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Visual and Clinical Outcome in Patients with Corneal Lacerations

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***Abstract*—**In industrialized nations, corneal lacerations are one of the most common reason for hospitalization. This study was designed to study visual and clinical outcome in patients presenting with full thickness corneal lacerations in Indian population and to ascertain the impact of various preoperative and operative factors influencing prognosis after repair of corneal lacerations. Males in third decade with injuries at work with metallic objects were common. Lens damage, hyphema, vitreous hemorrhage, retinal detachment and endophthalmitis were seen. All the patients underwent primary repair within first 24 hours of presentation. At 3 months, 74.3% had a good visual outcome. About 5.7% of patients had no perception of light.In conclusion, various demographic and preoperative factors like age, time of presentation, vision at presentation, length of corneal wound, involvement of visual axis, associated ocular features like hyphaema, lenticular changes, vitreous haemorrhage and retinal detachment are significant prognostic indicators for final visual outcome.

***Keywords*—**Cornea, laceration, visual outcome, wound repair.

I. Materials and Methods

THIS is a prospective, non-randomised, observational study conducted at Bangalore West Lions Super speciality Eye Hospital, Bangalore, which is a tertiary centre. A period of 25 months extending September 2010 to October 2012 was considered. A sample size of 35 was taken.

A. Inclusion Criteria

- (All age group) zone 1 full thickness corneal lacerations.

B. Exclusion Criteria

- Pre-existing corneal opacities or corneal degenerations,
- Corneo-scleral lacerations,
- Double perforating injuries,
- Surgical wound ruptures,
- Eyes having prior ocular surgery.

C. Patient Particulars

The age, gender, locality and socioeconomic status based on occupation, literacy and annual income were taken into consideration.

D. History and Examination

A detailed history was taken in each case. History of date, time, mode, mechanism (blunt/penetrating) of injury, associated IOFB and associated symptom was taken. Use of protective eye wear, consumption of alcohol/drugs and immunization status was inquired. History of any systemic disease was taken. Visual acuity was checked for both the eyes. A detailed slit lamp examination was done to examine the lids, lacrimal apparatus, conjunctiva, cornea, pupil, iris and status of the lens. A detailed diagram of the corneal laceration with colour coding was documented. Full thickness wound was confirmed by demonstrating Seidel's positive test. The characteristics of the laceration-site, length, depth, edges, visual axis involvement, presence of hyphema, hypopyon, anterior chamber depth, and content and any other additional details were recorded. A gentle B-scan was done for posterior segment evaluation. A routine systemic examination was performed. Investigations including X-ray orbit (if suspected IOFB), Hb%, RBS, ECG, BP was done for all patients.

E. Informed Consent

The study was approved by the ethical committee. Informed consent was taken for all patients undergoing the procedure. A separate guarded prognosis form was also attached. After signing a informed consent all the 35 patients included in the study underwent a complete medical assessment by physician and a well trained staff.

F. Preoperative Management

All patients were started on intravenous antibiotics and systemic corticosteroids.

G. Surgical Management

Corneal laceration repair was done under general anaesthesia for all patients. All wounds underwent exploration to their full extent and prolapsed iris, uvea, vitreous was either reposited or excised. If anterior capsule was damaged, loose lenticular matter was removed by aspiration. Corneal wounds were closed with interrupted No. 10-0 nylon sutures. Anterior chamber was reconstituted with saline to ensure watertight closure.

H. Postoperative Management

Postoperatively patients were administered topical broad-spectrum antibiotic and corticosteroid drops. Adjunctive treatment included anti glaucoma medication or/and cycloplegics. The patients were examined on 1st day, 7th day, 1 month and 3 months as follow-up.

II. Results

35 patients met the eligibility criteria and came for regular follow up. Thus, 35 eyes formed the study group. The results of the study were tabulated and analyzed as follows:

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TABLE I
AGE DISTRIBUTION OF PATIENTS

Age (in years)	No. of patients	Percentage (%)
0-20	20	57.1
20-40	9	25.7
40-60	6	17.2

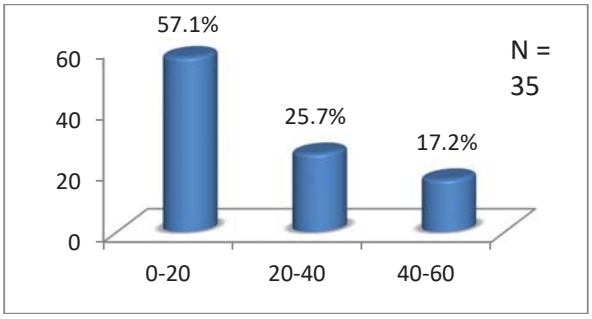

Fig. 1 Bar graph showing age distribution

Maximum numbers of our patients were in the age group of 0-20 years, accounting for 57.1%. The mean age of presentation in our study was 22.8 years. The youngest patient was 3 years of age and the oldest patient was 60 years of age in our study group.

