Original Article

Firecracker-related ocular injuries during Diwali festival season in a tertiary care center in Northern India

Mandeep Tomar₁, Gaurav Sharma², Rajeev Tuli², Rattan K. Sharma²

₁Department of Ophthalmology, Dr. Yashwant Singh Parmar Government Medical College, Nahan, Himachal Pradesh, India
₂Department of Ophthalmology, Dr. Rajendra Prasad Government Medical College, Kangra at Tanda, Himachal Pradesh, India

Received: 18 August 2019 / Accepted: 07 October 2019

Abstract

Background: 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. So, a single-centre, prospective study was done to evaluate the types of fireworks-related ocular injuries during Diwali season and visual outcomes in these patients.

Methods: We evaluated firecracker-related ocular injuries and visual outcomes among patients over three consecutive years (2015 to 2017) during the Indian festival season of Diwali at Dr. Rajendera Prasad Government Medical College (RPGMC). Detailed ocular examinations, managements of all patients and a follow up to six weeks were performed.

Results: A total of 38 patients presented to us during the Diwali season (28 males and 10 females). The age distribution was 1-15 years (52.63%), 15-40 years (31.57%) and >40 years (15.78%). Visual acuity at presentation was <3/60 in 42.10% of the cases, 6/36-3/60 in 18.4% and 6/6-6/24 in 39.47%. The most common modes of presentations were corneal abrasion/corneal epithelial defect (in 86.84% of the cases), conjunctival and corneal foreign bodies in 39.4%, hyphema in 31.57% and vitreous hemorrhage in 23.68%. Four of 38 patients had an open globe injury. The most common firecrackers causing ocular injury were bombs and fountains (60.52%) followed by rockets (23.68%) and sparkles (15.78%). After the six-week follow-up, 76.31% of the patients had a visual acuity of 6/6-6/24, 18.42% had 6/36-3/60 and 5.26% had < 3/60.

Conclusions: Firecracker injuries can cause serious and irreparable damage to vision. Preventive measures should be strengthened, including public education and legal restriction on the sale and use of fireworks.

Keywords: eye, festival, injury, India
Introduction

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 fireworks 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 fireworks injuries [1,2].

Of all reported ocular injuries, 1.6-2% are due to firecrackers [3]. Fireworks injuries can occur in most societies [2,4]. These injuries usually affect boys [3-5]. In India, the most fireworks-related injuries are reported during Diwali and Gurupurva [3,4]. Such injuries are common on New Year's Eve in China, the Prophet's birthday in Libya and the Fourth of July in the USA [6].

We evaluated firecrackers-related ocular injuries and visual outcomes among patients over three consecutive years (2015 to 2017) during the Indian festival of Diwali presenting at a tertiary eye care center of Northern India.

Methods

This study was a hospital-based, single-center prospective study in which 38 patients with ocular firecracker injuries were analyzed at the tertiary ophthalmology center at Dr. RPGMC over three consecutive years (2015 to 2017) during the festival season of Diwali. This study was conducted in accordance with the Declaration of Helsinki. The institutional ethical committee of Dr. RPGMC approved the study protocol before conducting the study.

Patients were subjected to visual acuity using the Snellen chart, anterior segment examination by slit-lamp biomicroscopy, intraocular pressure (IOP) measurement by Schiotz tonometer, gonioscopy (Goldmann 2 mirror), X-ray of the orbit to look for retained intraocular foreign body (IOFB), USG (A+B) scan to assess posterior segment status particularly, retinal detachment, vitreous hemorrhage and to rule out retained IOFB in patients with hazy media, fundus photography and direct and indirect ophthalmoscopy were done in each patient.

Visual outcomes were recorded and patients were followed up to six weeks. Patients with closed eye injuries were treated on an outpatient basis, most cases with open eye injury were advised admission for further management and observation. Admitted cases included patients with corneal and scleral tears, traumatic iridodialysis with hyphema, suspected IOFB and globe rupture. Injuries were classified according to the Birmingham eye trauma terminology system (BETTS).

All the results were compiled at the end of the study and the total number and percentage of each variable were calculated.

