immediate surgery.

Patients with open globe injuries presented early to the hospital to seek medical care. The presenting visual acuity in most eyes was 4/60-PL. Those with closed globe injuries had a better vision at presentation i.e. 6/30 or better.

The presenting visual acuity was influenced by the type of injury and not by the use of the protective gear.

A majority of the cases had no previous eye examination. Nearly 1/3rd of the workers were not aware of the possibility of eye injuries.

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