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# Incidence And Management of Chemical Injuries of Eye in A Tertiary Care Center in Southern Belt of Odisha,India

[*1]Dr. Ashish Bhoi, [2]Dr.SachalaBhoi, [3]Dr. Praggya Mishra[*],
[4]Dr. B.N.R. Subudhi,
*[1]Post Graduate,[2] Associate Professor, [3]Post Graduate,[4]Professor & HOD*
*Post-Graduate Department of Ophthalmology*
*M.K.C.G. Medical College & Hospital, Berhampur-760004, Odisha*
**Corresponding Auhor- Dr Praggya Mishr*a

***Abstract:*** *Chemical injuries to the eye may be of rare incidence but are not uncommon and pose one of the challenging areas of practice for ophthalmologists irrespective of area of practice**.**Chemical injuries are potentially devastating ocular surface injures that can result in permanent visual impairment. They may cause extensive damage to the eyelids, conjunctiva, cornea and anterior segment resulting in severe morbidity including permanent unilateral or bilateral blindness. As with other injuries, the nature of the chemical burning is variable and dependent on local circumstances. It is important to note the type of chemical, because the mechanism of injury varies between acidic and alkaline exposure. Acid burns is usually less severe than that caused by alkali burn. When acid comes in contact with corneal surface they cause coagulation of tissue protein forming a barrier, which prevents deep penetration.But alkalis, in contrast, cause saponification of cellular lipids disrupt the normal barrier of the cornea resulting in deep penetration to internal structures causing severe damage to the lens and anterior uvea.*

***Objective****: To study the incidence and management of chemical eye injuries in a tertiary care hospital in southern Odisha.*

***Design****: The present hospital based observational study was undertaken in department of ophthalmology at MKCG MEDICAL COLLEGE AND HOSPITAL, BERHAMPUR, ODISHA between OCT 2015 to SEP 2017, which is a period of 2 years. A total 84 patients were included in the study after counselling and written informed consent was also taken individually in each case.*

***Results:*** *Males were mostly affected(83.34%), incidence of injury was (11.2%), age group of 21-30 years were mostly affected, alkali (42.86)% was the most common causative agent, 85.72% of cases were unilateral, grade 2 injury being most common(39.58%), corneal scarring was the most common complication.*

***Conclusion:*** *majority of cases of chemical injury of eye are likely to be minor and in those where significant injury has occurred, early and intensive management may secure a good prognosis and minimize long term consequences.*

***Keywords:*** *acid, alkali, chemical injuries, saponification, complications, consequences*

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## I. Introduction

Chemical injuries to the eyes are common and represent one of the true ophthalmic emergencies. Practically any chemical can cause ocular irritation. Most of these injuries are inconsequential and do not cause serious lesions (e.g. shampoos, defence sprays, household cleaning solutions etc.) while other may result in permanent morbidity. Severe ocular damage is most commonly associated with strong alkaline or acidic compounds. Chemical injuries are potentially devastating ocular surface injures that can result in permanent visual impairment. They may cause extensive damage to the eyelids, conjunctiva, cornea and anterior segment resulting in severe morbidity including permanent unilateral or bilateral blindness. As with other injuries the nature of the chemical burning is variable and dependent on local circumstances. It is important to note the type of chemical, because the mechanism of injury varies between acidic and alkaline exposure. Common acids are sulphuric acid (car batteries), hydrofluoric acid (glass polishing), acetic acid, hydrochloric acid and nitric acid(gold maker). Common alkalis are lime(plaster),ammonia/ammonium hydrochloride (cleaning solution, drain cleaner), potassium hydrochloride, magnesium hydrochloride (fireworks). The pathophysiology [1] of chemical burns is extremely varied.Acid burns is usually less severe than that caused by alkali burn. When acid comes contact with corneal surface they cause coagulation of tissue protein forming a barrier, which prevents deep penetration. But alkalis in contrast, cause saponification of cellular lipids disrupt the normal barrier of the cornea resulting in deep penetration to internal structures causing severe damage to the lens and anterior uvea.

In severe cases phthisis bulbi may be the tragic endresult . Chemical injury is the one of the true ophthalmic emergencies and it needs immediate management. Chemical burns have a major impacts in terms of long term morbidity and so is a matter of major socio-economic importance. The sequels of chemical burn may have significant detrimental visual and psychological effects on the affected individual. Ocular burns usually lead to opacification of cornea resulting in loss of vision[2].Proper management in the acute setting as well as follow-up by an ophthalmologist is crucial 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 disabilities incurred and the outcome of treatment.

