• Investigation •

Ocular injury resulting in eye removal at a large tertiary care center in China

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Abstract

● **AIM:** To investigate the risk factors for eye removal following ocular trauma at a major ophthalmology department in China.

● **METHODS:** A retrospective study of patients who underwent eye removal surgery following ocular trauma was completed. Clinical outcomes were consulted in detail through the hospital's computed medical data system. Patients' information including age, gender, cause of ocular trauma, affected eye, and education level was collected and recorded in a standardized database. Chi-squared test, Student's *t*-test, Fisher's exact test, and bivariate correlation analysis were used for statistical comparisons.

● **RESULTS:** The present study included 1675 removal eyes from 1674 patients over the 20-year period. Patients included 80.5% males and 19.5% females, with mean age of 38y. The majority of the patients (70.7%) were blue-collar workers (physical laborers), and 1098 patients (65.6%) did not receive high school education. Work-related injuries were the most common reason for eye removal (*n*=739, 44.1%), of which 441 cases (59.7%) were related to metal/nail wounds. The most frequent injury type in males was work-related injuries (49.7%), whereas the most frequent injury type in females was home-related injuries (25.8%).

● **CONCLUSION:** Work-related injuries are a leading cause of severe ocular injury resulting in eye removal. In addition, men and undereducated patients are more likely to undergo eye removal surgery following ocular trauma. This study identified multiple high-risk factors leading to eye removal following ocular trauma, which is of great importance for preventing severe eye injuries.

● **KEYWORDS:** ocular trauma; enucleation; evisceration; injury types; risk factors

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INTRODUCTION

In developed and developing countries, ocular trauma remains a major cause of monocular blindness and visual impairment. According to the World Health Organization (WHO) Program for the Prevention of Blindness whose data represent the relatively more developed countries, every year 55 million eye injuries occur that restrict activities at least one day. Moreover, there are approximately 1.6 million people with blindness due to injuries, an additional 2.3 million people with bilateral low vision from this cause, and almost 19 million people with unilateral blindness or low vision[1]. However, the incidence of eye trauma may be higher in developing countries[2-3].

Unfortunately, removal of the eye, including enucleation and evisceration is still a common therapeutic modality for traumatic ocular injuries. In cases of injury, it is necessary to relieve ocular pain, protect vision in the unaffected eye, and even preserve life in severe cases. However, restoration of cosmetic appearance is also essential[4]. In our previous study, we showed that anxiety and depression were more prevalent in patients who underwent eye enucleation than in the general population[5].

With 725 600 patients treated and 72 400 ocular surgeries performed in 2018, the Department of Ophthalmology of the Second Affiliated Hospital of Zhejiang University School of Medicine has been one of the largest and the best-known eye centers in China. It offers both emergency and specialized care for ocular diseases and conditions for patients of all age groups. In this study, we aimed to investigate the risk factors for ocular trauma in order to develop preventive strategies. With

this in mind, we evaluated eye enucleations and eviscerations following trauma over a period of 20y to categorize the high-risk behaviors.

SUBJECTS AND METHODS

Ethical Approval The study was approved by the Ethics Committee of the Second Affiliated Hospital of Zhejiang University, and followed the tenets of the Declaration of Helsinki.

Subjects We performed a retrospective study of patients who underwent enucleation or evisceration following ocular trauma admitted at the Department of Ophthalmology of the Second Affiliated Hospital of Zhejiang University School of Medicine from January 1999 to December 2018. All the related medical records were anonymous and no patient information could be extracted except for research purposes. Clinical outcomes were consulted in detail through the hospital's computed medical data system. Patient information including age, gender, cause of ocular trauma, affected eye, and education level was collected and recorded in a standardized database. A total of 1818 patients were identified who underwent enucleation or evisceration following ocular injury. Data analysis was performed in 1674 patients who had information regarding the cause of ocular trauma recorded in the electronic medical record. Patients were excluded if there was no reported history of trauma or if the cause of the traumatic ocular injury was unknown.

