ORIGINAL RESEARCH

Severe ocular injuries that required hospitalization: a retrospective survey from a regional eye referral center

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Abstract

Aim: To profile the incidence and severity of ocular injuries in Hong Kong.
Materials and methods: A 4-year retrospective survey of all patients (n = 149) admitted to the Caritas Medical Centre between January 1995 and December 1998 with ocular trauma as the principal diagnosis.
Results: The mean age was 38.6 years and the male to female ratio was 3.52:1. The most common causes of ocular injuries were work-related events (43.6%) and assault (12.8%). Others included falls (12.1%), non-work-related and domestic accidents (12.1%), sports and recreational events (8.7%), traffic accidents (8.1%), human contacts (1.3%), and injuries by animals (1.3%). 62 patients (41.6%) had a poor visual outcome with visual acuity less than 6/12 in the injured eye and, in this group, 38 (25.5% of the total) became blind in the injured eye.
Conclusions: Ocular trauma is an important cause of preventable and predominantly monocular visual morbidity and blindness. Appropriate health education and safety strategies should be implemented in the future.

Key words: *Ocular injuries, Work-related events, Falls, Visual impairment*

Introduction

Ocular trauma is an important cause of preventable visual morbidity and blindness, particularly among younger people, who are at lower risk for chronic ocular diseases.[1-4] Various studies have shown that many patients with ocular trauma presenting to the ophthalmic services have minor injuries, and are therefore treated as outpatients, with only a small proportion (0.9% to 1.8%) being admitted to hospital.[5-7] Consequently, despite the importance of ocular trauma and the great potential for prevention, educational and preventive efforts have been hampered by a lack of epidemiological data for this condition. This study aims to report on the incidence, causes, and visual outcome of ocular trauma of sufficient severity to warrant hospitalization, so that effective preventive measures and safety strategies may be recommended.

Materials and methods

All the patients admitted to the Caritas Medical Center Eye Ward between January 1995 and December 1998, with a principal discharge diagnosis of ocular trauma were included in this study. The principal diagnosis was defined as an ocular trauma code recorded as the condition chiefly responsible for admission to hospital, based on the *International Classification of Diseases* (**Table 1**).[8] All data were collected by ophthalmologists. The case notes were reviewed, and the following details were recorded from each patient: age and sex, cause of injury, place of injury, identifiable objects causing injury, type of injury, surgeries performed,

Table 1. International Classification of Diseases (ICD 9) diagnosis codes for ocular trauma.[8]

ICD 9 code	Description
802.6-802.7	Orbital floor fractures (blow-out)
870.0-870.9	Open wounds of ocular adnexa
871.0-871.9	Open wounds of eyeball
921	Contusion of eye or adnexa
930	Foreign body on external eye
940	Burn confined to eye and adnexa
950.0-950.9	Injury to optic nerve and pathways

visual outcome, length of hospitalization, any previous ocular surgery, and presence or absence of protective eye wear.

Cause of injury was classified as follows: assault, work-related event, sports and recreational activities, road traffic accident, human contact (excluding assault, sports and recreational activities), fall, injury by an animal, and other activities (including domestic accident, event occurring during leisure, shopping, children playing). The final best-corrected visual acuity was obtained after all necessary procedures, including surgery and refractive correction, had been performed. This represented a definite stage where stability was likely to have been achieved and no further surgery was required, irrespective of type or severity of injury. Visual outcome was defined in terms of the best-corrected Snellen visual acuity in the injured eye (in the case of bilateral injuries, the more severely affected eye was taken). The definition of visual outcome was slightly modified from the definitions used by the World Health Organization.[9] A good visual outcome was defined as a Snellen visual acuity of 6/12 or better. Blindness was taken to be a visual acuity of less than 6/60 and visual impairment was taken as a visual acuity of 6/18 to 6/60 (inclusive). Corrective spectacles (without protective lenses) were not considered as a form of protection. The types of surgical procedures and the period of hospitalization were also noted.

Results

149 patients were admitted for ocular trauma during the study period. Of these, 116 (77.9%) were male and 33 (22.1%) were female. The mean age was 38.6 years (range 3 weeks to 95 years). The incidence of ocular trauma varied significantly with age and sex (**Figure 1**). For males, the incidence of hospitalized ocular trauma peaked in the 35 to 54 years age group, and decreased thereafter. For females, the peak incidence occurred in the 75 to 84 years age group. Eye injury rates were lower for women than for men except in the 0 to 4 years and 75 to 84 years age groups.