## II. Materials And Methods

### 2.1 Materials:

All the referred cases of chemical injuries to the eye as well as the new cases attending the eye O.P.D. and casualty of MKCG Medical College and Hospital, during the study period from 01.10.2015 to 30.09.2017 were taken into account. According to the severity of injuries some cases were treated on an out- patient basis and those requiring intensive measure were admitted to the indoor of this department.

### 2.2 Methods

The study conducted was a hospital based observational study. A detailed clinical history of each case was taken with reference to name, age, sex, address and occupation. With particular reference to time since injury, place of injury and the chemical involved in each case made. Patient's chief complaint, personal history and past history were also noted.After history taking, a thorough ocular examination (including normal eye) was done by all the available instruments. The conditions of ocular adnexa, conjunctiva, cornea, sclera, anterior chamber, iris, pupil and lens were evaluated by both naked eye examination with torch light illumination and slit- lamp examination. Fundoscopy was done by direct and indirect ophthalmoscope wherever possible. Distant visual acuity was recorded by Snellen's chart. Intraocular pressure was recorded and lacrimal passage irrigation was done whenever indicated. General examination and systemic examination was done in each case. Routine investigations and some special investigations were advised whatever required in some selected cases In order to institute a proper course of treatment and to estimate the eventual prognosis, all the patients were graded according to the severity of injury. Modified Hughes Grading of Ocular Chemical Injuries (2009) was taken in this account.

| **Grade of Injury** | **Clinical Findings** | **Prognosis** |
|---|---|---|
| Grade-I | No corneal opacity<br>No limbal ischemia | Excellent |
| Grade-II | Corneal haziness, but visible iris details, ischemia < 1/3 of limbus | Good |
| Grade-III | Significant corneal haziness to obscure iris details, ischemia 1/3 to ½ of limbus | Guarded |
| Grade-IV | Cornea is opaque, no view of iris or pupil, Ischemia > ½ of limbus, Ischemic necrosis of proximal conjunctiva and sclera. | Dismal |

All the patients were treated by available therapeutic measures in best possible conservative way. Patients of grade 1 and grade2 injuries were treated in the line of following conventional technique.

1. Immediate removal of chemical by thorough wash with normal saline.
2. Neutralization of chemicals wherever possible (sodium bicarbonate 3.2% solution was used in acid burns)
3. Topical antibiotics and Atropine (1%)
4. Glass rod passed in the fornix.
5. Patching of the injured eye.
6. Systemic antibiotics, anti-inflammatory agents, acetazolamide and vitamin-C.
7. Cautious use of local steroids.

In cases of grade-3 and grade-4 injuries, along with above mentioned measures, some special therapy was also instituted.
These include

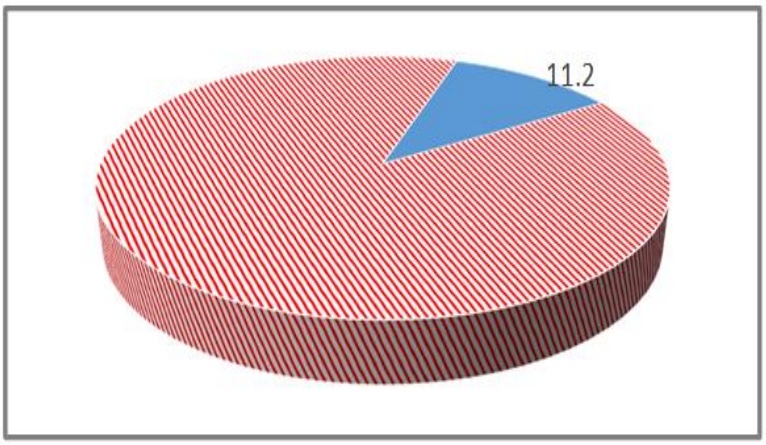
1. Instillation of 10% ascorbic acid solution (reconstituted from injectable preparation) frequently for first 48 hours followed by 4 times a day.
2. Intravenous infusion of amino acid preparations (Astimin)
3. Autohemotherapy, subconjunctival injection of 0.5 cc of the patient's own blood was given and repeated every alternate day as necessary.
4. Topical steroid was used after the corneal epithelium had regenerated.All the patients were followed up for a variable period of time extending from 1 week to 3 months, according to the grade of injury. In each follow up visit ocular condition was thoroughly examined and distant visual acuity was recorded.

## V. Results

In this present study, 84 cases of chemical injury of eye were taken into account. They were of different age group and mostly were unilateral. Different varieties of injurious agents and mode of injuries were noted. All the injuries were classified according to Modified Hughes grading and they were managed by best available conservative methods, according to the severity of injury. The visual improvement in each and every cases during the follow up period a maximum of 3 months were observed and compared with the initial visual acuity. The various data gathered from the present study are given below and simultaneously a comprehensive discussion of the observations were made.