TABLE II
GENDER DISTRIBUTION

Gender	No. of patients	Percentage (%)
Male	29	82.8
Female	6	17.2

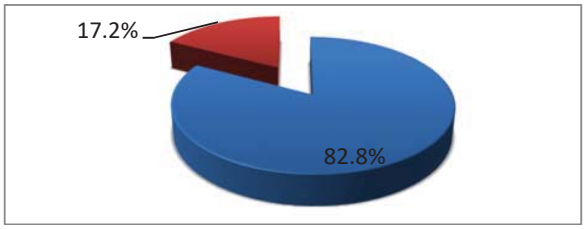

Fig. 2 Pie graph showing gender distribution

Majority of patients in our study were males accounting for 82.8% as compared to females forming 17.2%.

TABLE III
LATERALITY

Eye	No. of patients	Percentage (%)
Right	16	45.7
Left	19	54.3

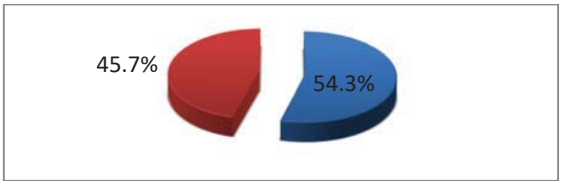

Fig. 3 Pie graph showing laterality of corneal lacerations

Most of the patients in our study group had involvement of left eye accounting for 54.3%.

TABLE IV
MECHANISM OF INJURY

Mechanism	No. of patients	Percentage (%)
Penetrating	33	94.3
Blunt trauma	2	5.7

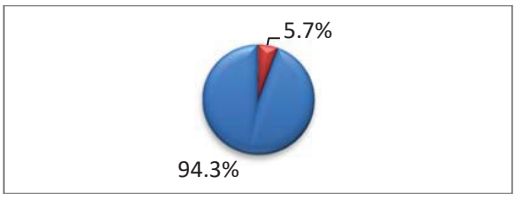

Fig. 4 Pie graph showing mechanism of injury

In our study 94.3% patients had penetrating type of injury while only 5.7% had blunt trauma.

TABLE V
MODE OF INJURY

Objects	No. of patients	Percentage (%)
Metallic	20	57.1
Stone	3	8.6
Wooden	9	25.7
Misc.	3	8.6

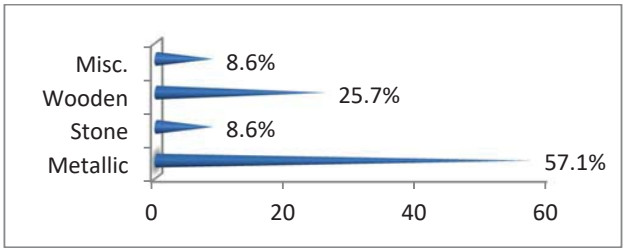

Fig. 5 Bar graph showing mode of injury

Metallic objects were common mode of injury accounting for 57.1% in our study. Next were the wooden particles and stone accounting for 25.7% and 8.6% injuries respectively.

TABLE VI
ACTIVITY DURING INJURY

Activities	No. of patients	Percentage (%)
Work	17	48.6
Play / Recreations	13	37.1
Assault	5	14.3

In our study, 48.6% of the patients had work related injuries, 37.1% had injury during recreational activities while assault accounted for rest 14.3%. None of the patients were using protective eyewear. There was no history of consumption of alcohol or drug abuse.

77.2% of patients presented to our hospital within 24 hours of injury while 11.4% presented after 72 hours of injury. Most of the patients presented with visual acuity < 20/400 accounting for 68.6% while only 17.1% patients presented with visual

acuity > 20/70. In our study, 54.3% of the patients presented with < 4mm of corneal laceration, 31.4% had length of laceration between 4-8mm and 14.3% had >8mm of laceration.

