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Original Article

Ophthalmology Section

Clinical Profile of Ocular Chemical Injuries in a Tertiary Care Centre of Kolar, Karnataka, India: A Retrospective Study

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ABSTRACT

Introduction: Ocular chemical injury is a true ophthalmic emergency which needs immediate assessment and management. They cause extensive damage to the ocular surface resulting in permanent visual impairment. The majority of victims are young and the exposure occurs at home, work place and with assaults.

Aim: To analyse the clinical characteristics, grade and visual outcome in patients with ocular chemical injuries.

Materials and Methods: This retrospective study was conducted on patients with chemical eye injuries who presented at Ophthalmology Department in Kolar tertiary care centre in the past five years. Medical records of 127 patients who presented from January 2017 to December 2021 with chemical eye injuries were assessed for age, gender, history of the mode of injury, pattern and grade of damage, visual outcome and treatment methods during the acute phase and at one month follow-up. Paired t-test and one-way Analysis of Variance (ANOVA) with posthoc test was the statistical method used for analysis.

Results: Out of 127 chemical injury cases, 104 (81.9%) were males and 23 (18.1%) were females. The incidence of chemical injury was found to be 51 (40.2%) in the age group of 31-45 years and 38 (29.9%) in 15-30 years with 74 (58.3%) cases affected by alkali and 27 (21.3%) cases by acids and 26 (20.4%) unknown injury. A total of 43 (34%) cases had grade I, 75 (59%) had grade II and 9 (7%) had grade III injury and the common clinical finding was conjunctival congestion in 147 eyes and epithelial defect in 107 eyes. Significant improvement in the visual acuity was observed after the initial management and subsequently at one month follow-up (p-value <0.001).

Conclusion: Male dominance and fields and workplace injuries were most common in the study. Initiation of immediate irrigation with tap water and early reporting to the hospital can reduce serious complications with early restoration of vision. It also emphasises the promotion of necessary protective measures to avoid workplace based accidental injuries.

Keywords: Acid, Alkali, Irrigation, Visual acuity

INTRODUCTION

Ocular chemical injury (alkali and acid) which represents 11.5%-22.1% of ocular traumas is one of the true ophthalmic emergencies which need an immediate assessment and management [1,2]. They cause extensive damage to the ocular surface epithelium, cornea, anterior segment and limbal stem cells resulting in permanent unilateral or bilateral visual impairment. The majority of victims are young and the exposure occurs at home, work place and in association with criminal assaults [3].

Common acids are sulphuric acid (car batteries), hydrofluoric acid, acetic acid, hydrochloric acid and nitric acid. Alkali injuries with lime, ammonia/ammonium hydrochloride, potassium hydrochloride, magnesium hydrochloride tend to be more common since they are extensively used in industries and in various households as cleansing agent.

Acids cause coagulation of tissue protein forming a barrier, which prevents deeper penetration, whereas an alkali cause saponification of cellular lipids that disrupt the normal barrier of the cornea resulting in deeper penetration and damage to internal structures like the lens and uvea [4].

Chemical trauma to the eye may vary in severity from mild irritation to complete destruction of the ocular surface epithelium, corneal opacification, visual loss and rarely loss of the eye. They have a major impact in terms of long-term morbidity and is a matter of major socio-economic importance [5]. The after effects may significantly affect the vision and psychological state of the affected individual. So it is crucial that immediate evaluation and intensive treatment in the acute setting as well as regular follow-up is essential in limiting adverse effects of ocular tissue damage secondary to the chemicals.

The aim of this study was to find out the pattern of ocular injury, nature of causative chemicals, the ocular features and the visual outcome in ocular chemical injury.

MATERIALS AND METHODS

This retrospective study was conducted at Ophthalmology Department, RL Jalappa Hospital, Kolar, Karnataka, India, from January 2017 to December 2021 and was analysed in December 2021.

Inclusion and Exclusion criteria: Total of 159 eyes of 127 patients were included, aged from 12-60 years who reported with history of chemical injury to the eye within the study duration. Patients with pre-existing corneal or lenticular opacity, uveitis and glaucoma were excluded from the study.

Study Procedure

Patients with chemical eye injuries were assessed for age, gender, occupation, location of ocular chemical injury, initial and final Best Corrected Distance Visual Acuity (BCVA), nature of the chemical, severity of injury, management methods, and complications. BCVA was recorded with Snellen's chart and final BCVA obtained at the one-month follow-up was considered.

The Intraocular Pressure (IOP) was determined using non contact tonometer. After perilimbal fluorescein staining the severity of ocular chemical injury was graded by the extent of corneal haze and limbal ischaemia according to the Roper-Hall (RH) classification [6]. Briefly,

- Grade I was defined as corneal epithelial damage without limbal ischaemia;
- Grade II as corneal haze and visible iris details with <1/3 limbal ischaemia;

- Grade III as total corneal epithelial loss, stromal haze, and obscured iris details >1/3 but <1/2 of limbal ischaemia; and
- Grade IV as opaque cornea and obscured iris and pupil with >1/2 limbal ischaemia.

