Original Article

Ocular Trauma From Fireworks During Diwali Festival

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Abstract

Background: Fireworks are an important part of festivals in India, especially Diwali. The use of these fireworks often result in ocular trauma with a loss of vision. The aim of this study was to determine the pattern of eye injuries from fireworks during the Diwali festival and the visual outcome at a tertiary eye hospital in south India. **Materials and Methods:** The cases of ocular trauma from fireworks over a 3-year period were retrospectively reviewed. Information regarding patient's age, gender, laterality, the type of firework, whether user or bystander, best-corrected visual acuity (BCVA) at presentation, the details of injuries, diagnosis, management, and BCVA at last follow-up visit were documented and analyzed using Epi Info 7.1.5.0 software. **Results:** A total of 114 eyes of 110 patients were analyzed. The study population comprised 89 (81%) males and 21 (19%) females, with a male-to-female ratio of 4.2:1. The median age was 14.0 years, with 61 (56%) patients aged <18 years. One hundred (88%) eyes had closed globe injury (CGI), whereas 14 (12%) eyes had open globe injury (OGI). Thirty-five (35%) eyes with CGI and 8 (57%) eyes with OGI had a BCVA of <3/60 at presentation. This improved with management with only 12 (12%) eyes with CGI and two (14%) eyes with CGI and 2 (14%) eyes with OGI having a BCVA of <3/60 at the last follow-up visit. These differences in visual acuity were not statistically significant with *P*-values >0.5. Twenty-two (19%) eyes developed long-term complications such as glaucoma, retinal detachment, and phthisis bulbi. **Conclusion:** Ocular trauma from fireworks commonly affects young boys and often results in serious, preventable, vision-threatening complications. The enforcement of existing legislation, health education, and public awareness are essential if the current trend in India is to be reversed.

Keywords: Diwali, fireworks, ocular trauma

Introduction

Fireworks are used worldwide to celebrate a variety of religious, patriotic, and cultural holidays and events.[1] They are largely used during such occasions for their sound, sparkle, and the sudden burst of colours, which light up the festive mood.[2] In India, they find a special place during Diwali, which is an annual festival marking an important Hindu mythological event.[2] This 5-day festival is also called the "festival of lights," where people light their homes with "lamps" and celebrate with firecrackers.[3]

The use of fireworks within the context of celebrations and holidays presents the ideal environment for accidents that lead to severe and dangerous injuries.[2] The eye is a common site of injury. In studies on firework-related injuries in Tehran[4] and Delhi,[5] the eyeball was found to be the third most commonly injured body site after the hands and face. Similarly, another study in the United States[6] reported the eyes to be the most commonly injured body site.

Eye injuries from fireworks can result in devastating visual and disfiguring effects.[3] During Diwali festival, there is usually a surge in the number of patients with ocular injuries from fireworks presenting to the hospital. The aim of this study, therefore, was to describe the pattern of ocular injuries from fireworks as seen in our hospital and the visual outcome following treatment. This was done to further highlight the inherent dangers associated with the unregulated use of fireworks in the society.

Materials and Methods

This was a hospital-based retrospective study involving the eyes with injuries from fireworks as seen at a tertiary eye hospital in Tamil Nadu, India during three consecutive Diwali festivals, that is, from 2013 to 2015. The study adhered to the

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tenets of the declaration of Helsinki and was approved by the Institutional Review Board of the hospital.

The cases were identified from the electronic medical records. Patients who presented 2 days before Diwali, on the day of Diwali, and 7 days after Diwali from 2013 to 2015 were included. Their case files were then retrieved, and the patient's age, gender, laterality, the type of firework, whether user or bystander, best-corrected visual acuity (BCVA) at presentation, the details of injuries, diagnosis, management, and BCVA at last follow-up visit were documented. Investigations such as B-scan ultrasonography, orbital X-ray, and optical coherence tomography were performed when indicated, and the results documented. Patients with lid tears, scleral tears, corneal tears, and intraocular foreign body were admitted and given immediate medical and surgical attention, whereas those with nonpenetrating injuries were treated on an outpatient basis.