65 (43.6%) injuries occurred at work, 19 (12.8%) from assaults, 18 (12.1%) from falls, 13 (8.7%) during sports and recreational activities, and 12 (8.1%) in road traffic accidents. 18 (12.1%) occurred in domestic accidents and non-work-related activities, two (1.3%) resulted from human contact (not due to assault and sports), and two from injury by animals. The cause of injury also varied widely with age (**Table 2**). Work-related accidents showed a peak incidence in the working age group (45 to 54 years). Injuries due to assault, sports, and recreational activities peaked in the younger age groups (15 to 24 years). Falls, on the other hand, dramatically increased in the older age group. Falls alone accounted for 100% of ocular trauma in citizens older than 74 years.

Among work-related accidents, 61 patients (93.8%) were male. The mean age was 43.3 years (17 to 69 years). Projectile objects accounted for 50.8% (33 patients) of all work-related ocular trauma. Metallic foreign bodies were the most frequent objects identified (23). The second most common type of work-related ocular injury was chemical injury of the eyes (8). Other objects identified included tools (8), nails (5), bungee cords (2), sticks (2), and tree branches (2). Injuries usually occurred during hammering, drilling, welding, or handling of industrial chemicals. Most patients (33) sustained a corneo-scleral laceration (partial

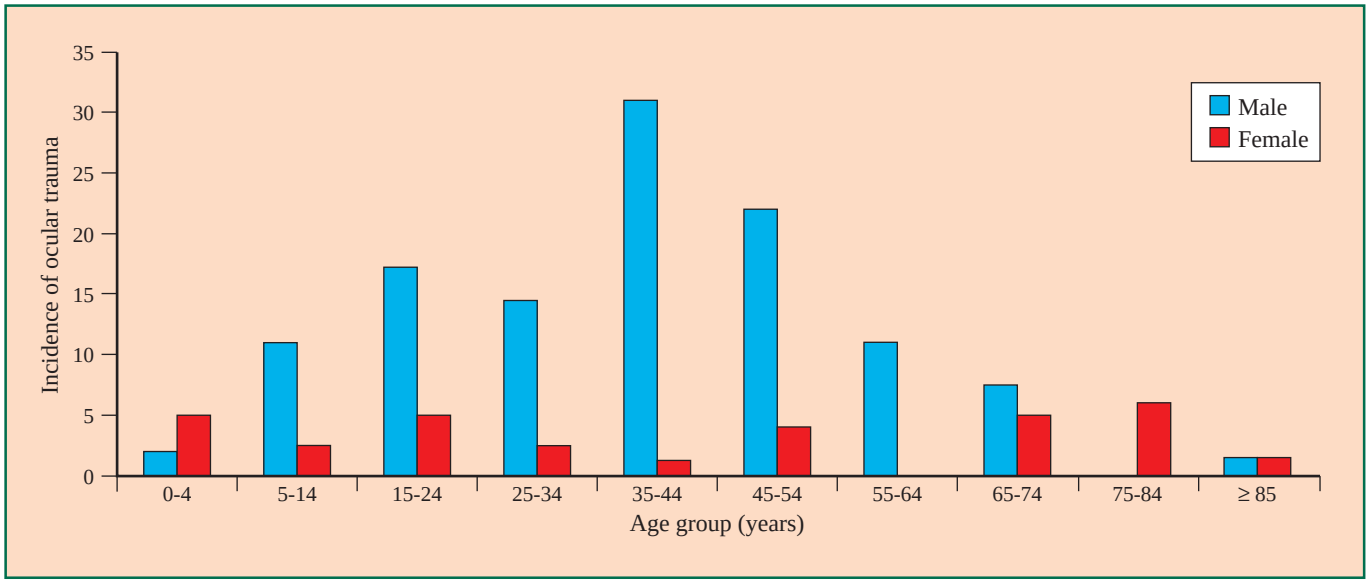


Figure 1. The incidence of ocular trauma for sex and age.

Table 2. Cause of ocular injury in different age groups.