The management included immediate irrigation after injury, manual removal of the chemical agent by cotton tipped applicator and topical medications {prophylactic antibiotics milflox 0.5% eye drops (Sun Pharmaceutical Industries Ltd., Panchamal, Gujarat), Oflox D eye drops (Ofloxacin 0.3%+ Dexamethasone 0.1%, Bengaluru, Karnataka), Zoxan eye ointment (Ciplox 0.3% eye ointment, Cipla Ltd., New Delhi) and Mydryn eye drops (2% Homatropine, Sunways India Pvt., Ltd., Mumbai), hourly lubricants and glass rod sweeping. Predmet {prednisolone acetate 1%, Sun pharma Lab Ltd., Andheri (E), Mumbai} for four weeks in a tapering dose was started after 5-7 days of the injury. All cases were followed-up at one month for improvement in the visual acuity and clinical signs.

STATISTICAL ANALYSIS

Visual acuity was considered as outcome variable. RH grade was considered as explanatory variable. Background characteristic and other related variables were other study relevant variables. Descriptive analysis was carried out by frequency and proportion for all the study relevant variables. Paired t-test and one-way ANOVA with posthoc test was used to compare outcome variable across different categories of explanatory variable. The p-value <0.05 was considered statistically significant. RStudio Version 1.2.1093 was used for statistical analysis. (Reference: RStudio Team (2020). RStudio: Integrated Development for R. RStudio, PBC, Boston, MA URL: http://www.rstudio.com/).

RESULTS

[Table/Fig-1] shows the various characteristics of the patients sustained with ocular chemical injuries. Out of the 127 chemical injury cases, 104 cases (81.9%) were male and 23 cases (18.1%) were female. The incidence of accidental ocular chemical injury was found to be 51 (40.2%) in the age group of 31-45 years, 38 (29.9%) in 15-30 years, 24 (18.9%) above 45 years and 14 (11%) in less than 14 years.

Characteristics		Frequency (n)	Percentages (%)
Gender	Male	104	81.9
	Female	23	18.1
Age group (years)	<14	14	11
	15-30	38	29.9
	31-45	51	40.2
	>45	24	18.9
Laterality	Unilateral	95	74.8
	Bilateral	32	25.2
Chemical	Alkali	74	58.3
	Acid	27	21.3
	Unknown	26	20.4
Location of injury	Fields	57	44.9
	Workplace	56	44.1
	Home	6	4.7
	Playground	8	6.3
Type of chemical	Lime	15	11.8
	Ammonia	14	11.0
	Magnesium hydrochloride	24	18.8
	Potassium hydrochloride	04	3.14
	Caustic soda	08	6.2
	Propane	09	7.0
	Hydrofluoric acid	22	17.3
	Sulfuric acid	01	0.7
	Boric acid	04	3.14
	Unknown	26	20.4
Time interval between injury and the initial visit	30-60 min	12	9.5
	>60-120 min	32	25.2
	>3 hour	47	37
	>1 day	36	28.3
Irrigation time	5-30 min	74	58.3
	>30-60 min	22	17.3
	Not done	31	24.4

[Table/Fig-1]: Characteristics of patients with ocular chemical injuries (N=127).

A total of 95 (74.8%) cases had unilateral and 32 (25.2 %) bilateral involvement by the offending agents. Different varieties of injurious agents and mode of injuries were noted out of which 74 (58.3%) cases had alkali injury, 27 (21.3%) cases had acidic injuries and 26 (20.4%) cases were injured with unknown agents. Magnesium hydrochloride was the most common type among alkali injury seen in 24 (18.8%) cases, second most common chemical was hydrofluoric acid seen in 22 (17.3%) cases and was the common acid among acid injuries. A total of 74 (58.3%) cases had irrigated the eyes immediately with tap water for approximately 5-30 minutes and intermittent irrigation for up to 60 minutes in 22 (17.3%) cases, whereas 31 (24.4%) cases had reported without any irrigation. Following this 12 (9.5 %) cases reported to the department within one hour, 32 (25.2%) within two hours, 47 (37%) more than three hours and 36 (28.3%) more than one day of injury [Table/Fig-1].

Since sufficient data for IOP was not available in the medical records, this parameter has not been mentioned in the results.

Grade of injury: [Table/Fig-2] shows all the injuries classified according to Roper Hall grading. Grade I injury was noted in 43 eyes (33.8%) out of which 28 were unilateral and 15 were bilateral. Grade II injury was observed in 90 eyes with 60 unilateral and 30 bilateral involvement. Nine eyes with grade III injury had unilateral involvement.