<table>
<thead>
<tr>
<th>Table 1. Various investigations performed for each patient in the study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial visual acuity using the Snellen chart</td>
</tr>
<tr>
<td>Diffuse torchlight and clinical examination</td>
</tr>
<tr>
<td>Anterior segment examination by slit-lamp biomicroscopy (Haag Streit 900)</td>
</tr>
<tr>
<td>Intraocular pressure measurement by non-contact tonometer (Shin Nippon)</td>
</tr>
<tr>
<td>Gonioscopy using Goldmann 2 mirror lens</td>
</tr>
</tbody>
</table>

Results

A total of 38 patients presented to us from 2015 to 2017 during Diwali week. Fifteen patients presented in year 2015, 10 patients in 2016 and 13 patients in 2017 [Figure 1]. Twenty-eight (73.68%) patients were males and 10 (13.32%) were females. A total of 47 eyes of 38 patients were involved. The right eye was involved in 14 patients, left eye in 15 patients and both eyes were involved in 9 patients. The age distribution was 1-15 years (52.63%), 15-40 years (31.57%) and >40 years (15.78%). Visual acuity at presentation was less than 3/60 in 16 (42.10%) cases, 6/36-3/60 in seven (18.4%) and 6/6-6/24 in 15 (39.47%) cases [Table 2]. Thirty-five of 38 patients had a closed globe injury (CGI) and three patients had an open globe injury (OGI) [Figure 2]. Two of three OGI cases [Image 1] had a corneal perforation whereas one patient had a scleral perforation. The most common modes of presentations were corneal abrasion/corneal epithelial defect (86.84%), anterior uveitis (55.26%), conjunctival and corneal foreign bodies (39.4%) and hyphema (31.57%) [Figure 3].
Table 2. Details of visual acuity at presentation

<table>
<thead>
<tr>
<th>Visual acuity</th>
<th>Number/percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;3/60</td>
<td>16 (42.10)</td>
</tr>
<tr>
<td>6/18-3/60</td>
<td>7 (18.4)</td>
</tr>
<tr>
<td>6/6-6/18</td>
<td>15 (39.47)</td>
</tr>
</tbody>
</table>

Figure 1. Patient distribution/year (N=38).

Figure 2. Type of injury.

Figure 3. Anterior segment manifestations.
FB: Foreign body.
Among posterior segment manifestations, there were vitreous hemorrhage (23.68%), Berlin's edema (10.52%), epiretinal membrane (5.26%) and IOFB (2.63%) [Figure 4]. According to the BETTS, 33 (86.84%) patients had contusions, nine (23.68%) patients had superficial foreign bodies [Image 2], two cases had a penetrating trauma. 36.84% of the cases were admitted and managed, 63.15% of the cases were managed on the outdoor basis and 15.78% of the cases were referred to the higher center due to unavailability of vitreoretinal surgical services in the center. Among referred patients, four cases were of non-resolving vitreous hemorrhage, one with posterior crystalline lens dislocation [Image 3], one with retinal tear and one case was of retained IOFB [Image 4]. Among all patients, 28 (73.68%) were actively indulged in firecrackers whereas 10 (26.31%) were observers. In indoor patients, six cases were of hyphema [Image 5] with anterior segment complications [Image 6], three cases of corneoscleral perforation, three cases with extensive corneal and conjunctival foreign bodies and two patients were of facial and lid burns. The most common firecracker causing ocular injuries were bombs and fountains (60.52%) followed by rockets (23.68%) and sparkles (15.78%) [Figure 5]. After the six-week follow-up, 29 (76.31%) patients had a visual acuity of 6/6-6/24, seven (18.42%) patients had 6/36-3/60 and three (5.26%) patients had a vision less than 3/60 [Table 3]. At the time of discharge among indoor patients, eight of 14 (57.14%) patients attained good visual acuity (6/6-6/24), three (21.42%) had a poor vision (less than 3/60) and one patient presented with no perception of light and remained as same [Table 4].
Image 2. Child with multiple facial injuries and foreign bodies after cone fountain blast.

Image 3. Patient with closed globe injury and posterior dislocation of the lens.

Image 4. Entry point for intraocular foreign body.
Image 5. Child with hyphema and vitreous hemorrhage.


Figure 5. Type of firecrackers causing injuries.
Table 3. Details of visual acuity at the end of six weeks

<table>
<thead>
<tr>
<th>Visual acuity</th>
<th>Number/percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;3/60</td>
<td>3 (5.26)</td>
</tr>
<tr>
<td>6/6-6/18</td>
<td>7 (18.42)</td>
</tr>
<tr>
<td>6/6-6/18</td>
<td>29 (76.21)</td>
</tr>
</tbody>
</table>

Table 4. Final visual acuity details in indoor patients (N=14)

<table>
<thead>
<tr>
<th>Visual acuity</th>
<th>At presentation (N)</th>
<th>At discharge (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/6-6/24</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>6/6-3/60</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>&lt;3/60-HMCF</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>PL+ve</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PL-ve</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

HMCF: Hand movement close to face, PL: Perception of light.