Data analysis was performed using Epi Info 7.1.5.0 software. Frequencies and percentages were computed for qualitative variables, whereas mean and standard deviation were computed for quantitative variables. Tests for statistical significance were performed using Mann–Whitney/Wilcoxon two-sample test (Kruskal–Wallis test for two groups). A *P*-value <0.05 was considered statistically significant.

Results

One hundred and seventeen patients were noted to have ocular injuries from fireworks during the period under review, however, only 110 (94.0%) case files were available for analysis. A total of 114 eyes were analyzed as four patients had bilateral ocular trauma. There were 89 males (81.0%) and 21 females (19.0%) giving a male-to-female ratio of 4.2:1. The age range of the patients was 1–74 years with a mean of 21.9 years (median 14.0 years, SD 16.7). The majority of the patients were aged ≤20 years, which included 61 (55.5%) children (<18 years) [Figure 1]. Females had a mean age of 27 years, whereas males had a mean age of 20.4 years. This difference was not statistically significant with a *P*-value of 0.12. The majority of the case files did not have details on whether the patient was an active launcher or a bystander.

Closed globe injury (CGI) occurred in 100 (87.7%) eyes, whereas 14 (12.3%) eyes had open globe injury (OGI). One hundred and six (96.3%) patients had unilateral injury, with the left eye involved in 59 patients and the right eye in 47 patients. The most common injuries were hyphema (48; 42.1%), vitreous hemorrhage (33; 28.9%), traumatic cataract (28; 24.6%), and traumatic iritis (21; 18.4%). There were three (2.6%) eyes with an intraocular foreign body [Figure 2] and one (0.8%) with a ruptured globe [Table 1].

BCVA at presentation ranged from 6/6 to no light perception. Thirty-five (35%) eyes with CGI and eight (57.1%) eyes with OGI had a BCVA of <3/60 at presentation. This difference

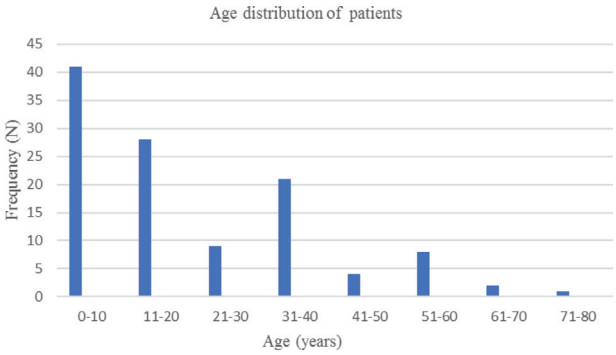

Figure 1: Age distribution of patients

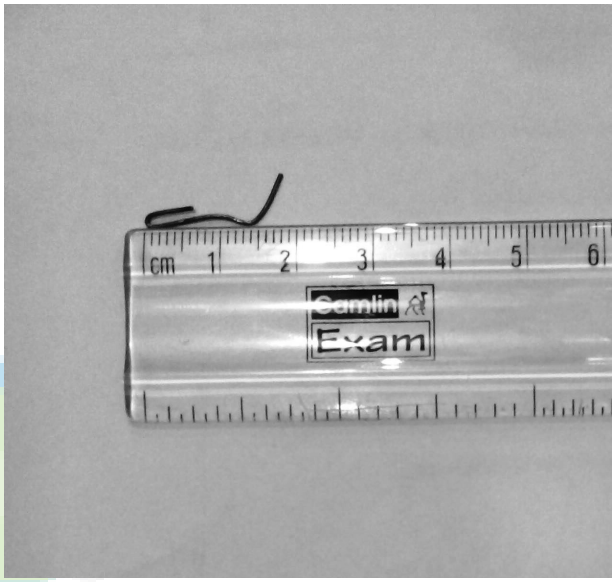

Figure 2: A staple pin retrieved from one of the eyes with intraocular foreign body

was not statistically significant (*P*-value 0.19). This improved with management with only 12 (12%) eyes with CGI and two (14.3%) eyes with OGI having a BCVA of <3/60 at the last follow-up visit [Table 2]. This difference was also not statistically significant (*P*-value 0.42). Twenty-two eyes developed late (>6 weeks) complications with foveal atrophy [Figure 3] and glaucoma being the most common complications [Table 3]. The causes of poor visual outcome included retinal detachment (RD), choroidal rupture, phthisis bulbi, and a ruptured globe. Fifty-five surgical procedures were performed in 47 (41.2%) eyes, with more than one procedure being performed in nine eyes.