RH grade	Unilateral	Bilateral	Frequency (n)	Percentages (%)
Grade I	28	15	43	33.8
Grade II	60	15	75	59
Grade III	9	0	9	7

[Table/Fig-2]: Grade of ocular injury N=127.

Ocular signs: [Table/Fig-3] reveals the ocular signs of which the most common finding was conjunctival congestion in 147 eyes (92.5%) and chemosis in 17 eyes (10.7%). Corneal signs included epithelial defect, stromal haze and corneal haze in 107 (67.3 %), 19 (11.9 %) and 31 (19.5%) eyes, respectively. Limbal ischaemia of <1/3 was observed in 90 (56.6%) cases and ischaemia of >1/3 was seen in 9 (5.7%) cases.

Complications		Frequency number of eyes	Percentages (%)
Conjunctiva	Congestion	147	92.5
	Chemosis	17	10.7
Cornea	Epithelial defect	107	67.3
	Stromal haze	19	11.9
	Corneal haze	31	19.5
Limbus	Ischaemia <1/3	90	56.6
	Ischaemia 1/3-1/2	9	5.7

[Table/Fig-3]: Ocular signs.

Visual outcome: [Table/Fig-4] compares the visual acuity at the initial and at one month follow-up visit. The mean Uncorrected Visual Acuity (UCVA) at the initial visit and follow-up visit was 0.46±0.29

log MAR and 0.09±0.16 log MAR, respectively. This improvement was statistically significant (p-value <0.001, paired t-test) when compared to the initial visit.

Visual acuity	Mean±SD	Mean difference	95% CI		p-value
			Lower	Upper	
Initial visit	0.46±0.29	0.38	0.33	0.42	<0.001
Follow-up	0.09±0.16				

[Table/Fig-4]: Comparison of visual acuity between initial and follow-up visit.

[Table/Fig-5] compares the mean visual acuity at initial and follow-up visit among patients classified as per Roper-Hall classification. There was a statistically significant improvement (p-value <0.001, One-way ANOVA) among all the patients of grade I, II and III.

RH grade	Visual acuity (log MAR) at initial visit (Mean±SD)	p-value	Visual acuity (log MAR) at follow-up (Mean±SD)	p-value
Grade I	0.20±0.17	<0.001	0.005±0.030	<0.001
Grade II	0.56±0.22		0.088±0.119	
Grade III	0.90±0.15		0.478±0.228	

[Table/Fig-5]: Comparison of visual acuity at initial and follow-up visit across RH grades. logMAR chart (Logarithm of the Minimum Angle of Resolution).

[Table/Fig-6] shows multiple pair-wise comparisons of visual acuity at initial visit to compare each grade with one another using Bonferonni posthoc test. Significant differences were obtained among grade I vs grade II, grade I vs grade III and grade II vs grade III.

Pair	Mean difference	95% CI		p-value
		Lower	Upper	
Grade I vs Grade II	0.37	0.28	0.46	<0.001
Grade I vs Grade III	0.70	0.53	0.88	<0.001
Grade II vs Grade III	0.34	0.17	0.51	<0.001

[Table/Fig-6]: Multiple pair-wise comparisons of visual acuity at initial visit to compare each grade with one another using Bonferonni posthoc test.

[Table/Fig-7] shows multiple pair-wise comparisons of visual acuity at follow-up to compare each grade with one another using Bonferonni posthoc test. Significant differences were obtained among grade I vs grade II, grade I vs grade III and grade II vs grade III.

Pair	Mean difference	95% CI		p-value
		Lower	Upper	
Grade I vs Grade II	0.083	0.032	0.134	<0.001
Grade I vs Grade III	0.473	0.375	0.571	<0.001
Grade II vs Grade III	0.390	0.296	0.484	<0.001

[Table/Fig-7]: Multiple pair-wise comparisons of visual acuity at follow-up to compare each grade with one another using Bonferonni posthoc test.

DISCUSSION

Patients suffering from a chemical injury often present to the Emergency Department. The victims are young and exposure occurs in workplace in an industrial setting, at home, playground and rarely in association with criminal assaults. These injuries are due to acid or alkali compounds with the latter being more common. Ocular chemical injuries can result in mild injury or severe ocular damage compromising the vision. The severity of ocular injury depends on four factors: the toxicity of the chemical, how long the chemical is in contact with the eye, the depth of penetration, and the area of involvement [7]. Therefore, it is essential to take a thorough history to document these factors.

All the patients had irrigated the eyes with tap water immediately after the injury before visiting the Emergency Department. Total of 91 patients reported within one day and 36 patients after one day of injury. After obtaining a quick brief history of chemical exposure and identification of the chemical, immediate treatment is copious irrigation prior to ophthalmic examination with isotonic saline or lactate ringer solution to change the pH to physiological levels. As irrigation is the cornerstone of managing chemical burns, it is generally accepted that irrigation should be continued until the ocular surface pH has been neutralised [8]. Better initial visual acuity was observed in grade I ocular chemical injuries. This study re-emphasis the fact that immediate and extensive irrigation should be commenced immediately because this could improve the visual prognosis.