**Table – I** Incidence Of Chemical Injury In Relation To Total Number Of Ocular Trauma

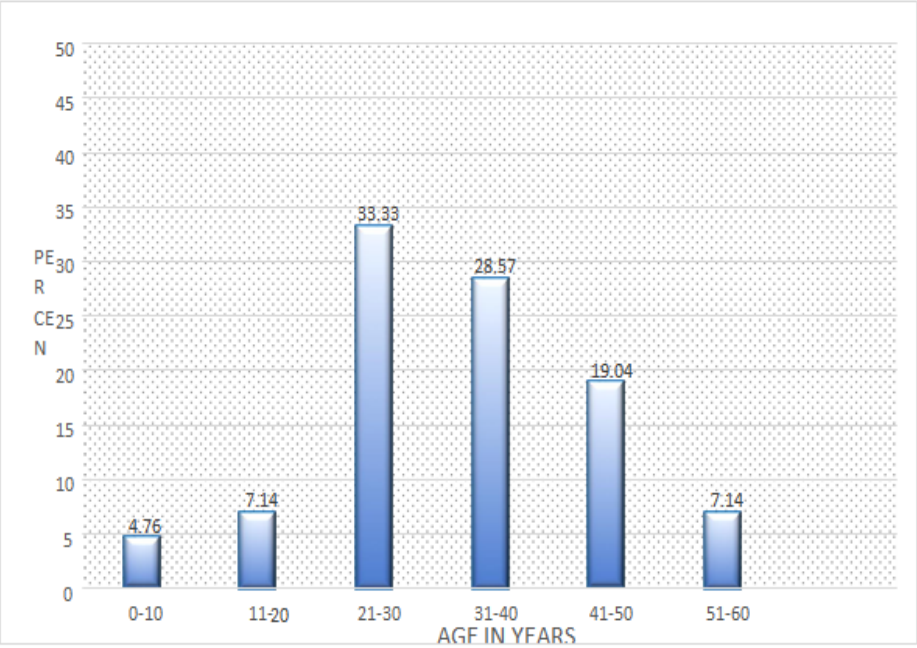
| Total No of Chemical Injury | Total No of Ocular trauma | Percentage |
|---|---|---|
| 84 | 750 | 11.2 |




The above table indicates that 84 cases of chemical injuries of eye were observed among 750 cases of ocular trauma attended in the OPD and casualty during the study period. The percentage was 11.2%. The incidence of chemical injury; reported by Verson SA et al[3](1983) was 7% to the total number of ocular trauma. Study by Jones N.P et al[4](1986), reported the incidence of 9.9% of all ocular trauma. But Karamanet al[5](2004) and Ho.C.K.Yen et al[6](2007) reported the incidence of 13.6% and 19.6% of all ocular trauma respectively.It means chemical injury cases increase due to vast use of chemicals in many fields, industries and day to day works. In the present study, the incidence of chemical injury was 11.2% of all ocular trauma, which seems to be higher in comparison to the 1983 and 1986 studies, but less than 2004 and 2007 studies. This is probably due to that most of the cases were referred to this hospital from other peripheral hospitals, as it serves as a major referral centre in this area.

**Table – II** Chemical Injury Showing Age Incidence

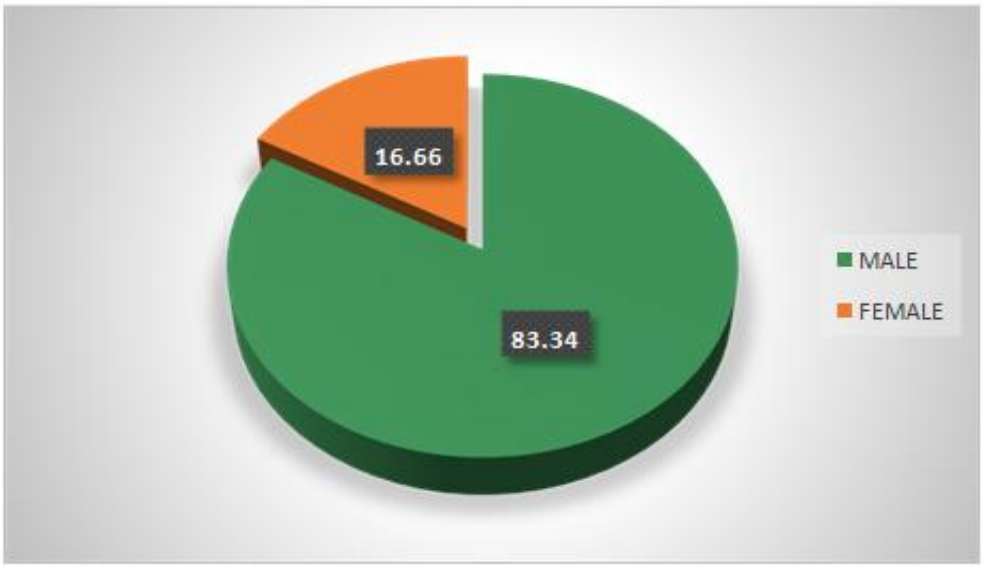
| Age in year | Number | Percentage |
|---|---|---|
| 0-10 | 4 | 4.76 |
| 11-20 | 6 | 7.14 |
| 21-30 | 28 | 33.33 |
| 31-40 | 24 | 28.57 |
| 41-50 | 16 | 19.04 |
| 51-60 | 6 | 7.14 |




