Six-year clinical study of firework-related eye injuries in North China

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ABSTRACT

Purpose To analyse the demographic data, clinical characteristics, management and prognosis of patients with firework-related eye injuries.

Methods A retrospective review was performed of patients with eye injuries related to fireworks referred to TianJin Eye Hospital in North China from 2008 to 2013. Demographic information, clinical features, management and visual outcome were analysed and prognosis factors were evaluated.

Results Ninety-nine patients (86 men) with 118 eye injuries were enrolled in the study. The average age of the patients was 32.0±20.5 years; 70/99 (70.7%) were aged >20 years. Eighty-one of the patients had been lighting the fireworks while the rest were bystanders. The main ophthalmic manifestations were hyphaema, vitreous haemorrhage, corneal/sclera/corneoscleral open globe injury, eyelid laceration, traumatic cataract, retinal/choroid detachment, endophthalmitis and intraocular foreign body (IOFB). Ninety patients required surgical intervention including repair of open globe injury, vitrectomy, cataract extraction and enucleation. 56/118 eyes (47.5%) received multiple operations. After treatment, final best-corrected visual acuity (BCVA) significantly improved (p=0.015). Some factors were significantly correlated with better final BCVA, including initial BCVA (p=0.036), closed globe injury (p=0.031), absence of endophthalmitis (p=0.014), absence of IOFB (p=0.024) and absence of retinal detachment (p=0.046).

Conclusions Firework-related eye injuries mainly occur in adult men and result in severe visual damage. The most common clinical manifestations are hyphaema and vitreous haemorrhage. Better initial BCVA and closed globe injury have a better visual result while endophthalmitis, IOFB and retinal detachment have a negative visual outcome. Improved eye protection, along with enhanced public education and legal ban on fireworks, could reduce the incidence of eye injuries.

INTRODUCTION

In developing and developed countries, eye injuries caused by fireworks account for 22% of overall eye trauma on average[1] and are therefore a major cause of visual disability. Fireworks cause many severe eye injuries, resulting in declined visual acuity or vision loss. The World Health Organization has suggested that the manufacture of fireworks should be forbidden in order to avoid injuries caused by fireworks.[2]

Lighting fireworks in the festive holiday has been a traditional custom in China for many years. When fireworks were banned in China, it led to a significant reduction in eye injuries. Similar results were reported in the USA,[3–5] Italy,[6] Ireland[7] and Denmark,[8] with a reduction in the incidence of ocular injuries of 87% if the government followed restrictive firework legislation.[1] However, it is difficult to completely prohibit the use of fireworks in China as they have been traditionally used by Chinese people for thousands of years to produce a festival atmosphere and express happiness. Eye injuries usually occur during the Chinese New Year, the most important holiday in China.

In the past a ban on the private use of fireworks decreased the incidence of ocular injuries. Recently, with the development of the economy and the abolition of the ban on fireworks, case reports of ocular injuries caused by fireworks have increased. To date, there has been no study of the demographic information, clinical features, treatment and outcome of firework-related eye injuries in North China.

We conducted a retrospective study of the manifestations, visual outcome, management and prognosis of fireworks-associated eye injuries over a 6-year period in consecutive patients referred to TianJin Eye Hospital of NanKai University, the fifth largest eye hospital in China.

METHODS

Patients

The notes of all consecutive patients with firework-related ocular injuries seen in TianJin Eye Hospital of NanKai University from 2008 to 2013 were retrospectively reviewed.

Data collection

We recorded patient age and gender, the presence or absence of eye protection, whether a bystander or lighting fireworks, ocular examination findings and management. Routine ophthalmological examinations were performed including slit-lamp examination of the anterior chamber, direct and indirect ophthalmoscopy of the posterior segment and tonometry to measure intraocular pressure (IOP). Ocular B-scan ultrasonography, ultrasound biomicroscopy and orbital CT scan were carried out to examine the retinal and vitreous status, ciliary body and lens, and intraocular foreign body (IOFB), respectively.