Age group (years)	0-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75-84	≥85
Assault	0	2	6	2	3	5	0	1	0	0
Work-related	0	1	5	9	20	17	9	4	0	0
Sport and recreation	0	4	4	3	2	0	0	0	0	0
Road traffic accident	0	0	5	1	4	1	0	1	0	0
Human contact (not due to assault, sport, recreation)	0	1	0	0	0	0	1	0	0	0
Falls	3	3	0	0	1	0	1	2	6	2
Animals	1	0	0	1	0	0	0	0	0	0
Others (foreign bodies, burns, domestic accidents)	3	3	2	1	2	3	0	4	0	0
Total	**7**	**14**	**22**	**17**	**32**	**26**	**11**	**12**	**6**	**2**

or full thickness). Other severe injuries included retention of intraocular foreign bodies (11), traumatic cataract (17), and retinal detachment (6). 44.6% of workers had a poor visual outcome in the injured eye (29). None were reported to be wearing safety spectacles at the time of injury.

Among the 19 assaults, 17 patients (89.5%) were male. The mean age was 33.8 years. Most of the assaults occurred in public areas (15). The most common objects causing injury were body parts, such as fists and feet (9), and airgun pellets (4). The most common tissue injuries were eyelid lacerations (8), hyphema (8), and corneal lacerations (8). Other more severe injuries were retinal detachment (2) and fractured orbit (1). Nine patients (47.4%) had a poor visual outcome. Among these, five patients became blind in the injured eye, all of whom sustained a corneal laceration with significant scarring of the visual axis.

The age distribution of fall injuries appears to follow a bimodal distribution, with most injuries occurring in people older than 60 years and younger than 16 years. The mean age was 51.4 years (8.4 months to 95 years). The male to female ratio was 8:10. The majority of falls (17) occurred at home. All of the injuries were incurred by hitting fixed settings such as table corners, furniture, or the ground. Tissue injuries included ruptured eyeballs, hyphema, eyelid lacerations, and retinal dialysis. 12 patients had a poor visual outcome, and seven eventually became blind. Most of these patients (10) were elderly—older than 64 years. It is worth noting that nine patients with a fall injury had undergone a previous operation to the injured eye, including cataract extraction, penetrating keratoplasty, and trabeculectomy. Seven of these patients had a poor visual outcome, and five became blind. Six falls involved children less than 15 years old (8 months to 13 years), two of which resulted in visual impairment due to corneal scarring or retinal dialysis.

The mean age of patients injured during sports and recreation was 21.5 years (10 to 36 years). There was a male preponderance (male to female ratio, 5.5:1). The sports most commonly associated with eye injuries were football (5, 38.5%) and badminton (4, 30.8%). Other sports associated with ocular injuries included squash (2), tennis (1) and basketball (1). Injuries were inflicted either by another player coming into contact with the eye or periorbita, or by the ball or racket. Traumatic hyphema, angle recession, and traumatic glaucoma were the most frequent tissue injuries. Two patients were visually impaired and one became blind due to a traumatic macular hole with retinal detachment. None of the injured patients were reported to be wearing safety glasses during the game. Shattered spectacle lenses while playing badminton, squash, or tennis injured three patients.

Injuries from road traffic accidents numbered 12. Most patients were young, with a mean age of 33.3 years (18 to 65 years). The majority sustained relatively superficial injuries such as eyelid lacerations (11). Only one patient became blind, due to corneal laceration.

Most of the injuries (43.6%) occurred in the workplace (**Figure 2**). This was followed by the home (18.8%), other public areas (11.4%), sports and recreational areas (8.7%), roads (8.1%), streets (2.0%), and schools (0.7%). The place where the injury occurred was not identified for 10 patients (6.7%). Among the 28 patients with domestic injuries, falls were the single most important cause (17), as already mentioned. A variety of other objects were also identified: pencils, fingernails, bungee cords, and metallic foreign bodies.