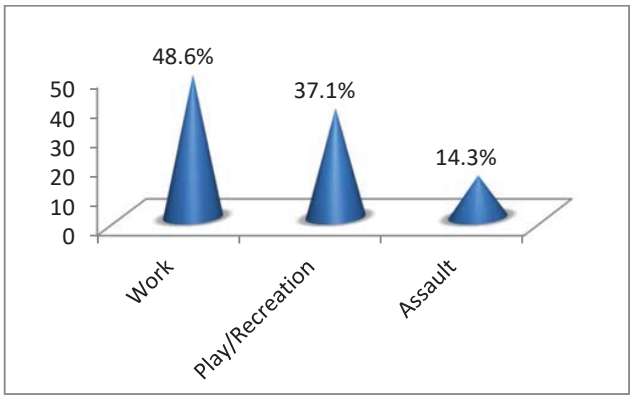

Fig. 6 Bar graph showing time of presentation of the patients

TABLE VII
TIME OF PRESENTATION

Time	No. of patients	Percentage (%)
Within 24 hrs	27	77.2
Within 48 hrs	0	0
Within 72 hrs	4	11.4
>72 hrs	4	11.4

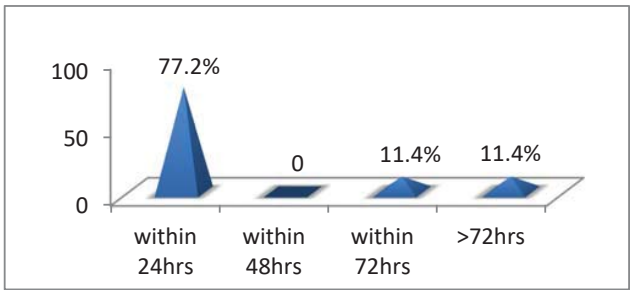

Fig. 7 Bar graph showing time of presentation of the patients

TABLE VIII
VISION AT PRESENTATION

Vision	No. of patients	Percentage (%)
>20/70	6	17.1
20/70 – 20/200	5	14.3
20/200 – 20/400	0	0
<20/400	24	68.6

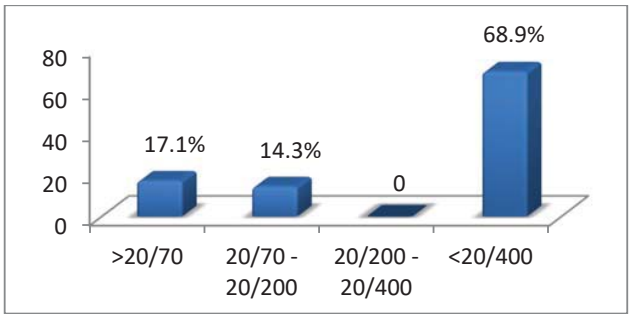

Fig. 8 Bar graph showing vision at presentation

TABLE IX
LENGTH OF CORNEAL LACERATION

Length of laceration	No. of patients	Percentage (%)
< 4mm	19	54.3
4mm – 8mm	11	31.4
>8mm	5	14.3

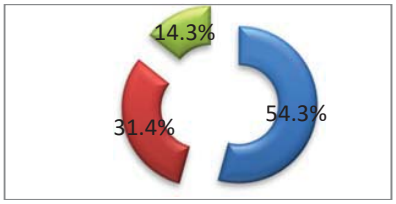

Fig. 9 Pie graph showing length of corneal laceration

TABLE X
VISUAL AXIS INVOLVEMENT

Visual axis involvement	No. of patients	Percentage (%)
Yes	11	31.4
No	24	68.6

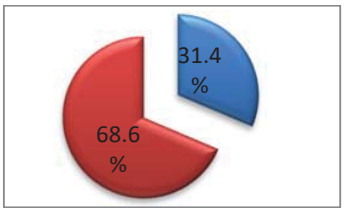

Fig. 10 Pie graph showing involvement of visual axis

In our study, 31.4% of the patients with corneal laceration showed involvement of visual axis.