Discussion

Injuries to the eye and adnexa constitute about 20% of firecracker injuries [1,2]. Many studies have reported on ocular injuries caused by firecrackers [1,2,7-18]. The reported injuries range from conjunctival or corneal burns to globe ruptures with interventions ranging from ocular wash to repair of globe perforation [19-21].

Fireworks-related injuries usually affect boys and children [3-5]. Kuhn et al found that up to 61% of firecracker injuries were sustained by children [7] as in our study, the majority (52.63%) were children less than 15 years of age.

In the present study, approximately one-third of patients presented with severe visual loss (less than 3/60) depicting the severe extent of injuries caused due to firecrackers. Three patients came with an OGI in which two cases were of corneoscleral perforation. One patient with a globe rupture and expulsion of intraocular contents presented to us which had undergone penetrating keratoplasty six months back, the graft was not found at presentation. Two patients presented with no perception of light including corneal graft recipient. Multiple corneal foreign bodies, corneal abrasions (CGI) and hyphema were predominant. Among posterior segment manifestations, vitreous hemorrhage was the most common.

According to the literature, only 5% of injuries required hospitalization [22], whereas 14% in our study were treated on an indoor basis. We had to refer seven (15%) patients of posterior segment involvement to other centers due to a lack of vitreoretinal services in our institute. The most common cause of referral was non-resolving vitreous hemorrhage followed by retained IOFB and retinal tear.

Two-third of injuries in our study were due to bombs and cone fountains followed by rockets and sparkles. One-fourth of patients had ocular injuries as they were observing the firecrackers only (onlookers).

At the end of the six-week follow-up, the majority (76.3%) of the patients achieved a good visual outcome (6/6-6/18), only three patients had a poor visual outcome (less than 3/60) which included one patient who had no perception of light at presentation. Sparkles produced only conjunctival or corneal burn or corneal abrasions without affecting the visual recovery, while rockets, cone fountain bombs and bombs caused lid laceration, OGI, iridodialysis, angle recession, vitreous hemorrhage and multiple corneal foreign bodies, all of which led to the poor visual outcome.

The patients who had an OGI and posterior segment involvement had poor visual outcomes while patients with anterior segment injuries involving the conjunctiva and cornea regained good visual outcomes.

Firecracker injury is a preventable cause of vision loss in children. Social awareness plays a key role in preventing such injuries. The Ministry of Environment and Forests in India has banned the manufacture, sale and use of firecrackers generating noise levels exceeding 145 dB. The Supreme Court has also banned firecrackers between 10 pm and 6 am during festival seasons. However, an effective legislation regarding celebrations involving firecrackers is generally lax in India and not followed strictly. Many countries have used legislative measures to regulate the use of fireworks [23,24].

In the United Kingdom (UK), it is an offense to use fireworks on any street, highway or public place and there is a huge penalty if someone disobeys this. According to the UK Fireworks Act 2003, it is an offense to use fireworks in public places and setting off fireworks between 11 pm and 7 am. Also in Canada, selling and setting off fireworks, except between October 24 and November 1 in any year is prohibited. It also specifies that fireworks may not be sold to a minor without the written permission of the parent or guardian.
Such kind of strict guidelines should be brought into play in our country as well to prevent such serious vision-threatening ocular injuries.

Conclusion

Fireworks injuries can cause serious and permanent damage to vision. These injuries occur mainly in children, males and rural settings. All these injuries are preventable, therefore preventive measures should be strengthened, including public education and legal restriction on the sale and use of fireworks. Most importantly, the restriction of fireworks in public open spaces (such as parks or playgrounds) should be banned. Quality of firecrackers should be regulated and the promotion of safe measures and cautions via schools and social media will also have a positive impact. Fireworks display should be observed with a safe distance and the use of protective eyewear should be promoted. Adults should supervise their children during fireworks handling. The use of manipulated or misused fireworks should be discouraged. Finally, public awareness by print and electronic media can have a huge impact on fireworks-related ocular injuries.

Conflict of interest

There are no conflicts of interest to declare for all of the authors.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References