There was an obvious higher incidence of chemical injury in males 104 (81.7%) than females 23 (18.3%) similar to Bizrah M et al., [9]. This male preponderance is attributed to their increased exposure to industrial works, agricultural fields, other outdoor activities and common in low socio-economic status population. As this is a tertiary care centre, most of the victims were farmers and small scale industry workers from rural background, who presented these accidental injuries that had occurred at the fields in 57 (44.9%) cases and at workplace in 56 cases (44.1%), comparable to a study conducted on 160 hospitalised patients [10,11].

Another contributing factor is the age group were majority 51 (40.2%) of the victims were between 31-45 years and 38 (29.9%) in 15-30 years, similar to other studies [12-14]. The fact that, people of this age group are the main working member of the family. Out of 127, 95 cases (74.8%) had monocular chemical injury similar to that observed in other studies.

It is well known that widespread utilisation of alkalis as household products and in the industries are the common cause of lipophilic injuries in which the most severe damage to the ocular surface is by pH change, ulceration, proteolyzes and collagen synthesis. However, acids are equally as devastating as alkalis in severe burns. Higher the concentration and prolonged exposure results in more severe the damage [15]. Although alkali injury was noted in 74 (58.3%) cases and acid injury in 27 (21.3%) cases of which magnesium hydrochloride was the most common type of chemical and second most common was hydrofluric acid amongst acid group, sight threatening injuries was not noted in any of these patients. According to Roper Hall grading, 43 (34%) cases had grade I, 75 (59%) cases had grade II and 9 (7%) cases had grade III injury.

The most common clinical signs were conjunctival congestion (92.5%), corneal epithelial defect 107 (67.3%), corneal haze 31 (19.5%), stromal haze 19 (11.9%) and chemosis 17 (10.7%). After perilimbal fluorescein staining Limbal ischaemia of <1/3 was observed in 90 (56.6 %) and >1/3 in 9 (5.7%), which recovered by conservative management by two weeks. Continuous irrigation and removal of any particulate material after double lid eversion is mandatory to reduce the ocular morbidity. Majority of the cases improved within 7-10 days from the acute phase managed with topical medications such as preservative-free artificial tears and antibiotics as chemical injury can destroy conjunctival goblet cells, leading to a reduction or even absence of mucus in the tear film, compromising the dispersion of precorneal tear film. Systemic tetracycline to prevent enzymatic proteolysis of the corneal stroma and vitamin C that is said to act as a powerful antioxidant enhances early recovery. Topical steroids were started after 4th day which was tapered after 10 days. Complete re-epithelialisation was observed by 14 days and none of the case had raised IOP.

Visual outcome after chemical injuries depends upon the severity of the injuries. The reporting time interval to hospital is another prognostic factor for good visual outcome. Most of the patients were from outreach areas of Kolar district accounting for the delayed reporting to the hospital. Immediate irrigation with tap water would reduce the severity of ocular damage and shorten the healing time.

The mean UCVA at the initial visit and follow-up visit was 0.46±0.29 log MAR and 0.09±0.16 log MAR, respectively. (p-value <0.001, paired t-test). Paired t-test done to compare the mean visual

acuity among the RH grades also showed significant improvement (p-value <0.001, paired t-test). Posthoc analysis done for pair-wise comparisons of visual acuity across each RH grade at initial and follow-up visit as well, showed statistically significant difference (p-value <0.001).

A retrospective case series study also observed the initial BCVA in the affected eye to be 0.380.25 and the final BCVA was better than the initial (p-value >0.001). Better initial VA was observed in cases of milder ocular chemical injuries, which was seen in other studies as well [16,17]. The risk factors for poor final BCVA were identified as older age, poor initial BCVA, and irrigation 24 hour after injury (p-value <0.001, p-value <0.001, and p-value=0.011, respectively) [15].

Limitation(s)

This retrospective study might be incomplete in patient selection and data collection. Since most of the patients had lost follow-up after one month, any fluctuations in the visual outcome and the clinical condition will be missed in this short follow-up. In addition, socio-economic status was not evaluated. An educational program on comprehensive eye care should be implemented and the use of protective eyewear should be stressed to prevent occupation-related ocular chemical injuries.

CONCLUSION(S)

As ocular chemical injury is an ophthalmic emergency, patients at high-risk of chemical injuries should be reminded to take necessary precaution and ensure prompt treatment. Male dominance and workplace and field injuries were the most common in the present study. Prompt irrigation with tap water and early reporting to the hospital can reduce serious complications with early restoration of vision.

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