The epidemiology of ocular trauma in Singapore: perspective from the emergency service of a large tertiary hospital

LI WERN VOON, JOVINA SEE,
TIEN YIN WONG

Abstract

Purpose To describe the epidemiology of ocular trauma from the perspective of the emergency service of a large tertiary hospital in Singapore.

Methods A prospective survey was conducted over a 3 month period (August to October 1997) on all patients seen at the ophthalmic unit at the Singapore General Hospital's emergency service. Data on clinical presentation, type and cause of injury and use of eye protective devices (EPD) were collected via a standardised interview and examination. **Results** A total of 870 persons presented with a diagnosis of ocular trauma, out of the 1631 patients seen during the study period. Compared with non-trauma cases, trauma cases were more likely to be male (odds ratio (OR): 4.2, 95% confidence interval (95% CI): 3.2, 5.4), non-residents (OR: 6.2, 95% CI: 3.7, 10.5), younger than 40 years of age (OR: 3.2, 95% CI: 2.7, 4.1) and less likely to require follow-up or hospital admission (OR: 0.2, 95% CI: 0.2, 0.3). The three most common types of injuries were superficial foreign body (58.2%), corneal abrasion (24.9%) and blunt trauma (12.6%), while open globe injury occurred in only 17 cases (2%). Comparison with a 10% random sample of all cases seen in the previous 9 months ($n = 284$) revealed no significant time variation in the types of injuries ($p = 0.63$). Work-related injuries accounted for 590 (71.4%) cases, where grinding, cutting metal and drilling were the specific activities in more than 90% of the cases. In appropriate settings, only 21.7% of patients with work-related injuries used EPD; 43.7% were provided with EPD, but did not use them at the time of injury; and the remaining 34.6% reported that EPD were not provided.

Conclusions Ocular trauma at the emergency service level in Singapore involved mainly young non-resident men, were work-related

and associated with well-defined activities, and were generally minor. The low prevalence of EPD use reinforces the need for a review of the design and implementation of occupational eye safety programmes, especially among non-resident workers.

Key words Eye injury, Eye protective device, Occupational eye injury, Ocular trauma

Ocular trauma is an important worldwide cause of preventable morbidity.¹ Whilst the epidemiology of ocular trauma has been described in the United States,²⁻⁸ Europe^{9,10} and Australia,^{12,13} among other countries, limited data on ocular trauma in Asia are available.^{14,15}

Our previous study in Singapore was focused on severe ocular trauma among Singapore residents, using hospital discharge and surgical procedures data.¹⁶ We observed an annual incidence of 13/100 000 hospitalisation for ocular trauma, a higher risk in men compared with women, and a bimodal age pattern with a higher risk in the young and the elderly. In addition, we observed racial variation in rates in men (with Indian men having twice the rates compared with Chinese or Malay men) but not in women, suggesting this may be related to different race-specific risk exposures in men (e.g. work, sports).

Although hospital discharge and surgical procedures data provide good estimates of the morbidity of severe ocular injury, they have well-defined limitations.¹⁷ First, the retrospective nature of these studies creates opportunities for inaccurate coding, misclassification and other biases. Second, critical information on aetiology and the setting of trauma, treatment and prognosis, as well as the use of eye protective devices (EPD), is usually not available. Third, less severe injuries not requiring admission to hospital or ophthalmic surgery are not captured. The burden of these injuries cannot be dismissed

L.W. Voon
J. See
T.Y. Wong
Singapore National Eye
Center & Eye Research
Institute
Singapore

L.W. Voon
Tan Tock Seng Hospital
Singapore

T.Y. Wong
Department of
Ophthalmology
National University of
Singapore
Singapore

T.Y. Wong
Department of
Ophthalmology and Visual
Sciences
University of Wisconsin,
Madison
Wisconsin, USA

Tien Yin Wong, FRCS, MPH ✉
Department of
Ophthalmology
National University of
Singapore
10 Kent Ridge Crescent
Singapore 119260
Singapore
Tel: (65) 772 5317
Fax: (65) 777 7161
e-mail:
tienyinwong@yahoo.com

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Lauderdale, USA, 10-15
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easily because they can potentially lead to sight-threatening complications (such as traumatic infective keratitis), incur both cost of medical care (direct costs) and time lost from work (indirect costs), and are often the most amenable to preventive measures such as EPD.^{5,17}

In response to these limitations from our previous study, we conducted a prospective survey of cases presenting to the emergency service of a large tertiary Singapore hospital to describe the setting, cause and nature of ocular trauma not requiring hospitalisation, and to determine the prevalence of EPD use among work-related injuries.

Methods

Study population

The study was a prospective survey involving all patients seen by the ophthalmic unit at the emergency service of the Singapore General Hospital (SGH). SGH is the largest tertiary hospital in Singapore, and sees a wide variety of cases from the entire island. In 1997, out of a total of 547 178 patients seen at all casualty departments in Singapore, 145 368 patients (26.6%) were managed at the casualty department in SGH (data from the Information Services Department, Ministry of Health, Singapore, 1999). Of these, 40 502 were patients with trauma as the principal cause of presentation.