Excluding sporting injuries (13), the objects causing injuries were identified in the remaining 136 cases. Of these, 33.8% were caused by projectiles, 33.1% by blunt objects, 22.1% by sharp objects, 6.6% by burns, and 4.4% by blasts

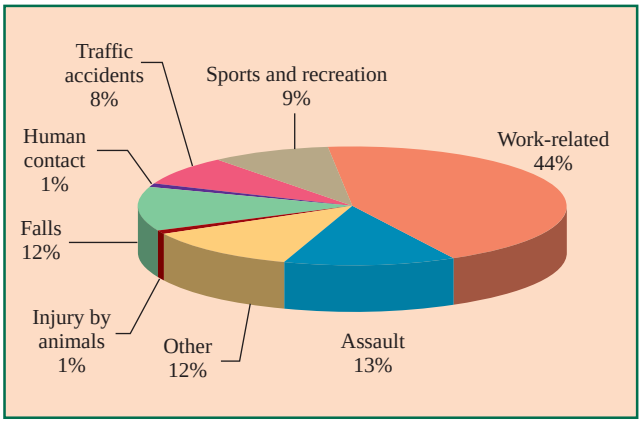


Figure 2. Causes of ocular injury.

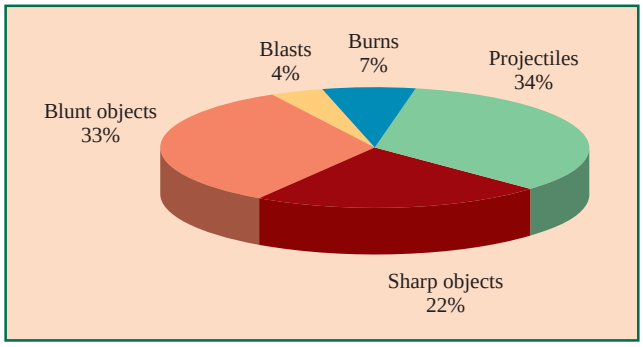


Figure 3. Objects causing ocular injury.

(**Figure 3**). The most common specific objects causing injuries were projectile metallic foreign bodies (25). Others included tools (14), sharp glasses (11), industrial chemicals (8), airgun (BB) pellets (6), tree branches (5), nails (5), and bungee cords (4).

Ocular injuries were categorized anatomically into 4 groups (**Table 3**): extraocular, anterior segment, posterior segment, and orbital injuries. Some patients sustained more than one type of injury; therefore the total number of injuries is greater than the total number of patients (149). Extraocular injuries consisted primarily of eyelid lacerations (38), ecchymoses (5), foreign bodies in eyelids (3) and burns to eyelids (2). Anterior segment injuries included full-thickness or partial thickness corneal and scleral lacerations (62), traumatic hyphema (35), traumatic glaucoma (23), traumatic cataract (23), retained foreign bodies in the anterior chamber (10, including three in the lens), lens dislocation and subluxation (7). Superficial injuries to the anterior segment, including corneal foreign bodies (17), chemical keratitis (8), and corneal abrasions (4), were also noted. The posterior segment category included rhegmatogenous retinal detachment and retinal dialysis (12), vitreous hemorrhage (21), retinal hemorrhage and edema (12), and retained magnetic foreign bodies on the retina (3). Orbital injuries included fractured floor of orbit (2), compressive optic neuropathy (2) and intraorbital foreign body (1).

Table 3. Types of ocular tissue damage in 149 patients.