Data analysis

χ^2 and Wilcoxon signed rank tests were used to evaluate the ocular clinical manifestations and visual results. Statistical analysis of the data was performed using SPSS V.11.5; $p<0.05$ was considered statistically significant.

RESULTS

Patient characteristics

Ninety-nine patients (86 men, 13 women) with 118 eye injuries were enrolled in this study of

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ocular injuries associated with fireworks from 2008 to 2013 (male/female ratio 6.62:1). Follow-up averaged 10.2±2.6 months. The occurrence rate was higher in men than in women (χ^2 test, p=0.029). The average age of patients was 32 years (range 6–63). Most of the patients (70/99, 70.7%) were adults (aged >20 years). The majority did not wear eye protection; only four patients were aware of eye protection but ordinary glasses did not prevent injuries. Most of the patients (81/99, 81.8%) had personally lit the fireworks; 18/99 (18.1%) were bystanders. Firework-related ocular injuries occurred mainly in the Spring festival in our 6-year records.

Of the 99 patients, 35 (35.4%) had open globe injury (OGI) while 64 (64.6%) had closed globe injury (CGI). Twenty-two clinical manifestations from ocular examinations are shown in table 1. The most common injuries were hyphaema (49/99, 41.5%) and vitreous haemorrhage (49/99, 41.5%). There were 10 anterior segment injuries, including hyphaema, corneal/scleral/corneoscleral OGI (penetrating injury and rupture injury), lens injury (traumatic cataract and dislocation), conjunctival/corneal foreign body, corneal contusion, iris injury, angle recession/secondary glaucoma, ciliary body detachment and traumatic iritis. Of the posterior segment injuries, the eight most common were vitreous haemorrhage, optic nerve/retinal contusion, choriodal/retinal detachment, retinal/macular hole, IOFB, endophthalmitis and choroid rupture. Orbital fracture and laceration of the eyelid and lachrymal duct were also seen. Ten eyes had only one injury while the others had multiple injuries (16 eyes with 2 injuries, 13 eyes with 3 injuries and 78 eyes with >3 injuries per eye). The maximum number of injuries per eye was 10. Other features of anterior segment and posterior segment trauma in our patients are summarised in table 1.

Table 1 Clinical manifestations of firework-related eye injuries in 99 patients

Clinical manifestation	N (%)
Eyelid laceration	36 (30.5)
Orbital fracture	17 (14.4)
Canalicular laceration	4 (3.4)
Symblepharon	3 (2.5)
Anterior segment trauma	
Hyphaema	49 (41.5)
Corneal/sclera/corneoscleral laceration	39 (33.1)
Traumatic cataract	34 (28.8)
Conjunctival/corneal foreign body	29 (24.6)
Corneal contusion (corneal blood staining)	23(4) (19.5)
Iris laceration/iridodialysis	22 (18.6)
Angle recession/secondary glaucoma	22 (18.6)
Lens subluxation/luxation	17 (14.4)
Ciliary body detachment	16 (13.6)
Traumatic iritis	9 (7.6)
Posterior segment trauma	
Vitreous haemorrhage	49 (41.5)
Optic nerve/retinal contusion	34 (28.8)
Retinal detachment	20 (16.9)
Choroidal detachment	20 (16.9)
Traumatic retinal/macular hole	17 (13/4) (14.4)
Intraocular foreign body	12 (10.2)
Endophthalmitis	6 (5.1)
Choroid rupture	3 (2.5)

Surgical treatment

The patients were admitted either for surgical management or for medical treatment. Of the 118 eyes, 11 received medical treatment only and 107 (90.7%) were treated surgically. A total of 186 ocular operations were performed; the most common procedures are summarised in table 2. One operation was required in 51 eyes (43.2%). Most eyes (56/118, 47.5%) received multiple surgical interventions (37 (31.4%) required 2 operations, 15 (12.7%) required 3 operations and 4 eyes underwent 4 surgical procedures; table 3). Initial surgery included extraction of corneal foreign body, repair of OGI, traumatic cataract extraction and insertion of intraocular lens, anterior chamber washout, repair of ciliary body detachment following medication due to low IOP, iris repair and extraction of IOFB. Some patients required surgical management after the first operation, including amniotic graft, pars plana vitrectomy, corneal transplantation and enucleation. Thus, among all the surgical procedures, repair of OGI was the most frequent operation followed by vitrectomy. Enucleation was performed in seven eyes, two of which had ocular atrophy when the patients were transferred to hospital and the other five did not undergo vitrectomy.