TABLE XI
ASSOCIATED OCULAR DAMAGE AT PRESENTATION

Ocular damage	No. of patients	Percentage (%)
Iris prolapse	20	57.1
IOFB	3	8.6
VH	13	37.1
Lenticular changes	16	45.7
Hyphaema	14	40
Hypopyon	2	5.7

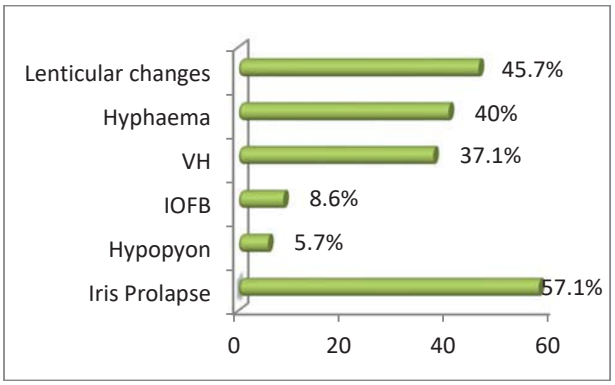

Fig. 11 Bar graph showing associated ocular damage at presentation

57.1% of the patients had iris tear/prolapse, 45.7% had associated lenticular changes, 40% had hyphaema and 37.1% had vitreous haemorrhage. IOFB (2 in vitreous cavity and 1 embedded in corneal stroma) and hypopyon was seen in 8.6% and 5.7% patients respectively.

TABLE XII
INTERVENTIONS

Interventions	No. of patients	Percentage (%)
Additional Procedure	**17**	**48.6**
• Cataract Extraction	14	
• Vitrectomy	5	
- Scleral Buckle	1	
- Silicon oil injection	3	
• Reposition of iris/Resuturing	1	
• Pupiloplasty	1	

48.6% underwent additional surgical procedures like lens aspiration, core vitrectomy, vitrectomy with silicon oil/scleral buckle etc. for 3 months follow-up period.

TABLE XIII
BCVA AT 3 MONTHS

Vision	No. of patients	Percentage (%)
>20/70	26	74.3
20/70 – 20/200	4	11.4
20/200 – 20/400	0	0
<20/400	3	8.6
PL –ve	2	5.7

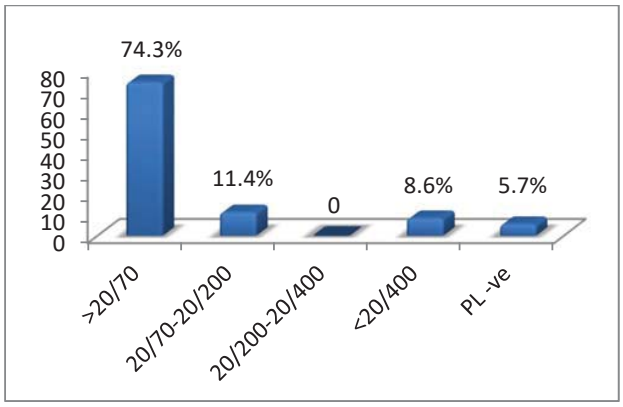

Fig. 12 Bar graph showing BCVA at end of 3 months follow-up

At the end of 3 months follow up 74.3% of the patients had visual acuity >20/70. Presumed cause for decreased vision were influence of residual corneal opacity, astigmatism, resolving VH, unsettled RD, lenticular changes and sequel of endophthalmitis/removal of IOFB.

TABLE XIV
TIME OF PRESENTATION

Vision	No. of patients	Percentage (%)
>20/70	18	66.7
20/70 – 20/200	4	14.8
20/200 – 20/400	0	0
<20/400	3	11.1
PL –ve	2	7.4

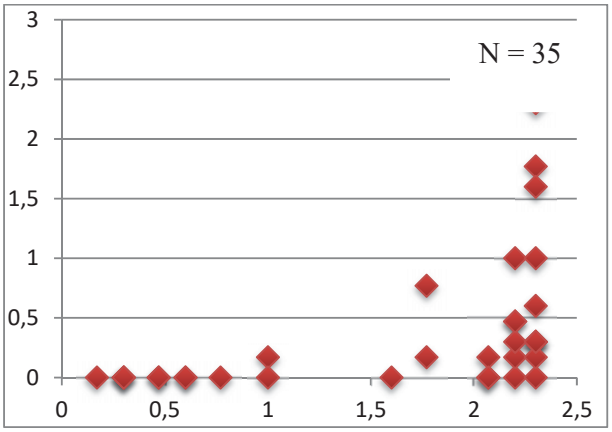

Fig. 13 Scatter graph showing vision at presentation and final vision after 3 months follow up

The chart represents the change in visual acuity of 35 patients taking into account the vision at presentation and the BCVA at the end of 3 month follow-up.