In this series the incidence of chemical injury in patients below 10 years was 4 (4.76%) and between 11 to 20 years, it was 6 (7.14%) and between 21 to 30 years it was 28 cases (33.33%) were observed, which was the highest so far. 24 cases (28.57%) were encountered in the age group of 31 to 40 years and 16 cases (19.04%) were in the age group of 41 to 50 years. In the group of 51 to 60 years of age, 6 cases (7.14%) of chemical injuries of eye were found. This higher percentage of chemical injury was observed in the age group of 21 to 30 years (33.33%) and 31 to 40 years (28.57).This is due to the fact that, people of this age group are the main working member of the society. P.Singh et al[7](2013) also studied and found that the chemical injury patients are mostly found in age group between 20 to 40yrs. Aleksandra Radosavljevic et al[8](2013) also reported that in between 21-40years ocular chemical injury constituted of 48.5%.

**Table – III** Sex Incidence of Chemical Injury

| | **Total Number** | **Percentage** |
|---|---|---|
| Male : | 70 | 83.34 |
| Female : | 14 | 16.66 |



Out of total 84 cases of chemical injury, 70 cases (83.34%) were found to be male and 14 cases (16.66%) were female.Marijamatovicet al[9] (2014) found that males were more often reported with injures than females (66.37% vs. 33.63%).Subrat das et al[10](2015) found that male to female ratio was 1.7:1. Males between 21-30 years and 41-50 years were mostly affected whereas females of 41-50 were affected most.Preponderance of male to chemical injury is more because of their more exposure to industrial works, agricultural fields and other outdoor activities.

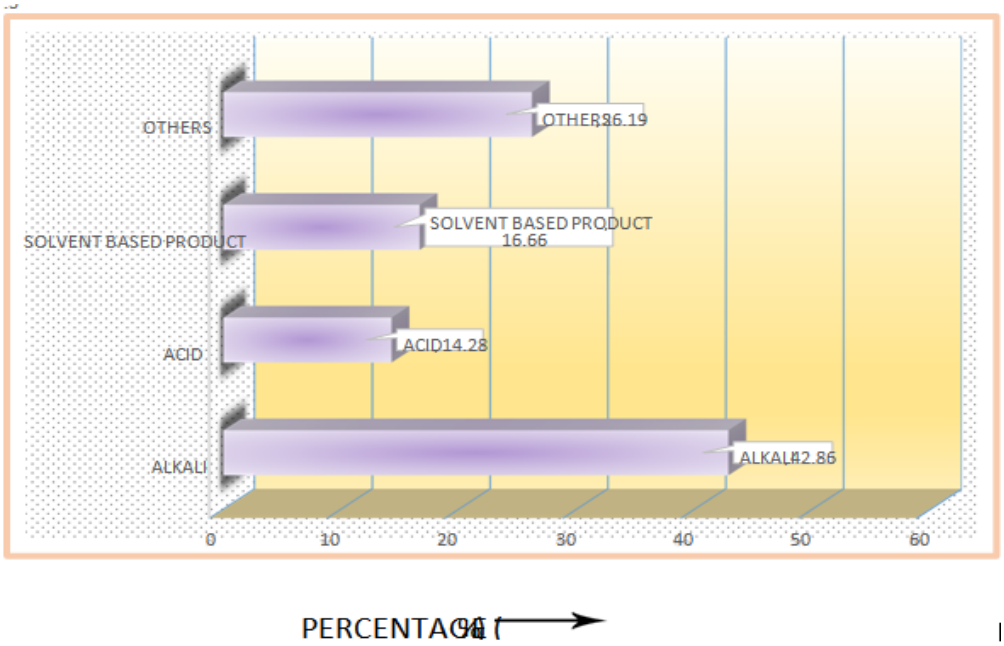
**Table –** IV Laterality Of Chemical Injury

| | **Total Number** | **Percentage** |
|---|---|---|
| Unilateral : | 72 | 85.72 |
| Bilateral : | 12 | 14.28 |

Out of 84 cases, unilateral involvement of either right or left eye was found in 72 cases (85.72%) whereas bilateral involvement was in 12 cases (14.28%).Aleksandra Radosavljevic et al[8](2013) reported in his study that unilateral cases are more that of 63.5% than the bilateral of 36.5%.

