

Spectrum of ocular firework injuries in children: A 5-year retrospective study during a festive season in Southern India

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Purpose: Ocular trauma is a major cause of acquired monocular blindness in children. Firework injuries account for 20% of ocular trauma. The purpose of our study was to document the profile of ocular firework injuries in children during the festive season of Diwali and to determine the prevalence of unilateral blindness in them. **Materials and Methods:** A retrospective chart analysis of ocular firework injury in children during the festival of Diwali from 2009 to 2013, conducted in a tertiary care eye center in Tamil Nadu, Southern India. Children below 18 years of age with ocular firework injuries who presented to the emergency department for 3 consecutive days - the day of Diwali, 1 day before, and 1 day after Diwali - were included in this study. **Results:** Eighty-four children presented with firework-related ocular injuries during the study period. Male to female ratio was 4:1 with mean age 9.48 ± 4 years. Forty-four percentage required hospitalization. The prevalence of unilateral blindness in children due to fireworks was found to be 8% (95% confidence interval - 2–13%). **Conclusion:** Vision 2020 gives high priority to avoidable blindness, especially in children. In our study, for every 12 children who presented with firecracker injury, one resulted in unilateral blindness. This is an avoidable cause of blindness. Awareness needs to be created, and changes in policy regarding sales and handling of firecrackers including mandatory use of protective eyewear should be considered.

Key words: Firecracker injury, ocular firework injury, ocular injuries in children

Fireworks have an important role in various celebrations and festivals in most parts of the world. The difference between the celebrations in developing countries such as India and their counterparts in the Western world is mainly in the laxity of legislation regarding the execution of the firework display. Fireworks are an integral part of most celebrations in India. Although fireworks are meant for entertainment, injuries caused by them carry a high price to pay. Ocular injuries constitute about 20% of firework injuries.^[1,2] Trauma is one of the major causes of unilateral avoidable blindness in children.^[3-5] It is estimated that worldwide 160,000–280,000 children under the age of 15 years sustain ocular injuries every year which require inpatient care.^[3] However, only 5% of ocular injuries usually require admission. Hence, the actual incidence of pediatric ocular trauma worldwide is much higher amounting to 3.3–5.7 million annually.^[3] With vision 2020 giving high priority to avoidable blindness, especially in children, every attempt should be made to prevent such injuries and blindness in children.^[6]

Diwali, the festival of lights, is a major Indian festival celebrated in most parts of the country, and fireworks form an integral part of these celebrations. During this festival season, we find a dramatic increase in the number of patients with ocular injuries due to fireworks, presenting to the emergency department (ED). Visual impairment and disability in children can be a financial burden on the family and society. We

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conducted this retrospective study to document the profile of ocular firework injuries and visual outcome in children treated during the festive season of Diwali over 5 years. The purpose of our study was to find the prevalence of unilateral blindness in these children.

Materials and Methods

We included all children up to the age of 18 years, who sustained ocular injuries with firecrackers and presented to us during the festive season of Diwali from 2009 to 2013 on 3 consecutive days - the day of Diwali, 1 day before, and 1 day after Diwali. These are the days when people maximally engage in festivities involving fireworks.

The study was conducted in a tertiary care eye center in Tamil Nadu, Southern India. We did a retrospective analysis of the medical records of children who presented to the ED of our hospital during the Diwali season for 5 consecutive years. The study was conducted after obtaining the approval of the study site Institutional Review and Ethics Board.

All patients underwent complete ophthalmological evaluation. Visual acuity (VA) was tested using Snellen chart or Cardiff acuity cards or finger counting. A complete slit lamp

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biomicroscopic examination and fundus examination were done in all patients at the time of presentation and on follow-up. All patients who sustained open globe injuries underwent preoperative imaging of the eye and orbit to rule out retained foreign bodies. The spectrum of ocular involvement was noted. The details of management were recorded. Surgical intervention, when indicated, was done within 24 h of presentation to the ED.