Enucleation was performed mainly for patients for whom evisceration was contraindicated or not feasible. Surgeries were performed under general or local anesthesia. For enucleation, a 360° peritomy and blunt dissection of the conjunctiva and Tenon's capsule were performed. The muscles were isolated and secured with a locking suture by 5-0 polyester suture. The optic nerve was transected with a curved enucleation scissor, the globe was removed, direct pressure as well as bipolar cautery were used for hemostasis. The implant was selected and soaked in an antibiotic solution, and placed in the socket. The recti and oblique muscles were sutured, securing the implant within the muscle cone. Tenon's capsule and conjunctiva were closed in separate layers using 6-0 polyglactin sutures. During evisceration, a 360° peritomy, limbic sclerotomy and keratectomy were performed with corneoscleral scissors. Uveal tissue was completely removed aided by careful scraping and aggressive rubbing. The scleral shell was closed with 6-0 polyglactin sutures. Tenon's capsule and conjunctiva were sequentially closed using 6-0 polyglactin sutures.

We classified the injuries into six groups, namely work-related injuries, home-related injuries, sport-related injuries, outdoors/recreational activity, assault, and motor-vehicle accident, based on Birmingham Eye Trauma Terminology system (BETT), the standardized international classification system for ocular trauma[6].

Statistical Analysis All statistical analyses were performed using IBM SPSS Statistics Version 18.0 (IBM Corp., Armonk, NY, USA). Chi-squared test, Student's *t*-test, Fisher's exact test, and bivariate correlation analysis were used for statistical comparisons. A *P*-value <0.05 was considered statistically significant.

RESULTS

During the 20-year period from January 1999 to December 2018, a total of 2784 globes were removed. Among these, 1818 eyes (65.3%) were removed following ocular trauma at the Department of Ophthalmology of the Second Affiliated Hospital of Zhejiang University. Review of these 1818 cases revealed 1674 cases with an identifiable cause and object of injury. The age of these 1674 patients ranged from 1 to 85y (mean age 38.0±14.4y). Among these patients, 1348 (80.5%) were males, and 326 (19.5%) were females, thus yielding a male-to-female ratio of 4.1:1. Mean age in males was 38.3±13.8y and mean age in females was 36.8±16.6y (*P*=0.098). There was no significant difference in the frequency of injuries between the right and the left eyes (829 right *vs* 844 left, and 1 bilateral eye injury).

Overall, the most frequent injury type was work-related injuries, followed by injuries due to outdoors/recreational activities, violence-related injuries, and home-related injuries. The different causative factors leading to eye injury are listed in Table 1. Among work-related injuries, metal/nails were the leading cause of eye injuries, while firecrackers were the primary cause of eye injuries among injuries related to outdoors/recreational activities. Scissors/needles were the main cause of home-related injuries. The most common causative factors of violence-related injuries were finger, fist, or foot.

There was a correlation between cause of injury and gender (*P*≤0.001). Traumatic eye removal was approximately 4.1 times more common in males than in females (1348 males *vs* 326 females). After division of the whole study population into injury-related subgroups (Figure 1), the most frequent injury type in males was work-related injuries which were significantly higher than that in females (49.7% *vs* 21.2%, *P*<0.001), whereas the most frequent injury type in females was home-related injuries which were much higher than that in males (25.8% *vs* 9.1%, *P*<0.001). In addition, several other critical causes were reported in males including outdoors/recreational activities (19.1%), and violence-related injuries (13.6%). In females, work-related injuries (21.2%) and outdoors/recreational activities (20.9%) were also important causative factors besides home-related injuries.

In the present study, most of the patients (70.7%) were blue-collar workers (physical laborers) and 1098 patients (65.6%)