**Table – V** Types of Chemical Agents Involved

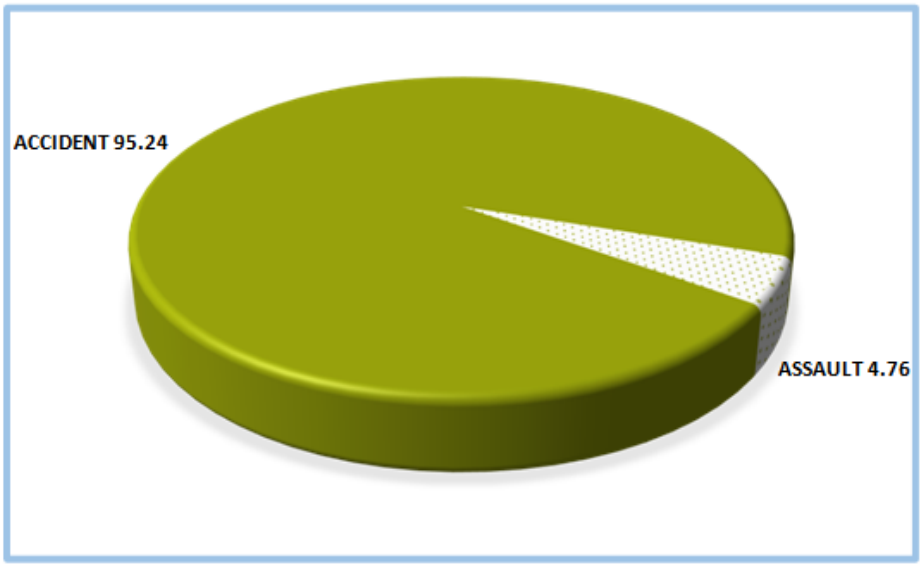
| **Chemical Agent** | **Number** | **Percentage** |
|---|---|---|
| Alkali | **36** | 42.86 |
| Acid | **12** | 14.28 |
| Solvent based product | **14** | 16.66 |
| Others | **22** | 26.19 |




Above table shows that 36 cases (42.86%) of chemical injury were caused by alkalis and 12 cases (14.28%) by acids. Solvent based products were responsible for 14 cases (16.66%) and rest 22 cases (26.19%) were caused by other agents. Aleksandra Radosavljevicet al[8](2013) found in his study that 73% were affected by alkali chemical injury and only 18.2% affected by acids. Nimmymerin Mathew et al[11] (2017) in a study found among the 34 eyes with chemical injury, 52.9% were alkali injuries, 32.4% were acid injuries and rest due to other chemicals.

**TABLE – VI** Modes Of Chemical Injury

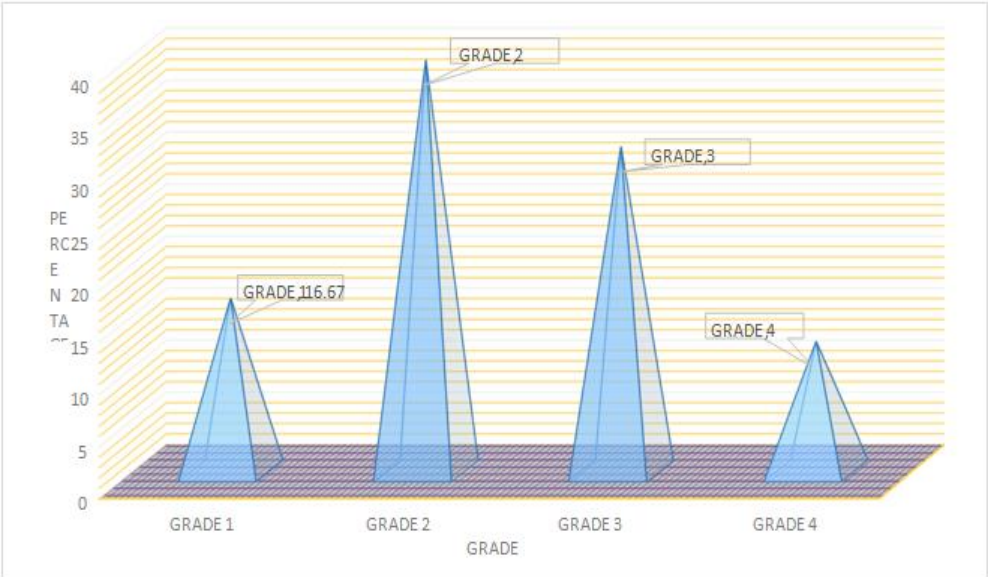
| | **Number** | **Percentage** |
|---|---|---|
| **Assault :** | 4 | 4.76 |
| **Accident :** | 80 | 95.24 |
| i) Industrial | 30 | 35.71 |
| ii) Domestic | 26 | 30.95 |
| iii) Laboratory | 6 | 7.14 |
| iv) Agriculture | 6 | 7.14 |
| v) Others | 12 | 14.28 |