Demographic data of all the patients, the nature and site of injury, the initial and final VA, and the intervention done were noted. The causes of severe visual loss and blindness were also recorded. Poor visual outcome was defined as vision <6/60 and unilateral blindness as <3/60 in the injured eye. Frequency and percentage were calculated for categorical variables, and mean \pm standard deviation for continuous variables. Data were collated and analyzed using SPSS version 20 (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp).

Results

Eighty-four children presented with ocular injuries due to fireworks over 3 consecutive days during the Diwali season between 2009 and 2013. The age and gender distribution are given in Fig. 1. Eighty percentage were male. The mean age of boys was 9.8 ± 4.2 years and that of girls 8.4 ± 3.2 years. 56.5% of ocular injuries were sustained by boys aged 6–15 years. The youngest child was a 1-year-old boy who had sustained an injury while watching the celebrations with his mother. Twenty-six children (31%) had bilateral involvement. Eighty-five percentage of bilateral ocular involvement was in boys. Twenty-six children (31%) sustained injury while watching, and 26 (31%) sustained an injury while igniting firecrackers themselves. History regarding the type of firecracker was not documented in 32 children (38.1%).

The spectrum of eye involvement in the children in our study is summarized in Table 1. The most common site of injury was the cornea, which was affected in 51 (60.7%) children. Twenty-four (28.6%) children had lid and adnexal injury, 56 (66.7%) had anterior segment, and 17 (20.2%) had posterior segment involvement.

Among the 84 children who presented to us, 37 (44%) required hospitalization. Parents of six children requested for discharge against medical advice. Among the remaining

31 inpatients, five had penetrating trauma to the globe, and three had intraocular foreign bodies (two in the posterior segment and one in the lens). All open globe injuries were managed surgically. All children with closed globe injuries who were treated as inpatients were managed conservatively, except for one child who underwent a superficial corneal foreign body removal under general anesthesia. One child with closed globe injury had an intraorbital foreign body; this child was lost to follow-up once poor visual prognosis due to retinitis sclopetaria and choroidal rupture were explained.

Ten children with closed globe injury had a traumatic cataract at presentation. Six of them underwent lens matter aspiration with intraocular lens implantation. Among the remaining four, one child had angle recession and anterior subluxation of the lens with corneal edema. He underwent lens matter aspiration and partial anterior vitrectomy but was left aphakic due to corneal edema and macular scar. Another child had iridodialysis, secondary glaucoma with corneal edema, and cataract. He underwent trabeculectomy, iridodialysis repair, and lens matter aspiration. Intraocular lens was not placed due to corneal edema. One child had cataract surgery with lens implantation but had poor vision due to choroidal rupture. Another child with cataract and macular scar was lost to follow-up.

VA at presentation ranged from 6/6 to perception of light (PL). The mean duration of follow-up was 1.5 months. Final visual outcome is summarized in Table 2. Poor visual outcome was taken as vision <6/60 in the injured eye. After