III. ANALYSIS OF PROGNOSTIC FACTORS

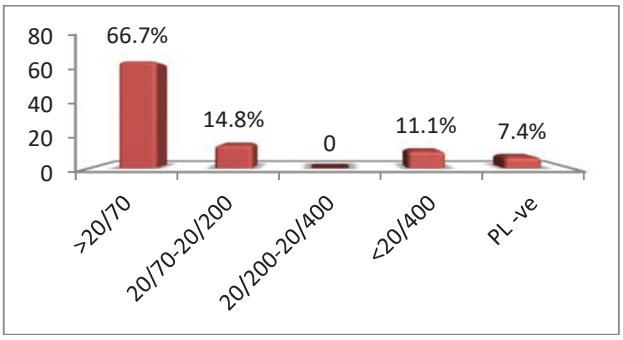

Fig. 14 Bar graph showing visual outcome of patients who presented within 24 hours of injury

In our study, out of 77.1% of the patients who presented within 24 hours of the injury, majority of them i.e. 66.7% had the visual acuity of >20/70 after 3 months. This was statistically significant with p=0.013. In our study, 94.3% of the patients had penetrating injury, out of them 75.7% had the visual acuity >20/70 after 3 months. 5.7% had blunt trauma with poor final outcome.

In our study, 54.3% of the patients had < 4mm of corneal laceration, out of them 94.7% had visual acuity >20/70 at 3 months. Statistical significant with p=0.013 was seen. All patients having wound length less than 4mm had cylindrical refractive values of less than 3 diopters at the end of 3 months.

TABLE XV
MECHANISM OF INJURY

Vision	No. of patients	Percentage (%)
>20/70	25	75.7
20/70 – 20/200	4	12.1
20/200 – 20/400	0	0
<20/400	2	6.05
PL –ve	2	6.05

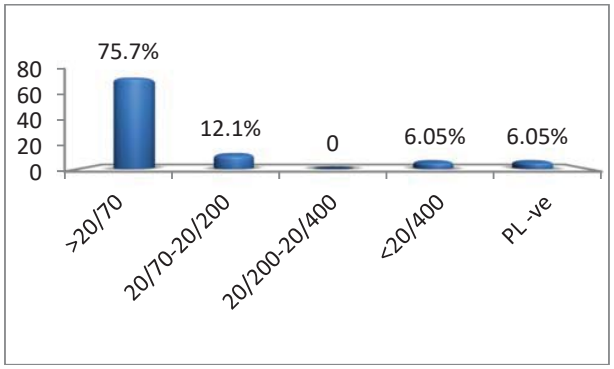

Fig. 15 Bar graph showing visual outcome in patients having penetrating injuries

TABLE XVI
LENGTH OF CORNEAL LACERATION

Vision	No. of patients	Percentage (%)
>20/70	18	94.7
20/70 – 20/200	1	5.3
20/200 – 20/400	0	0
<20/400	0	0
PL –ve	0	0

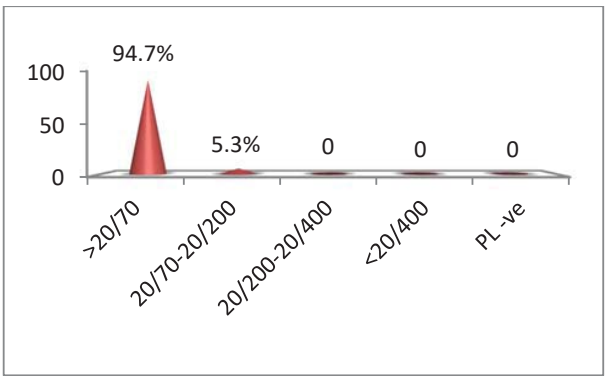

Fig. 16 Bar graph showing visual outcome in patients with <4mm of corneal laceration

TABLE XVII
AMOUNT OF ASTIGMATISM AT 3 MONTHS FOLLOW UP

Astigmatism (cylinder value)	Length of wound	
	< 4mm	4mm to 8mm
0-0.75	4	1
1.0 -1.75	2	1
2.0-3.0	0	2