Best-corrected visual acuity (BCVA)

In the 118 evaluated eyes the visual acuity of 13 eyes was not attainable because the patients did not cooperate with the examination. Initial and final best-corrected visual acuity (BCVA) in the remaining 105 eyes is shown in table 4. Vision was divided into five grades: initial BCVA was non-light perception–finger counting (NLP–FC) in 76/105 (72.4%), 0.01–0.09 in 7/105 (6.7%), 0.1–0.2 in 4/105 (3.8%), 0.3–0.4 in 9/105 (8.6%) and >0.5 in 9/105 eyes (8.6%). BCVA at last follow-up examination was considered as final BCVA and the grades were as follows: NLP–FC in 45/105 (42.9%), 0.01–0.09 in 7/105 (6.7%), 0.1–0.2 in 16/105 (15.2%), 0.3–0.4 in 13/105 (12.4%) and ≥0.5 in 24/105 eyes (22.9%).

In 21 eyes with initial vision of NLP, surgical management was discontinued in16 and the remaining five eyes underwent vitrectomy. After surgery the final BCVA improved in 4/5 eyes (80%), including one with 0.2. In the 16 eyes in which surgical management was discontinued, 5 (31%) underwent enucleation.

Table 2 Surgical management of 118 eyes

Surgical management	N (%)
Corneal/scleral/corneoscleral suture repair	35 (29.7)
Vitrectomy	33 (28.0)
Cataract extraction and IOL insertion	25 (21.2)
Repair of eyelid	18 (15.3)
Extraction of corneal foreign body	17 (14.4)
Extraction of IOFB	12 (10.2)
Iris repair	10 (8.5)
Trabeculectomy	8 (6.8)
Enucleation	7 (5.9)
Anterior chamber washout	6 (5.1)
Reattachment of ciliary body	6 (5.1)
Repair of canalicular laceration	3 (2.5)
Amniotic membrane graft	3 (2.5)
Symblepharon separation	3 (2.5)
Corneal transplantation	1 (0.8)

IOFB, intraocular foreign body; IOL, intraocular lens.

Table 3 Frequency of surgical treatment in 118 eyes

Operation frequency	Open globe injury	Closed globe injury	Total
0	0	11	11 (9.3%)
1	10	41	51 (43.2%)
2	19	18	37 (31.4%)
3	4	11	15 (12.7%)
4	2	2	4 (3.4%)

The final BCVA was significantly improved following medical treatment (Wilcoxon signed rank test, Z=2.466, p=0.015). The number of eyes with BCVA of ≥0.5 increased from 8.6% to 22.9%. Factors that were significantly associated with better final BCVA were better initial BCVA (p=0.036), CGI (p=0.031), absence of endophthalmitis (p=0.014), absence of IOFB (p=0.024) and absence of retinal detachment (p=0.046), according to the χ^2 tests.

DISCUSSION

In this study we analysed 99 patients with 118 eye injuries caused by fireworks. Most of the injuries occurred in men, which is consistent with the findings from previous studies.[9] This finding was different from the results of an earlier paper,[7 10–13] in which the incidence was highest in young people (<20 years of age). A possible reason for this difference is that more supervision over children decreases the incidence of injury in young people. Our study indicates that men are the major victims of eye injuries caused by fireworks because they are actively involved in lighting fireworks while lacking appropriate personal protection equipment (PPE). In this study the proportion of bystander victims was 18.1%, which is relatively small. However, the extent of injuries in the bystanders was quite serious, which indicates that bystanders are not safe and that it is essential to pay special attention when watching fireworks.