Out of 84 cases considered in this study 80 cases (95.24%) were the result of accidents and 4 cases (4.76%) were due to assaults. Out of 80 accidental injuries, 30 cases (35.71%) were industrial accidents and 26 cases (30.95%) were domestic accidents. 6 cases (7.14%) were caused by laboratory accidents and 6 cases (7.14%) by agricultural accidents. Rest 12 cases (14.28%) were as a result of various type of other accidents like injury during building automobile works. In the study of S.J. Morgan et al[12](1987), the percentage of assault cases was 10.6% and that of accident cases was 89.4%. In the present study, the percentage of assault cases is quite low in comparison to the above study.P. Singh et al[7](2013) found in the study that industrial chemical injury cases were 61%, domestic injury cases were 37% and others constituted of only 2%.Aleksandra Radosavljevic et al[8](2013) studied and found that 20.3% ocular injuries were found in work place and 28.4% in home and did not give any data about 49.3%.

**TABLE – V11 Severity Of Chemical Injury**
**(Modified Hughes Grading)**

| | Number of eyes | Percentage |
|---|---|---|
| Grade-1 | 16 | 16.67 |
| Grade-2 | 38 | 39.58 |
| Grade-3 | 30 | 31.25 |
| Grade-4 | 12 | 12.50 |



Among 84 cases, some had unilateral and some had bilateral eye involvement, so that total number of eyes affected was 96. Above table shows that 16 cases (16.67%) were of grade-1 and 38 cases (39.58%) were in grade -2 injury. Grade -3 injury was found in 30 cases (31.25%) and grade – 4 injury in 12 cases (12.50%). Aleksandra Radosavljevic et al[8](2013) found in his study and concluded that Grade-1 chemical injury constituted of only 4%,Grade-2 of 31.1%,Grade-3 of 42.6% and Grade-4 of 18.3%(in 4% no data available).It is concluded that Grade-2 and Grade-3 ocular chemical injuries constituted most cases.