Discussion

Firework traumas are a preventable cause of severe ocular injury and blindness, with countries using restrictive firework legislation having remarkable lower trauma incidence rates.[7] In India, however, despite existing legislation on the indiscriminate use of fireworks, there has been a failure with regard to administrative efforts in bringing down the incidence of firecracker-related injuries.[2]

Table 1: Ocular injuries caused by fireworks

Site of injury	Type of injury	CGI *n* (%)	OGI *n* (%)	Total *n* (%)
Eyelids and adnexa	Eyelid burns	10 (10.0)	–	10 (8.7)
	Eyelid laceration	4 (4.0)	–	4 (3.5)
	Eyelid abrasion	7 (7.0)	–	7 (6.1)
	Eyelid hematoma	1 (1.0)	–	1 (0.9)
	Subconjunctival hemorrhage	5 (5.0)	–	5 (4.4)
	Conjunctival laceration	5 (5.0)	–	5 (4.4)
Anterior segment	Scleral tear	–	6 (42.9)	6 (5.3)
	Corneal abrasions	12 (12.0)	–	12 (10.5)
	Lamellar corneal laceration	8 (8.0)	–	8 (7.0)
	Full thickness corneal laceration	–	8 (57.1)	8 (7.0)
	Corneal edema	1 (1.0)	–	1 (0.9)
	Superficial corneal foreign body	1 (1.0)	–	1 (0.9)
	Hyphema	42 (42.0)	6 (42.9)	48 (42.1)
	Traumatic iritis	21 (21.0)	–	21 (18.4)
	Iris sphincter tear	3 (3.0)	–	3 (2.6)
	Traumatic mydriasis	3 (3.0)	–	3 (2.6)
	Subluxated lens	9 (9.0)	–	9 (7.8)
	Traumatic cataract	20 (20.0)	8 (57.1)	28 (24.6)
	Dislocated PCIOL	1 (1.0)	–	1 (0.9)
Posterior segment	Intraocular foreign body	–	3 (21.4)	3 (2.6)
	Vitreous hemorrhage	31 (31.0)	2 (14.3)	33 (28.9)
	Choroidal detachment	3 (3.0)	1 (7.1)	4 (3.5)
	Choroidal rupture	4 (4.0)	–	4 (3.5)
	Commotio retinae	16 (16.0)	–	16 (14.0)
	Subretinal hemorrhage	1 (1.0)	1 (7.1)	2 (1.8)
	Retinal tear	2 (2.0)	–	2 (1.8)
	Disc edema	1 (1.0)	–	1 (0.9)
	Ruptured globe	–	1 (7.1)	1 (0.9)

CGI = closed globe injury, OGI = open globe injury.

Table 2: Visual outcome following ocular fireworks injuries

Category of vision	At presentation *n* (%)		At last visit *n* (%)	
	CGI	OGI	CGI	OGI
≥6/18	43 (43.0)	–	68 (68.0)	6 (42.9)
< 6/18–6/60	15 (15.0)	5 (35.7)	15 (15.0)	1 (7.1)
<6/60–3/60	4 (4.0)	–	4 (4.0)	4 (28.6)
<3/60–1/60	7 (7.0)	1 (7.1)	3 (3.0)	–
<1/60–PL	26 (26.0)	6 (42.9)	6 (6.0)	1 (7.1)
NPL	2 (2.0)	1 (7.1)	3 (3.0)	1 (7.1)
Not stated	3 (3.0)	1 (7.1)	1 (1.0)	1 (7.1)
Total	100	14	100	14 (100)