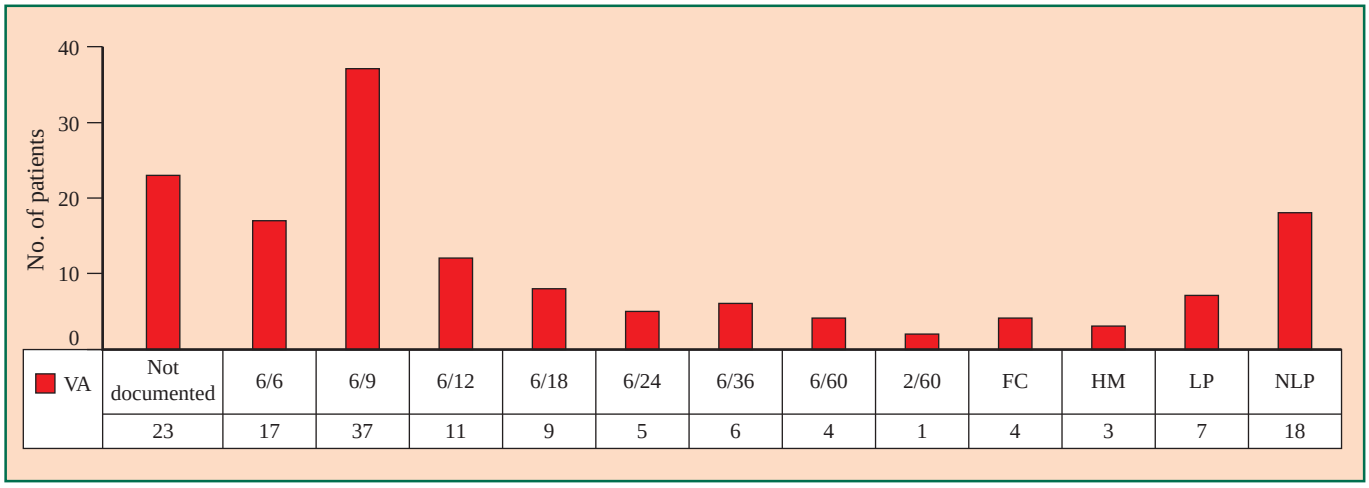
Tissue damage	No. of patients	Percent
Extraocular injury		
Eyelid lacerations	38	25.5
Ecchymoses	5	3.4
Foreign bodies in eyelids	3	2
Burns to eyelids	2	1.3
Anterior segment injury		
Corneo-scleral lacerations	62	41.6
Traumatic hyphema	35	23.5
Traumatic glaucoma	23	15.4
Traumatic cataract	23	15.4
Retained foreign bodies in anterior segment	10	6.7
Lens dislocation / subluxation	7	4.7
Corneal foreign bodies	17	11.4
Chemical keratitis	8	5.4
Corneal abrasions	4	2.7
Posterior segment injury		
Rhegmatogenous retinal detachment	9	6
Retinal dialysis	3	2
Vitreous hemorrhage	21	14
Retinal hemorrhage and edema	12	8
Retained magnetic foreign bodies on retina	3	2
Orbital injury		
Fractured floor of orbit	2	1.3
Compressive optic neuropathy	2	1.3
Intraorbital foreign body	1	0.7

Table 4. Some major surgical procedures performed for ocular injuries.

Surgical procedure	No. of procedures
Repair of corneo-scleral lacerations	55
Repair of eyelid lacerations	36
Removal of corneal and conjunctival foreign bodies	18
Lens removal	12
Removal of intraocular foreign bodies	8
Scleral buckling	6
Retinal barrier and cryotherapy	7
Trabeculectomy	4
Glaucoma valve implantation	3
Penetrating keratoplasty	2
Reduction of orbital fracture	1
Evisceration and enucleation	6

Surgery was necessary for 113 patients (75.8%), in a total of 176 surgical sessions (**Table 4**), involving more than 200 surgical procedures. Primary repair of a corneal or scleral laceration was performed for 55 patients (36.9%). Other common procedures included repair of eyelid lacerations (36), removal of corneal and conjunctival foreign bodies (18), lens removal (12), removal of intraocular foreign bodies (8), scleral buckling (6), retinal barrier and cryotherapy (7), trabeculectomy (4), glaucoma valve implantation (3) and penetrating keratoplasty (2). Reduction of orbital fracture was performed for one patient, and six patients eventually required removal of the eyeballs by evisceration or enucleation. The 36 patients who needed no surgical interventions included those admitted for hyphema (16), chemical eye injuries (7), and corneal abrasions (4). Five patients were admitted for computerized tomographic scan to rule out an intraocular foreign body. The mean period of hospitalization was 10.6 days. Most patients (56.4%) stayed for 1 to 7 days.

Final visual outcome was not documented for 23 patients (15.4%; **Figure 4**). Four children (all younger than 1 year old) were too young and uncooperative for accurate visual acuity tests. There was also 1 psychiatric patient and one patient with dementia for whom reliable visual outcome



VA	Not documented	6/6	6/9	6/12	6/18	6/24	6/36	6/60	2/60	FC	HM	LP	NLP
	23	17	37	11	9	5	6	4	1	4	3	7	18

Abbreviations: VA = visual acuity; FC = finger count; HM = hand movement; LP = light perception; NLP = no light perception.

Figure 4. Distribution of final visual acuity.

documentation was not possible. The remaining patients were lost to follow up before the final visual acuity check. Eight patients had relatively minor injuries that did not require surgery.