**Table-VIII Visual Outcome In Relation To Grade Of Injury**

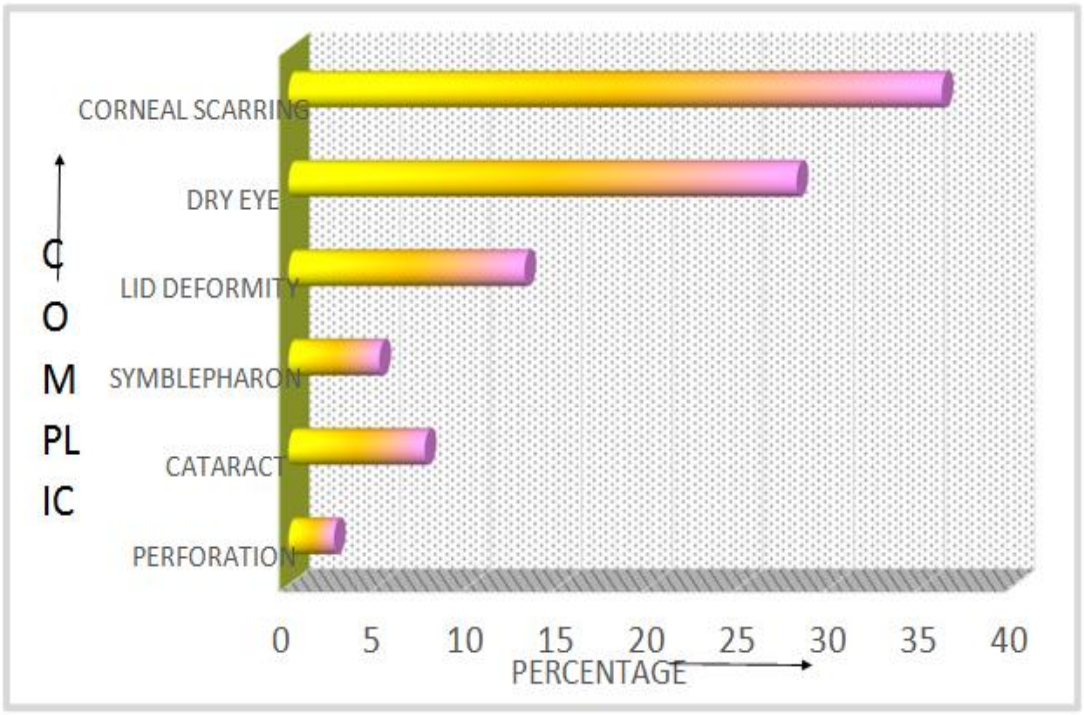
| Grade of injury | Total No. of eyes | Visual acuity | No. of Pretreatment eyes | No. of Post treatment eyes |
|---|---|---|---|---|
| Grade-1 | 16 | 6/6 | 4(25%) | 16(100%) |
| | | 6/9 | 12(75%) | |
| Grade-2 | 38 | 6/6 | None | 38(100%) |
| | | 6/9 | 8(21.05%) | - |
| | | 6/12 or 6/18 | 24(63.15%) | - |
| | | >6/60&<6/18 | 6(15.8%) | - |
| Grade-3 | 30 | 6/18 or better | None | 18(60%) |
| | | >6/60&<6/18 | 4(13.33%) | 8(26.67%) |
| | | >1/60 &<6/60 | 24(80%) | 4(13.33%) |
| | | HM | 2(6.67%) | - |
| Grade-4 | 12 | CF | None | 2(16.67%) |
| | | HM | 8(66.67%) | 2(16.67%) |
| | | PL | 4(33.33%) | 6(50%) |

Above table shows the following observations -

1. Out of 16 eyes having the grade – 1 injury, the pre-treatment VA was 6/6 in 4 eyes (25%) and 6/9 in 12 eyes (75%). After receiving treatment, the best corrected VA became 6/6 in all 16 cases. The success rate in visual improvement was 100%.
2. Out of 38 eyes having grade-2 injury, the initial VA was 6/9 in 8 eyes (21.05%) 6/12 or 6/8 in 24 eyes (63.15%) and in rest 6 eyes (15.8%) VA was better than 6/60 but worse than 6/18. The best corrected VA after treatment was 6/6 in all the 38 eyes. So here also the success rate was 100%.
3. Total No of eyes with grade-3 injury were 30. Out of this, initial VA was better than 6/60 but worse than 6/18 in 4 eyes (13.33%), better than 1/60 but worse than 6/60 in 24 eyes(80%) and HM only was present in 2 eyes (6.67%). After treatment, the best corrected VA was improved to 6/18 or better in 18 eyes (60%). In 8 eyes (26.67%) corrected VA improved to 6/60 or better and in 4 eyes (13.33%) best corrected VA improved to better than 1/60.
4. Out of 12 eyes with grade – 4 injury, the VA before treatment was HM in 8 eyes (66.67%) and perception of light in 4 eyes (33.33%). After treatment the best corrected VA was CF in 2 eyes (16.67%) HM in 2 eyes (16.67) and PL in 6 eyes (50%). In 2 eyes of this group caused by alkali in an industrial accident, there was perforation followed by infection which was finally eviscerated.Nimmymerin Mathew et al[11] (2017) in a study found among the 34eyes with chemical injury on review after 2 months, 30 eyes had best corrected visual acuity improved to 6/6 - 6/18 (88.2%). Still, 3 eyes (8.8%) had their visual acuity in the range of 6/24 - 3/60 and one eye had visual acuity<3/60.

**Table-VIII incidence of Complication**

| Complications | Number of cases | Percentage |
|---|---|---|
| Corneal Scarring : | 34 | 35.38 |
| i) Mild Scarring | 10 | 10.4 |
| ii) Moderate scarring | 16 | 16.66 |
| iii) Severe scarring | 8 | 8.32 |
| Dry eye : | 26 | 27.04 |
| Lid deformity | 12 | 12.48 |
| Symblepharon | 4 | 4.16 |
| Cataract | 6 | 6.24 |
| Perforation | 2 | 2.08 |




During the course of treatment and follow up period, several cases were found to have some complication. In 34 eyes (35.38%) there was corneal scarring, out of which mild scarring was observed in 10 eyes (10.4%), moderate scarring in 16 eyes (16.66%), whereas the cornea was severely scarred in 8 eyes (8.32%). Dry eyes were found in 26 eyes (27.04%), most of which were due to either severe scarring of cornea or due to lid deformity. The lid deformity of various types was found in 12 eyes (4.16%). Symblepharon was seen in 4 eyes (4.16%). Cataract as a complication of chemical injury was found in 6 eyes (6.34%). In those eyes having severe corneal scar, the detection of cataract was not possible. In 2 eyes (2.08%) there was perforation followed by infection which was finally subjected to evisceration.