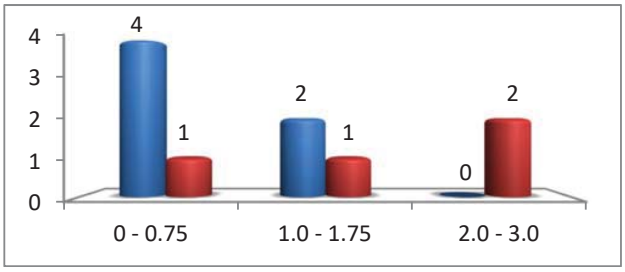

Fig. 17 Bar graph showing amount of corneal astigmatism at 3 months follow up

TABLE XVIII
VISUAL AXIS INVOLVEMENT IN CORNEAL LACERATION

Vision	No. of patients	Percentage (%)
>20/70	5	45.5
20/70 – 20/200	3	27.3
20/200 – 20/400	0	0
<20/400	1	9.1
PL –ve	2	18.1

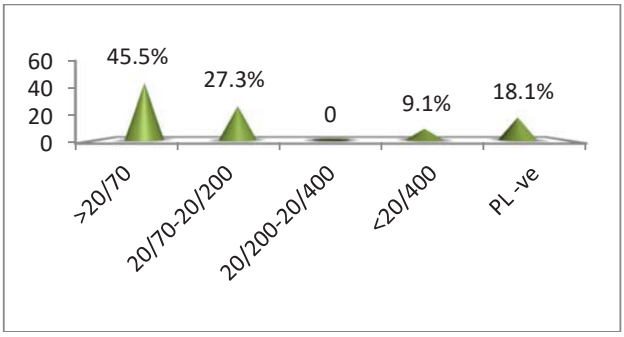

Fig. 18 Bar graph showing visual outcome in patients with involvement of visual axis

In our study, 31.4% of patients presented with involvement of visual axis, out of them only 45.5% had vision >20/70 at 3 months. 18.1% had no light perception at 3 months. Statistical significance with p = 0.021 was seen.

TABLE XIX
CAUSES OF DECREASED VISUAL ACUITY AFTER 3 MONTHS

Causes	Number of Patients		
	0-0.5 logmar	0.6-1.0 logmar	1.0-2.4 logmar
None	20	0	0
Cataract	1	1	1
Retinal Detachment	0	0	3
Scar	1	3	1
Optic neuropathy	2	0	1
Endopthalmitis	0	0	1

In our study, out of 35 patients 20 had BCVA > 20/70. 2 patients had reduced vision because of cataractous changes while 1 had useful vision in spite of localised lenticular opacity. Corneal scarring was seen as cause of reduced visual acuity in 4 patients. Posterior segment complications like optic neuropathy, retinal detachment and endophthalmitis were accountable for poor visual outcome in 1, 3, and 1 patients respectively.

Ocular survival in our study was 94.7% with only 5.3% having no visual potential at the end of 3 months.

TABLE XX
OCULAR SURVIVAL AT 3 MONTHS

Visual Potential	No. of patients	Percentage (%)
Yes	33	94.3
No	2	5.7

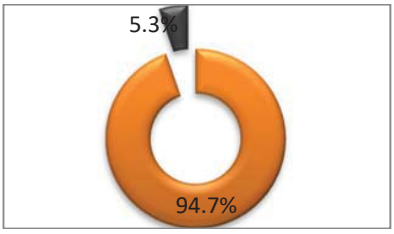

Fig. 19 Pie graph showing ocular survival at 3 months

IV. Discussion

A. Age

Age is one of the important prognostic factors for visual and anatomical outcome in patients with corneal laceration. In our study the patients ranged in age from 3 to 60 years; the average age was 22.8 years [1]-[4]. It is seen that eye injuries due to falls occur predominantly in elders and air gun injuries occur predominantly in adolescents (mean/median ages range from 13 to 15 years). The young age of the typical injured person underlines the importance of prevention as those affected are often faced with loss of career or educational opportunities and commonly suffer permanent physical disfigurement as well. In addition to the physical and psychological cost of eye injuries to the affected people, the direct and indirect financial costs to society are enormous.

B. Sex

29 (82.8 %) cases were men and 6 (17.2 %) were women and gender ratio was 4.8:1. A male predominance (86%) was seen in study on corneal lacerations by Bunya [3], Shoja [5] study of corneo-scleral lacerations found a male preponderance with ratio of 3:1. This could be attributed to increased outdoor activities of males.

C. Laterality

In our study, 54.3% cases left and 45.7% cases right eye was involved. This slight left-eye dominance has been a consistent finding in almost all source categories since the early years of USEIR surveillance [2], [5].