62 patients with documented final visual acuity (41.6% of the total admission) had a poor visual outcome. Of these, 24 (16.1% of the total) had a visual acuity between 6/18 and 6/60 (inclusive), and 38 (25.5% of the total) were blind with a visual acuity of less than 6/60 in the injured eye. 18 of the patients who became blind eventually lost all perception of light.

Discussion

Eye injuries are common; it has been estimated that eye trauma accounts for 38 to 52% of all new patients seen in an eye casualty department.[5,6] The incidence of acute hospital-treated eye injuries found in this study is an underestimation of the true incidence of eye injuries. Patients with less severe injuries not requiring admission were not represented, nor were patients with injuries that may have become manifest only after the initial insult.

The strong associations of younger age and male gender with ocular trauma have been consistently documented in previous studies.[2,3,10,11] In the present series, 77.9% of patients injured were males, with a male to female ratio of 3.52:1. 61.7% of ocular injuries occurred in people aged less than 44 years. One important reason for this is that work-related accidents constituted 43.6% of all trauma cases (65), with a peak incidence in the 35 to 44 years age group. Among these 65 cases, there was a strong predominance of the male gender (61, 93.8%). This is in accordance with other studies that found that younger age and male sex are greater risk factors for severe work-related ocular injury.[11,12] 21 children (14.1%) aged less than 15 years were admitted, again with a male predominance (male to female ratio of 1.62:1). The preponderance of ocular injuries in boys is presumably due to more aggressive and violent play. Males had a higher rate of ocular trauma than females except in the 0 to 4 years and 75 to 84 years age groups. After the age of 65 years, the male to female admission ratio decreased dramatically. This change in incidence is also reported in other studies.[2,3,13] In the 5 to 64 years and older age groups, males and females are more likely to have differences in their occupations, sports, and domestic activities, with each of these environments having their own intrinsic risks for injury, while in the 0 to 4 years and 65 years and older age groups, males and females are more likely to share similar environments throughout the day, with similar exposures to risk of injury.

The majority (43.6%) of injury was caused by work-related accidents, with the workplace being the most frequent place for ocular injuries to occur. A very similar incidence of work-related ocular trauma (42.2%) was also shown in another major series.[5] Most of these injuries are preventable. However, a fact that causes concern is that none of the workers injured were reported to have been wearing eye protection at the time of injury. In a survey by the Bureau of Labor Statistics in the USA, 56% of injured workers who were wearing eye protection reported that the eye-wear had reduced their injuries, while 49% felt that better eye protection could have further reduced the injuries.[14] Thus the importance of eye protection at work cannot be over-emphasized. There is no data in the present series to explain the absence of protective eye-wear during work, but reasons given in previous studies are: unavailability of eye protection, discomfort, inability to perform the task being performed, or ignorance of the importance of eye protection.[5] It is the authors' overall impression that many workers are unaware of the potential hazards of their jobs, and therefore do not use protective eye-wear. For example, some of the most serious penetrating ocular injuries occurred when nearby co-workers were hammering. In addition, it does not appear to be common practice for workers to routinely wear protective clothing while using hard tools such as hammers and chisels. It is of paramount importance that educational and legislative measures be taken to encourage the availability and use of occupational eye protection. Protective eye shielding, however, may only partially solve

the problem. Environmental hazards should be identified and modified. Potentially dangerous chemicals should be clearly labeled with warning signs, and running water made available for irrigation at the place of injury. Engineering controls may also improve shielding of workers from dangerous operations. Where possible, it is also advisable to set up partitions between workers to reduce the risk of projectile injury from the side. In certain industrial settings, it is recommended that the employers and workers set up safety committees to modify the safety hazards in their environment. While the government has made a determined effort to reduce the risk of foot injury in construction sites, it is interesting to note that work-related ocular injury does not receive the same amount of public attention. Profiling and presenting the magnitude of this problem to the authorities concerned may help to improve this situation in the future.