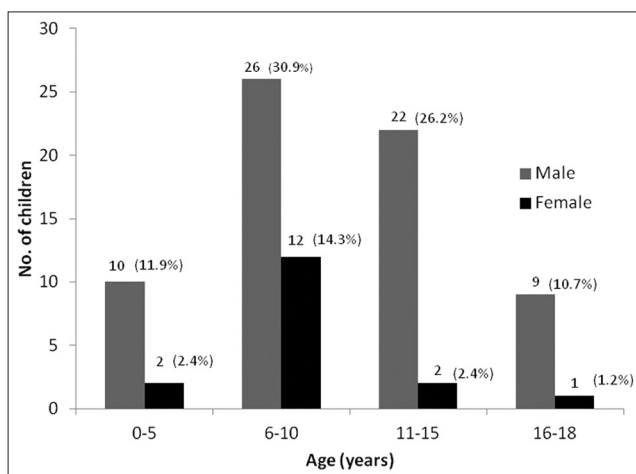


Figure 1: Age and gender distribution

Table 1: Spectrum of ocular involvement in children with firecracker injury

Site of injury	Closed globe injury (n=79 patients)	Open globe injury (n=5 patients)
Lid and adnexa	Lid burns	36
	Lid tear	1
	Ectropion	1
	Orbit foreign body	1
Anterior segment	Conjunctival tear	6
	Epithelial defect	63
	Corneal foreign body	32
	Corneal edema	14
	Hyphema	20
	Anterior uveitis	31
	Iridodialysis	6
	ZD/lens subluxation	5
	Traumatic cataract	10
	Angle recession	5
Posterior segment	Secondary glaucoma	3
	Berlin's edema	10
	Retinal tear	2
	Choroidal rupture	1
	Vitreous hemorrhage	6
	Macular hole/scar	4
	Epiretinal membrane	1
	Lid tear	1
	Conjunctival tear	2
	Epithelial defect	2
Corneal foreign body	1	
Corneal edema	4	
Hyphema	4	
Anterior uveitis	4	
Corneal tear	1	
Corneoscleral tear	2	
Scleral tear	2	
IOFB	1	
ZD/lens subluxation	1	
Traumatic cataract	3	
Vitreous hemorrhage	2	
IOFB	2	
Retinal tear	1	

ZD: Zonular dialysis, IOFB: Intraocular foreign body

either surgical or medical intervention, 77.5% (93 eyes) had the good visual outcome (6/18 or better). Of the five open globe injuries, four had a poor visual outcome. Only one child with open globe injury with a foreign body within the lens had a good visual outcome. The prevalence of unilateral blindness in our study was 8% (95% confidence interval - 2–13%), with 10 children having final VA worse than 3/60. The causes of unilateral blindness are mentioned in Table 3.

On follow-up, many children were noted to have long-term complications, which could potentially compromise vision. Five children had angle recession and three who developed secondary glaucoma are on regular follow-up. One child was a steroid responder but was lost to follow-up. Two children developed a traumatic macular hole, and epiretinal membrane was seen in one child. One child with severe facial burns developed lower lid cicatricial ectropion which was managed surgically.

Discussion

Injuries to the eye and adnexa constituted about 20% of firecracker injuries.^[1,2] Many studies have reported on ocular injuries caused by firecrackers.^[1,2,7-18] However, to the best of our knowledge, there have not been any study focusing on ocular firework injuries in the pediatric age group. Kuhn *et al.* found that up to 61% of firecracker injuries were sustained

by children.^[7] Boys in the age group of 6–10 years constituted the majority (56.5%) of cases in our study. This is similar to the results of the study by Wilson.^[19] Marilyn *et al.* reported one-third of permanent blindness among children who sustained ocular injury due to fireworks.^[1] In contrast, in our study, only three children (5.1%) with ocular injuries did not have even PL while 10 (11.9%) children had vision worse than 3/60 in the injured eye. Our study demonstrates the magnitude of severe ocular morbidity and loss of vision in children due to firecracker injuries.

According to the literature, only 5% of injuries required hospitalization,^[3] while 44% in our study needed inpatient care. Among the 84 children who presented to us, one-third was only observing the event, and one-third acquired bilateral ocular injury. Vision loss in children causes a huge burden to the family as well as society. Factors such as hospital stay, psychological impact, loss of school days, and treatment expenses are also important considerations.

Firecracker injury is a preventable cause of vision loss in children. Social awareness plays a key role in preventing such injuries. Awareness needs to be created among children by parents and teachers, regarding the possible danger of injury from firecrackers and about the careful handling of these devices. This can be accomplished through school education programs and media campaigns via television, radio, and newspapers. Social workers and organizations also have a key role to play in creating public awareness and curbing blindness due to firecracker injury. The importance of strict parental supervision during these celebrations also needs to be emphasized.