## VI. Discussion

The present study was conducted in the Dept. of Ophthalmology, MKCG Medical College and Hospital, BERHAMPUR between October 2015 to September 2017.Out of the total 750 cases of ocular trauma attending the OPD and casualty, 84 cases of chemical injury of the eye were accounted. All the cases were studied in detail and they were graded according to Modified Hughes grading system. The best possible and available conservative methods of treatments was given to every cases depending upon the severity of injury. All the cases were followed up for a maximum period of 3 months. The observations made in this study are as follows. The incidence of chemical injury in relation to the total number of ocular trauma during the study period was 11.2%.The incidence of chemical injury was found to be maximum in the age group of 21 to 30 years, which was 33.33%. It was followed by 28.57% in the age group of 31 to 40 years. The incidence was 7.14% each in the age group of 11 to 20 years and 51-60 years. And in the age group of 41 to 50 years, the incidence was 19.04%. The lowest incidence of 4.76% was encountered in the age group below 10 years. Higher incidence of chemical injury was found in male (83.34%) than female (16.66%).Most of the cases of chemical injury were unilateral (85.72%).Chemical agents involved in ocular trauma were alkali in 42.86%, acid in 14.28% and solvent based products16.66%. Rest 26.19% was caused by various other agents. Mode of chemical injury was mostly accidental (95.24%) and very few was due to assault (4.76%). Among accidental injuries, industrial accidents (35.71%) and domestic accidents (30.95%) together accounted for over half the cases. According to the severity of injury (using Modified Hughes Grading), grade – 2 (39.58%) and grade – 3 (31.25%) injury were found in most of the eyes. Incidence of grade–1 (16.67%) and grade–4 (12.50%) injury was relatively less. After treatment, visual outcome was observed in relation to the grade of injury. In all the eyes having grade-1 and grade-2 injury, the best corrected visual acuity improved to 6/6 with a 100% result. In grade-3 injury, the best corrected VA improved to 6/18 or better in 60% of

eyes and in 27.67% of eyes it was better than 6/60 but worse than 6/18. In 13.33% of eyes, the best corrected visual acuity was better than 1/60 but worse than 6/60. In eyes with grade-4 injury, post-treatment VA was PL only in 50% of eyes, where as in 2 eyes vision improved to counting finger closed range and in 2 eyes it remained hand movement. 2 eyes of this grade of injury was complicated by perforation and infection which was finally eviscerated. Corneal scarring, the most common complication in this series, was found in 35.38% of eyes involved. This was followed by dry eye detected in 27.04% of eyes and lid deformity observed in 12.48% of eyes involved. Other complication like symblepharon, cataract and perforation were relatively less.

## VII. Conclusion

Chemical injuries of the eye, though constitutes a small fraction of ocular trauma, its socio-economic importance is significant; as at times, some of the chemical injuries are potentially blinding. The activities of the individual play an important role in the causation of injury. The incidence of such injury extends mostly in the industrial fields and some other outdoor activities. So a large number of cases must be preventable by the provision and use of adequate eye protection at work. Men of young working age are clearly the most at risk group and also the most resistant to the use of any kind of protection.The type of the chemical involved is another important factor to determine the severity of injury. Notably, those involving strong alkalis cause more damage and visual disability. Immediate and copious irrigation with bland sterile solutions and removal of all solid particles should always precede a full history and examination. In the treatment of mildest chemical injury topical steroids, antibiotics and padding may be all that is required. But in cases with severe injury, intensive management with topical antibiotics, mydriatics, steroids, Ascorbate along with systemic anti-inflammatory agents, antibiotic, vitamin-C, acetazolamide are often rewarding. Autologous haemotherapy should be considered in some places where there is chance of symblepharon formation and corneal perforation. New surgical procedures like limbal stem cell transplantation, amniotic membrane transplantation, tenoplasty, keratoplasty and use of keratoprosthesis are the revolutionary effective treatment in case of severe ocular chemical injuries.From these facts, it can be concluded that the majority of cases of chemical injury of eye are likely to be minor and in those, where significant injury has occurred, early and intensive management may secure a good prognosis and minimize long term sequelae.

**Conflict Of Interest: Nil**

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