Table 1 Mechanism of ocular trauma

Parameters	Total (%)	Male (%)	Female (%)	Mean age (y)
Work-related	739 (44.1)	670 (49.7)	69 (21.2)	42.3±11.5
Metal/nail	441	401	40	39.7±10.6
Wood fragment	74	63	11	48. 4±12.1
Stone	61	57	4	47.7±10.9
Explosion	39	39	0	40.7±12.4
Farm related	31	18	13	52.3±9.7
Thermal burn	24	24	0	43.1±9.2
Chemical burn	18	17	1	47.6±9.7
Machinery	16	16	0	45.4±10.7
Pipe/hose	12	12	0	42.3±14.1
Plastics	6	6	0	41.8±14.1
Glass fragment	5	5	0	38.4±8.7
Gas/water	5	5	0	39±13.8
Fall	5	5	0	31.0±3.0
Other	2	2	0	52.0±11.3
Outdoors/recreational activity	326 (19.5)	258 (19.1)	68 (20.9)	31.6±14.3
Firework	117	109	8	38.9±14.2
Tree/branch trauma	79	53	26	27.3±12.9
Metal/nail	53	41	12	26.1±10.8
Glass	44	30	14	30.7±13.4
Stone	12	10	2	31.0±16.8
Pen/ruler	10	6	4	29.1±12.5
Toys bullets	7	6	1	27.7±11.8
Plastics	2	1	1	34.0±19.8
Battery	1	1	0	29.0
Door	1	1	0	50.0
Home-related	206 (12.3)	122 (9.1)	84 (25.8)	34.2±17.0
Scissors and needles	90	44	46	27.8±13.5
Fall	61	46	15	41.1±18.7
Bottle explosion	22	14	8	29.7±14.4
Instant pot explosion	9	3	6	43.8±9.4
Chemical	7	4	3	30.0±20.2
Burn	4	3	1	61.5±11.3
Domestic appliances	4	2	2	38.5±9.9
Carton	2	1	1	46.0±22.6
Stone	2	1	1	45.0±1.4
Hair	1	1	0	67.0
Other	4	3	1	34.5±17.1
Assault	243 (14.5)	184 (13.6)	59 (18.1)	36.2±14.7
Finger/fist/foot	90	67	23	39.7±14.4
Knives/scissors	46	34	12	33.4±13.4
Stick	34	25	9	32.8±15.3
Stone	25	20	5	40.0±13.8
Attacked by animal	20	14	6	36.3±15.2
Glass bottle	10	9	1	35.2±8.6
Gunshot wound	8	7	1	40.8±21.3
Metal/nail	6	5	1	40.5±20.6
Belt	4	3	1	39.3±7.4
Motor vehicle accident	152 (9.1)	106 (7.9)	46 (14.1)	39.5±16.2
Sport-related	8 (0.5)	8 (0.6)	0	29.9±10.5
Total	1674	1348 (80.5)	326 (19.5)	38.0±14.4

did not receive high school education among these total 1674 cases. In particular, up to 76.5% (565/739) of the patients with work-related injuries had less than high school level education. Furthermore, students at school were more likely to be injured due to outdoors/recreational activities (54/114, 47.4%; Figure 2).

DISCUSSION

According to previous research, trauma was the most common clinical diagnosis leading to eye removal worldwide. In our study, trauma was the primary pathogenesis for removal eyes (1818/2784, 65.3%). This finding is similar to the results of the Chinese Tong Ren Eye Center (62.5%)[7] and the Chinese People's Liberation Army General Hospital (65.62%)[4], which may jointly reflect the characteristic conditions in China. Other studies were also consistent with our study, showing ocular trauma to be the primary cause for eye removal[8-12]. However, tumors were the most frequently cause leading to enucleation in India[13], while the infection was the most common cause in southern Nigeria[14].

In the present study, work-related injuries (739/1674, 44.1%) were the leading cause of eye removal following trauma, with metal/nail wounds (441/739, 59.7%) representing the majority of these cases. Other studies have shown that assault[10] and firecracker[12] injuries to be the most common injuries leading to eye removal. Metal/nail wounds represent the leading cause of eye injuries among all the work-related injuries according to the previous reports in different countries[15-17]. This finding might be attributed to the specific conditions associated with the most common tasks such as metal cutting, nailing, grinding, welding, hammering, drilling, and carpentry that may cause injury. Workers always have to use high-powered tools that generate metal fragments/nails with high speed, which might have crushing effects on the eyes during these activities[18]. In our study, all the patients with metal/nail wounds had no particular eye protection. Thus, our results indicated that it is crucial to improve the equipment and the strategy of eye protection while executing dangerous tasks.

According to the ophthalmic literature and WHO's Blindness Data Bank, the major risk factors for ocular injuries include age, gender, socioeconomic status, and lifestyle[1]. The present study showed a higher frequency of all types of ocular injuries in males, especially work-related injuries (49.7%), injuries during outdoors/recreational activities (19.1%), and violence-related injuries (13.6%). This finding is consistent with those of several other studies in which males tended to have a higher frequency of ocular injuries than did females[10-12,19-22]. Furthermore, the most frequent injury type in females was home-related injuries (25.8%) which were significantly more frequent than that in males. A plausible explanation for this finding is that men are the primary labor force in industrial activities, with a high frequency of occupational or outdoor