Previous research[14] and our study show that most eye injuries are occur because no eye protection was worn during fireworks, which underlines the importance of eye protection for the prevention of eye injuries. It has been suggested that, in order to reduce the incidence of eye injuries caused by fireworks, firework sellers should provide protective glasses when selling them.[15] We support this view; if fireworks cannot be completely banned, PPE could be a very useful way to reduce eye injuries.

The force of the explosion caused by fireworks can damage several parts of the body, and eye damage is a common injury. An injured eye might have many of the clinical manifestations mentioned above such as hyphaema, vitreous haemorrhage, corneal/scleral/corneoscleral laceration, traumatic cataract, retinal detachment, IOFB and endophthalmitis. In our study the most common injuries were hyphaema and vitreous haemorrhage, both accounting for 41.5%. The incidence of these two injuries was lower (28%) in one domestic report.[16] In previous studies, corneal abrasion[1] and ocular OGI[17] were the most frequent features. Reported firework-related eye injuries in China are usually more severe than those in developed countries. The possible reasons for this are: (1) fireworks in China are more powerful than those available in Western countries; (2) personal eye protection equipment is not usually worn when lighting or watching fireworks; and (3) primary medical care is not widespread in China and people usually go to see an ophthalmologist only when they have a severe injury.

The final BCVA reached a better level after treatment, indicating the significance of ocular microsurgery such as vitrectomy. Better initial BCVA was associated with a better final BCVA, which underlines the importance of the severity of the initial injury for visual prognosis. When endophthalmitis and IOFB were present, the final vision could be poor. These results agree with previous conclusions.[18] On the other hand, our research also found that OGIs could statistically cause a worse final BCVA than CGIs, which is opposite to the finding of Jing *et al*.[16] A possible reason for this difference could be the relatively small sample size in the previous study. We found that retinal detachment was also associated with the final outcome, and eyes without retinal detachment achieved better final vision.[19] Furthermore, active surgical treatment plays an important role in saving vision,[20 21] especially in eyes with initial vision of NLP. Doctors should therefore have a positive attitude to encouraging patients to have proper surgery in order not to miss the opportunity of treatment.

In summary, a retrospective study of firework-related ocular injuries was undertaken because fireworks cause serious damage to eyesight and may even result in blindness.[22] Only a limited number of patients were analysed and more cases are needed for further detailed assessment. As ophthalmologists, we need to emphasise to our patients that enhanced public awareness, strengthened education on safety and proper legislation for using fireworks are the key methods to reduce such serious trauma.

Table 4 Comparison of initial and final best-corrected visual acuity (BCVA) on different ocular injury types in 105 eyes

	Open globe injury		Closed globe injury		Total	
Grade of BCVA	No of eyes	%	No of eyes	%	No of eyes	%
Initial vision						
NLP–FC	32	30.5	44	41.9	76	72.4
0.01–0.09	2	1.9	5	4.8	7	6.7
0.1–0.2	0	0	4	3.8	4	3.8
0.3–0.4	0	0	9	8.6	9	8.6
≥0.5	0	0	9	8.6	9	8.6
Final vision						
NLP–FC	24	22.9	21	20	45	42.9
0.01–0.09	1	1.0	6	5.7	7	6.7
0.1–0.2	3	2.9	13	12.4	16	15.2
0.3–0.4	2	1.9	11	10.5	13	12.4
≥0.5	4	3.8	20	19.0	24	22.9
	34		71			

Difference between initial and final vision is significant by Wilcoxon signed rank test: Z=2.466, p=0.015.
FC, finger counting; NLP, non-light perception.

Main messages

- Most patients with ocular injuries from fireworks are men and most were responsible for lighting the fireworks.
- The most common ocular injuries were hyphaema and vitreous haemorrhage.
- A good outcome with subsequent return to normal vision was associated with better initial best-corrected visual acuity, closed globe injury, absence of retinal detachment and absence of intraocular foreign body.

Current research questions

- What are the clinical characteristics of firework-related ocular injuries in North China?
- What is the clinical outcome of firework-related eye injuries after surgical and medical treatment?
- Which factors are strongly correlated with better final best-corrected visual acuity?

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Competing interests None.

Patient consent Obtained.

Ethics approval Ethical approval was obtained from the hospital ethics committee.

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