The incidence of work-related trauma has also been shown to change over time, with 16 patients in 1995, 14 in 1996, 24 in 1997, and 11 in 1998. One possible reason for the surge in the incidence of work-related accidents in 1997 is that many of the injured workers participated in the construction of the new Hong Kong International Airport and its related infrastructure. The peak time of the construction work was 1997 to early 1998, possibly accounting for the rise in incidence of ocular trauma in 1997, and the decrease after completion of most of the infrastructure. There should not be a false impression that the incidence of work-related ocular trauma is declining. With the commencement of the construction of new railways and other infrastructure in the coming decade, work-related ocular trauma may increase again if workers continue to ignore the importance of safety eyewear.

Assaults are commonly cited as a common cause of serious eye injury, especially in the younger age group.[4,15] The circumstances and cause are often difficult to determine, thus it is more difficult to devise strategies to prevent assault-related eye injuries than it is to devise strategies to prevent eye injuries in the workplace or in recreational settings. It is, however, alarming that BB pellets caused four patients to be injured. Ocular injuries by BB pellets often represent a devastating form of trauma.[16] The four patients were passers-by injured by the airguns of hidden assailants. Eye trauma involving BB guns is completely preventable. The public needs to be made aware of the danger of air-powered guns. Measures to control the possession and use of air-powered guns should be enforced.

Fall as an important cause of ocular injury in the elderly population is well documented.[2,3] One observation that has not been adequately reported previously is the incidence of a previous operation in the injured eye. In the present series, nine of 10 people older than 70 years with an injury due to a fall had had a previous surgical procedure in the injured eye. It is possible that an eye that has undergone surgery may be more vulnerable to further trauma. Moreover, with the aging population in Hong Kong, the waiting time for cataract extraction is relatively long. An elderly patient with one eye operated and the other eye pending cataract extraction sustains an added risk of fall and injury, especially in the immediate post-operative period. This bears a special risk in the crowded home environment in Hong Kong. Further research is recommended to investigate the risk factors for falls, as this may imply a change in the indication for hospitalization for eye surgery for the elderly. Meanwhile, to prevent injury, the focus of health education should be placed on post-operative home care and on the necessity of modifying home hazards after eye surgeries.

Fall was the single most important cause of ocular injuries for children aged less than 16 years (26.1%). All falls occurred at home, representing 55% of all children's injury at home. This contrasts studies in other areas, in which sports and recreational activities were cited as the most frequent cause of childhood injury.[17,18] It may be that this difference occurs because there are few spacious recreational areas in Hong Kong, and unsupervised children playing in the crowded home environment may result in falls and injuries. Closer parental supervision and modifying home hazards such as the placement of furniture may prevent some of these accidents.

Sport is an important cause of severe ocular injuries, especially in the young population.[5] Though there was only one blinding injury in this series, patients with hyphema and angle recession may carry a lifelong heightened risk of glaucoma.[19] The absence of proper protective eye-wear for all sports injuries should arouse concern. Compliance with use of polycarbonate safety glasses for the relevant ball games is of vital importance.

There was only one blinding injury among the patients injured in road traffic accidents. Most patients experienced super-ficial injuries and eyelid lacerations from broken glasses. Though the number of subjects is too small to draw a conclusion, it is possible that severe eye injuries are reduced after mandatory seat belt legislation. This is also the finding in other studies in which severe penetrating eye injuries in car accidents are reduced by 60 to 73% following seat belt legislation.[20,21]

It is difficult to quantify the health care burden of visual morbidity caused by trauma. However, this may be reflected from the huge number of operative sessions and demand on hospital beds (average period of stay: 10.6 days) required to treat trauma patients. The total period of hospital stay of all patients amounted to more than 1500 days. This implies that during the past 4 years, there has always been a hospital bed reserved for a patient with ocular trauma. Thus, ocular trauma does not only cause suffering to patients, but presents a significant burden to the already heavily loaded ophthalmic service in Hong Kong.

Conclusions

Ocular trauma remains an important cause of preventable and predominantly monocular visual morbidity and blindness. This study aims to profile the epidemiology of

severe injuries which warrant hospitalization. The complete absence of eye protection in work-related and sports injuries should arouse concern since most of these ocular traumas can be prevented. It appears that there is much scope for promoting the use of protective eyewear in these fields. Falls at home are identified as a major cause of eye injury for children and the elderly. A disproportionate amount of serious eye injuries occurred in elderly patients with a history of eye surgery to the injured eyes. Health education and safety strategies should be directed towards this previously neglected area for the prevention of serious eye injuries.

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