In this study, the majority of the patients were males. This is consistent with observations from previous studies.[3,8-14] Males are more adventurous, more likely to take risks, and have a higher presence on the streets.[3,4] Information on whether the patient was actively involved in launching the fireworks or was just a bystander was not available in most of the case files. Previous studies have, however, shown that it is just as perilous to be in the vicinity of a firework being launched as to be actively involved in lighting it.[3,7,10,13]

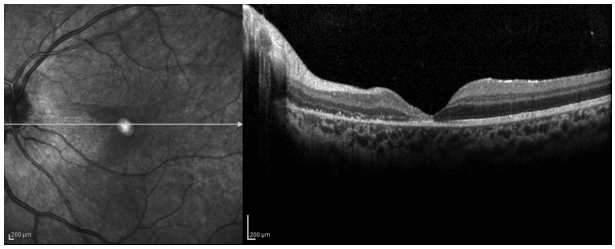

Figure 3: Foveal atrophy following ocular trauma from fireworks

The majority of the injuries were sustained by individuals 20 years of age and below, with 56% occurring in children. This is also in agreement with other studies,[9,10,11,14] such as Kuhn *et al.*[14] reporting that 61% of the firecracker injuries occur in children. Children are particularly vulnerable because of their inquisitive nature and their excitement when in close proximity with fireworks. They also cannot readily anticipate danger and are unable to know how to keep themselves safe and act decisively in an emergency.[15] They are, therefore, very susceptible to trauma from fireworks.

Table 3: Long-term complications

Complication	CGI	OGI	Total
	n (%)	*n* (%)	(%)
Macular/foveal atrophy	6 (6.0)	–	6 (5.2)
Choroidal neovascular membrane	1 (1.0)	–	1 (0.8)
Glaucoma	6 (6.0)	–	6 (5.2)
Phthisis bulbi	2 (2.0)	1 (7.1)	3 (2.6)
Retinal detachment	1 (1.0)	2 (14.2)	3 (2.6)
Macular hole	1 (1.0)	–	1 (0.8)
Cataract	1 (1.0)	–	1 (0.8)
Endophthalmitis	–	1 (7.1)	1 (0.8)

There was a preponderance of CGI in this study. This is similar to findings from other studies in India,[3,8,10-12] Britain,[13] and the United States.[16] Studies from China documenting firework-related injuries during the spring festival, however, found a higher proportion of OGI.[9,17] In this study, hyphema and traumatic cataract were the most common anterior segment findings, whereas vitreous hemorrhage was the most common posterior segment finding. This is consistent with the findings by Patel and Mukherjee,[8] also in south India. In north India, Venkatesh *et al*. reported corneal epithelial defect and corneal foreign body as the most common anterior segment injuries and vitreous hemorrhage as the most common posterior segment finding.[3] The type of fireworks involved may determine the severity of injury sustained. Sparklers tend to produce only conjunctival or corneal burn or corneal abrasions, whereas rockets, cone fountain bombs, and bombs cause more severe injuries such as lid laceration, OGI, iridodialysis, angle recession, vitreous hemorrhage, and multiple corneal foreign bodies.[11] The type of fireworks involved was not available in most of the records reviewed in this current series. Patel and Mukherjee, however, reported bombs (sound-emitting devices) and flower pots "anar" as the most common types of fireworks causing ocular injury.[8] The severity of ocular damage has also been shown to be greater for active launchers compared with bystanders.[3]

Firework-related ocular trauma can lead to serious visual impairment, with one in six eyes showing severe vision loss.[3,7] Factors such as initial BCVA, CGI, the absence of intraocular foreign body, the absence of endophthalmitis, and the absence of RD are associated with better final BCVA.[18,19] An improvement in final visual acuity observed in this study is consistent with findings from similar studies.[9,19,16] Poor visual outcome was recorded in 12% of the eyes. This compares favorably with the 13.2% reported by Venkatesh *et al*.[3] The causes of poor outcome in this series included RD, phthisis bulbi, choroidal rupture, and OGI.

The limitations of this study include its retrospective nature and the exclusion of other cases of ocular firework injuries occurring at other times of the year. Restricting the cases studied to those that occurred during Diwali may have resulted in an underestimation of the magnitude of the problem.