In India, the Ministry of Environment and Forests has banned the manufacture, sale, and use of firecrackers generating noise levels exceeding 125 dB or 145 dB. The Supreme Court has also banned setting off firecrackers between 10 pm and 6 am during festival seasons. However, effective legislation regarding displays and celebrations involving firecrackers is generally lax in India. The Central Pollution Control Board estimates that 95% of firecrackers violate noise and pollution norms. Moreover, legislation regulating bursting of firecrackers by individual members of the public is virtually nonexistent.

It is high time that stringent legislative measures are implemented to govern the use of fireworks both for public displays as well as by private individuals.

Many countries have used legislative measures to regulate the use of fireworks.^[19,20] In the UK, it is an offense to throw or set off fireworks on any street, highway, or public place. There are huge penalties and fines for this. According to the UK Fireworks Act 2003, it is an offense to possess fireworks in public places, and setting off fireworks during the night (between 11 pm and 7 am) is a punishable offense. The Fireworks Act in Canada prohibits selling and setting off fireworks in the country, except between October 24 and November 1 in any year. It also specifies that fireworks may not be sold to a minor without the written permission of the parent or guardian of the minor.

Implementation of similar legislative measures would go a long way in reducing firework-related injuries in India. Apart from these regulations, legislation should stipulate all safety

Table 2: Visual outcome following ocular firecracker injury in children

WHO classification	VA categories	Closed globe injury (n=105 eyes)		Open globe injury (n=5 eyes)	
		Initial VA	Final VA	Initial VA	Final VA
		Normal	6/6	21	68
Visual impairment	6/9-6/18	42	25	0	1
	6/24-6/60	10	05	0	0
Blindness	5/60-3/60	4	01		0
	<3/60-PL	17	6	3	1
	No PL	0	0	0	3
	Not recorded	11	-	2	-

PL: Perception of light, VA: Visual acuity, WHO: World Health Organization

Table 3: Causes of unilateral blindness following firecracker injury in children

Case	Age/sex	Final VA	Complications
1	11/male	No PL	Extrusion of contents resulting in evisceration
2	05/male	No PL	Total retinal detachment, Phthisis bulbi
3	10/female	No PL	Phthisis bulbi
4	04/male	PL +	Dense amblyopia
5	10/male	CF 5 m	Decompensated cornea
6	10/female	PL+	Traumatic optic neuropathy
7	12/male	PL+	Retinal detachment sequelae
8	3/male	CFCF	Choroidal rupture
9	10/male	CFCF	Decompensated cornea, scar at macula
10	2/male	PL+	Retinitis sclopetaria, choroidal rupture

PL: Perception of light, CFCF: Counting fingers close to face, VA: Visual acuity

measures including the age limit for independently handling these devices, as well as the minimum distance that has to be maintained while lighting firecrackers and watching fireworks. Children should handle firecrackers only under adult supervision. Protective eyewear should be made compulsory and available in the market along with firecrackers. Regulations for the safe handling of these devices should be introduced and implemented to prevent further such injuries in the future.

One of the limitations of this study is that we included only children who sustained firecracker injury during 3 consecutive days around Diwali. We did not include those who presented later or during other festive seasons. This may have resulted in underestimation of the problem. As this was a retrospective study, we could not gather accurate information on preinjury vision, parental supervision, or the type of firecracker that caused maximal ocular damage.

Conclusion

Ocular firework injuries that occur in children can result in considerable ocular morbidity and lead to permanent blindness. Assuming all eyes had a good vision before trauma, 1 out of 12 children injured by firecrackers in our study became blind unilaterally. It is imperative that adequate measures are taken through public education and legislation to ensure that celebrations involving fireworks are conducted in a safe manner to prevent ocular injuries and visual loss, especially in children.

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Conflicts of interest

There are no conflicts of interest.

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