D. Activity at Time of Injury

The present study has shown that the majority of injuries (48.6%) occur in the workplace, usually while the patient was carrying out light industrial tasks. Others were due to recreational activities (37.1%) or due to assault (14.3%). This was comparable to study by Macewen et al. [6]. Injuries at work numbered 17 in our study; 16 (94%) of the patients were male and 1 (6%) were female, which was comparable to study by Macewen et al. [6]. This explained the vulnerability of men engaged in outdoor activity. The type of work performed was grinding/buffing in 1 (5.8%) and welding in 6 (29.4%). At the time of injury all our patients were not wearing any eye protection, though this was usually available. Reasons given for not wearing it were: discomfort, inability to see the task being performed, forgot, or did not feel that it was really necessary. Interestingly, many people working under cars or in dusty atmospheres thought that protection was unnecessary, and some workers remain unaware of the dangers of hammering without eye protection. According to Macewen [6], no serious injury requiring admission occurred when eye protection was in use, suggesting that existing protective eye wear is effective against severe injury. Hence, it is important to encourage the continued use of occupational eye protectors and constantly improve the devices available. None of the patients in our study were under influence of alcohol/drugs.

E. Mechanism of Injury

This study showed penetrating 94.3% and blunt trauma 2% as causes for corneal laceration. According to Nik-Eghbaly [7], this rate was 92% and 17%. In a similar study by Shoja [5], penetrating, blunt, and missile trauma caused corneoscleral tear in 79.4%, 15.1% and 5.5% cases respectively.

F. Mode of Injury

57.1% of the objects causing injury were metallic, 25.7 % wooden, 8.6 % stone and other 8.6% were miscellaneous in nature.

G. Time of Presentation

In our study, 77.2% presented within 24 hours of injury out of which 66.7% had vision >20/70 at 3 months. This was a significant prognostic indicator (p=0.013). This is similar to Shoja et al. [5] in which if presentation was less than 12 hours no cases of no light perception was found, but all cases of no light perception were in those presenting after 48 hours.

Time interval from onset of injury to repair and final visual acuity determined that when this period was shorter, final outcome was better and vice versa. Delayed presentation correlated with a poorer final visual acuity in Smith et al. [4].

H. Corneal Laceration

When length of corneal laceration was less than 4mm, 94.7% had a VA better than 20/70, in rupture of 4-8mm, 63.6% and in more than 8mm, only 20% had VA more than 20/70. 2 no light perception cases belonged to the patients with lacerations more than 10 mm in length (p=0.013). Our results were comparable to Shoja et al. [5], Barr et al. [1], and Sternberg et al. [8].

Visual axis involvement was seen in 31.4% out of whichonly 45.5% had vision >20/70 at 3 months. This had a significant influence on final outcome at 3 months (p=0.021). Non–statistical difference was observed between the good outcome group and poor outcome group regarding distance from the center of the visual axis by Bunya et al. [3].

I. Vision at Presentation

In our study, 68.9% patients presented with visual acuity < 20/400. Using univariate analysis, initial visual acuity had statistically significant influence on the outcome at 1 and 3 months. Multiple logistic regression proved this factor to be statistically significant (p=0.000). The most important factor of prognostic significance in corneal injury was the initial visual acuity.

J. Associated Ocular Damage

1. Iris Prolapse

In this study, 57.1% presented with iris tear/prolapse.

2. Hyphema

The importance of a hyphema is that its presence indicates that the eye has suffered a significant injury and structures within the anterior and posterior segments are likely to be damaged. Hyphema was noted in 14 eyes (40%) and was drained during primary repair. Of these, 50% at 1 month, 35 % at 3 months had poor outcome (<20/200). Hyphema was found to be a significant predictor of visual outcome at 3 months (p=0.000).

Lavanya [9] found it significant at 1 month. Charles Barr [1] found hyphema to be a predictor of visual outcome.

Hypopyon

Only 2 patients had a hypopyon preoperatively. Both had good visual acuity (20/20) at last follow-up. In Barr [1], 4 out of 122 patients had hypopyon, out of which 2 did not turn up for follow up, 1 had good vision and 1 underwent enucleation.

Lenticular Change

Lens opacities were found in 16 eyes (45.7%). 14 had cataract extraction. 1 had useful vision in spite of lens opacities. We found statistically significant predictive value for lens damage by univariate, multivariate analysis at 3 months (p=0.009).