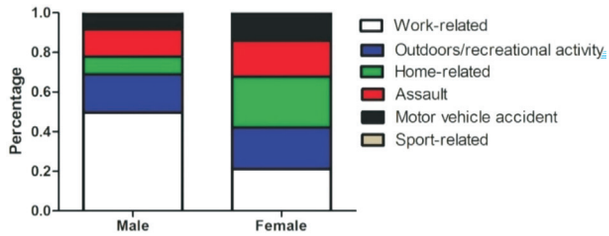

Figure 1 Frequency of different types of eye injuries according to gender The most frequent injury type in males was work-related injuries (49.7%), followed by outdoors/recreational activities (19.1%) and violence-related injuries (13.6%). The most frequent injury type in females was home-related injuries (25.8%), followed by work-related injuries (21.2%) and outdoors/recreational activities (20.9%).

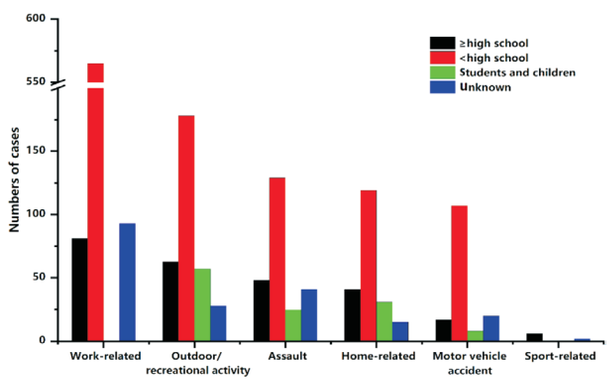

Figure 2 Education levels in patients with different types of eye injuries Among the total cases, 65.6% of the patients did not receive high school education. In particular, 76.5% of the patients with work-related injuries had less than high school level education.

exposure. In contrast, women are more likely to stay at home with a large proportion pursuing domestic duties.

In addition, the current study showed that the education level was associated with the risk for ocular trauma. We found that 65.6% of the patients among the total cases did not obtain high school education. Especially, 76.5% of the patients with work-related injuries (565/739) had less than high school level education. This finding may be due to the fact that people with low education are disproportionately employed in jobs that entail exposure to hazardous working conditions[23], or due to highly educated people having more work experience that might reduce risky situations or hazardous conditions at workplace because of their higher skills[24].

Notably, trauma due to firecrackers was the primary cause of eye injuries (117/326, 35.9%) related to outdoors/recreational activity, especially in young men. Usage of fireworks to celebrate national and religious events is a well-known phenomenon worldwide. These celebrations include the Fourth of July and New Year's Eve in the United States, Guy Fawkes Day in Britain, Halloween in Northern Ireland, Diwali Festival in India, Hari Raya Festival in Malaysia, and New Year's Day in Austria, Denmark, Italy, and Iran. Various studies showed that there were significantly higher numbers of firework-

related injuries around these periods in these countries where the festivals were celebrated[25]. Moreover, the Spring Festival is the most important holiday in China. On this traditional holiday, most of the people are likely to use fireworks, which may lead to an increase in firework-related injuries. Wang *et al*[25] reported that firework-related ocular trauma accounts for 11.4% of the firework-related injuries in China. Fireworks are also associated with severe and multiple injuries of hands, fingers, head, face, and trunk. Stricter enforcement of firework legislation, educating the population about the dangers of fireworks, and restricting the personal use of fireworks are proven methods to lower the incidence rate of firework-related casualties remarkably.

This study has several limitations. First, the study was limited by its retrospective nature which usually results in loss of a lot of analytical possibilities and results due to the data irregularity. Second, the Second Affiliated Hospital of Zhejiang University is a tertiary referral center. Thus, the ocular injuries included in our study might be more severe than those typically seen in other regions. Last but not least, the cause of ocular injuries might have overlapped in some special occupations. However, we believe that the major findings of our study still have beneficial implications despite these potential limitations.

In conclusion, trauma is an important cause of severe ocular injury that may lead to eye removal. In addition, this study identified multiple high-risk factors leading to eye removal following trauma. Preventive efforts based on the analysis of these risk factors may reduce the incidence of ocular trauma. All our data suggest that appropriate use of protective eyewear, better education, and decrement of environmental risks and high-risk activities could reduce the morbidity associated with eye injuries.

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