In conclusion, ocular trauma from fireworks commonly affects young boys and often results in serious, preventable, vision-threatening complications. The enforcement of existing legislation, health education, and public awareness are essential preventive measures for curbing this hazard to ocular health in the country.

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Conflicts of interest

There are no conflicts of interest.

References

1. Tadisina KK, Abcarian A, Omi E. Facial firework injury: A case series. West J Emerg Med 2014;15:387-93.
2. Tandon R, Agrawal K, Narayan RP, Tiwari VK, Prakash V, Kumar S, Sharma S. Firecracker injuries during Diwali festival: The epidemiology and impact of legislation in Delhi. Indian J Plast Surg 2012;45:97-101.
3. Venkatesh R, Gurav P, Tibrewal S, Agarwal M, Dubey S, Mathur U, *et al*. Appraising the spectrum of firework trauma and the related laws during Diwali in North India. Indian J Ophthalmol 2017;65:140-3.
4. Hatamabadi HR, Tabatabaey A, Heidari K, Karim MK. Firecracker injuries during Chaharshanbeh Soori festival in Iran: A case series study. Arch Trauma Res 2013;2:46-9.
5. Bagri N, Saha A, Chandelia S, Dubey NK, Bhatt A, Rai A, *et al*. Fireworks injuries in children: A prospective study during the festival of lights. Emerg Med Australas 2013;25:452-6.
6. Witsaman RJ, Comstock RD, Smith GA. Pediatric fireworks-related injuries in the United States: 1990–2003. Pediatrics 2006;118:296-303.
7. Wisse RP, Bijlsma WR, Stilma JS. Ocular firework trauma: A systematic review on incidence, severity, outcome and prevention. Br J Ophthalmol 2010;94:1586-91.
8. Patel R, Mukherjee B. Crash and burn: Ocular injuries due to fireworks. Semin Ophthalmol 2016;31:243-8.
9. Singh DV, Sharma YR, Azad RV. Visual outcome after fireworks injuries. J Trauma 2005;59:109-11.
10. Jing Y, Yi-Qiao X, Yan-Ning Y, Ming A, An-Huai Y, Lian-Hong Z. Clinical analysis of firework-related ocular injuries during Spring Festival 2009. Graefes Arch Clin Exp Ophthalmol 2010;248:333-8.
11. Malik A, Bhala S, Arya SK, Sood S, Narang S. Five-year study of ocular injuries due to fireworks in India. Int Ophthalmol 2013;33:381–5.
12. Kumar R, Puttanna M, Sriprakash KS, Rathod BLS, Prabhakaran VC. Firecracker eye injuries during Deepavali festival: A case series. Indian J Ophthalmol 2010;58:157-9.
13. Arya SK, Malhorta S, Dhir SP, Sood S. Ocular fireworks injuries: Clinical features and visual outcome. Indian J Ophthalmol 2001;49:189-90.
14. John D, Philip SS, Mittal R, John SS, Paul P. Spectrum of ocular firework injuries in children: A 5-year retrospective study during a festive season in Southern India. Indian J Ophthalmol 2015;63:843-6.
15. Knox FA, Chan WC, Jackson AJ, Foot B, Sharkey JA, McGinnity FG. A British Ophthalmological Surveillance Unit study on serious ocular injuries from fireworks in the UK. Eye 2008;22:944-7.

16. Kuhn FC, Morris RC, Witherspoon DC, Mann L, Mester V, Módis L, *et al.* Serious fireworks-related eye injuries. Ophthalmic Epidemiol 2000;7:139-48.
17. Smittenberg MN, Lungelow D, Rode H, van As AB, Millar AJW. Can fireworks-related injuries to children during festivities be prevented? S Afr Med J 2010;100:525-8.
18. Chang IT, Prendes MA, Tarbet KJ, Chang SH, Shaftel SS. Ocular injuries from fireworks: The 11-year experience of a US level I trauma center. Eye 2016;30:1324-30.
19. Lin Y, Liang X, Liu X, Qu B, Ni Y, Jiang S, Liu Y. Prognostic factors and visual outcome for fireworks-related burns during spring festival in South China. J Burn Care Res 2012;33:108-13.