Many studies mention lens damage as a predictor of outcome. Corneal lacerations without lens damage have a better prognosis. The most common complicationwas a traumatic cataract (74 patients, 59% of all complications), followed by infection (13 patients, 10% of all complications) in Smith [4].

IOFB

IOFB was associated with 3 (8.6%) cases. Out of 57% injuries that were caused by metallic objects, 2 patients had IOFB in vitreous cavity and underwent viterectomy. Statistical analysis was not significant.

3. Vitreous Haemorrhage

Vitreous haemorrhage was found in 13 eyes (37.1%). In our study, significant association with final visual outcome was found at 3 months (p=0.040). Lavanya [9] showed significance at one and six months (p<0.001).

4. Retinal Detachment

Retinal detachment was found in 3 eyes (8.5%). We found that all patients with retinal detachment had poor visual outcome <20/200, showing it to be a significant prognostic factor (p=0.027) at 3 months. Lavanya [9] also showed similar result.

5. Endophthalmitis

In our study, there was 1 case of endophthalmitis (2.8%) caused by Staphylococcus aureus, seen within a week of presentation. It received intravitreal vancomycin and ceftazidime, but was prepthysical at about 3 months. Bunya [3] found endophthalmitis caused by Bacillus cereus, in 1 case. In Lavanya [9], endophthalmitis was seen in 8 eyes, out of which only 1 had a good outcome of 20/30.

K.Surgical Intervention

1. Primary Repair

All the patients underwent initial primary repair within 24 hrs. of their presentation under general anaesthesia by a single surgeon. There was no bias towards repairing the most severe injuries first, thereby influencing the results.

Secondary procedures

Of the 35 patients, 17 (48.6%) patients underwent additional operative procedures. 14 underwent cataract extraction, 5 had pars plana vitrectomies out of which 1 had an added scleral buckling procedure and 3, added silicon oil injection. 3 patients received intravitreal antibiotics. Reposition of iris and pupilloplasty was done in 1 each. 53% of the patients with corneoscleral lacerations and lens damage in study of Adhikary [10] and 27% in Barr [1] underwent secondary procedures. Patients undergoing cataract extraction tended to do well (VA of 6/12 or better) and patients undergoing vitrectomy tended to do poorly (VA < 6/60), this was comparable to Barr [1] et al. No patient in this report underwent corneal transplantation. In our study, 3/5 (60%) had improvement in visual acuity of two or more Snellen lines with viterectomy. Hence, we are in agreement with the statement of Barr [1] that vitrectomy, performed at the time of initial repair or within the first 14 days of injury, will lead to better results.

L. Final Visual Outcome

In our study, initial visual acuity had statistically significant influence on the outcome at 1 and 3 months (p=0.000).

Initial visual acuity is an important prognostic indicator of visual outcome. Sternberg [8] et al., found initial visual acuity >20/800 as the most important factor for favorable prognosis. In Smith [4] et al. study, there was a correlation between poor initial visual acuity and poor final visual acuity. Study performed by Edmund [11] also related the initial vision to final visual outcome. Good visual outcome was associated with a better initial visual acuity on presentation in Bunya [3] et al. study.

The amount of corneal astigmatismwas measured in 26 patients and we found that 10 (38%) patients had cylinder, 8 (30.7%) spherical and other 10 (38%) had plano refractive values. The corneal astigmatism was not measured in patients with poor vision (visual acuity ranging from hand motions to no light perception) or in patients who were uncooperative. All corneal lacerations less than 4 mm in length had less than 3 diopters of astigmatism. This finding is in complete agreement with the findings of Eagling [12] study, in which only those patients who had lacerations greater than one third of the corneal diameter had more than 3 D of astigmatism. The same results were seen in Barr [1] et al. study too.

In our study, final VA of more than 20/70 was seen in 74.3% patients. Hence, ocular survival in our study was 94.7% with only 2 (5.7%) patients having no visual potential at the end of 3 months.

V. Conclusion

The treatment of patients with good initial visual acuity (6/60 or better) is usually successful and there is probably little that can be done for the most severely damaged eyes. It is the patients with an initial acuity of light perception or hand motions who need more aggressive surgical treatment. Prognostic indicators for vision at 3 months are age, time of presentation, length of wound, visual axis involvement, vision at presentation and associated features like hyphema, lenticular changes, vitreous haemorrhage and retinal detachment.

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