Patients seen at the emergency service in SGH are first managed at the triage section and are directed to either general care or appropriate specially units (e.g. ophthalmic, plastic, otolaryngology units) located within the service. The ophthalmic unit at the emergency service is staffed by ophthalmologists from the Singapore National Eye Centre (SNEC), a tertiary ophthalmic centre located within the SGH compounds. Due to the high daily patient volume, the ophthalmic unit is manned 24 hours a day by an ophthalmology resident. For all cases, the resident will normally take a history, perform an ocular examination and dispense medication or other treatment, with the help of the nursing staff. For this study, all patients seen by the ophthalmic unit for a 3 month period (1 August 1997 to 31 October 1997) were included.

Data collection and definition

During the study period, a standardised data form was designed to collect the following information: patient demographics, presenting complaints, presenting visual acuity, clinical diagnosis, management and consultation outcome. In addition, for ocular trauma cases, information on setting and aetiology of injury was collected. If the injury occurred at work, questions were also asked regarding the use of EPD.

Ocular trauma was defined as any injury or foreign body affecting the eye or adnexa. Consultation outcome was coded as one of the following: (1) admitted to the SGH's ophthalmology ward for inpatient care; (2) referred to the SNEC for specialist outpatient care; and (3) discharged from further ophthalmic follow-up. Use of

EPD was classified into three categories: (1) yes, used at the time of injury; (2) no, not used because EPD were not provided; (3) no, not used although EPD were provided. When the person did not use EPD, further questions were asked regarding the reason for not using them and coded as a 'free text' answer in the data form.

Age was defined as the age at presentation. Residency status and race were defined as follows: Patients were defined as Singapore residents if they possessed national identity numbers (and had national identity cards). For this group, race was classified into one of four main ethnic groups: Chinese (refers to persons of Chinese origin such as Hokkiens, Teochews, Cantonese, Hakkas), Malays (refers to persons of Malay or Indonesian origin such as Javanese), Indians (refers to persons of Indian, Pakistani, Bangladeshi and Sri Lankan origin such as Tamils, Bengalis) and others (comprising all persons other than the first three categories such as European, Eurasian, Arab and Japanese). Patients without national identity numbers were defined as non-residents. This group included foreign non-residents working in Singapore (on a working permit pass) and other *ad hoc* non-residents (e.g. tourists). Race in this group was classified according to country of origin (e.g. India, Bangladesh, China).

To determine whether seasonal variation in cases presenting to the emergency service was significant, we also analysed retrospectively the case records of a random 10% sample of all patients seen up to 9 months preceding the study (1 November 1996 to 31 July 1997). Basic data on number of injuries per month, age, gender and race of patients, as well as clinical diagnosis, were compared with our 3 month survey.

Statistical analysis

Routine statistics, including proportions, means and chi-square tests, were carried out with SPSS (SPSS, Chicago, IL). Odds ratios (OR) and 95% confidence intervals (95% CI) were computed to evaluate the strength of association between various factors (e.g. age) and trauma cases, using non-trauma-related cases as the comparison group.

The tenets of the Declaration of Helsinki were followed and the institutional review board of the Singapore National Eye Centre approved the study.

Results

A total of 1631 patients were seen at the SGH's casualty department during the study period, of which 863 (52.9%) had a clinical diagnosis of ocular trauma. Compared with non-trauma cases, trauma cases were more likely to be male (OR: 4.2, 95% CI: 3.0, 5.4), less than 40 years of age (OR: 3.2, 95% CI: 2.7, 4.1) and non-residents (OR: 6.2, 95% CI: 3.7, 10.5) (Table 1). Among the non-residents, the four most common countries of origin of these patients were: Bangladesh, China, Malaysia and India.

Table 1. Characteristics of patients with ocular trauma and non-trauma-related conditions presenting to the ophthalmic unit of the casualty service at the Singapore General Hospital

	Number (%)		OR (95% CI)
	Trauma (n = 863)	Non-trauma (n = 768)	
Gender			
Male	760 (88.1)	490 (63.8)	4.2 (3.2, 5.4)
Race			
Chinese	322 (37.3)	487 (63.4)	1.4 (0.8, 2.2)
Malay	69 (8.0)	79 (10.3)	1.8 (0.9, 3.2)
Indian	28 (3.2)	57 (7.4)	1.0
Non-residents	444 (51.4)	145 (18.9)	6.2 (3.7, 10.5)
Age group (years)			
<20	68 (7.9)	67 (8.7)	5.1 (2.9, 9.0)
20–29	329 (38.1)	184 (2.4)	9.0 (5.7, 14.5)
30–39	275 (31.9)	144 (18.8)	9.6 (6.0, 15.5)
40–49	124 (14.4)	128 (16.7)	4.9 (2.7, 8.1)
50–59	39 (4.5)	104 (13.5)	1.9 (1.1, 3.4)
60 or older	28 (3.2)	141 (18.4)	1.0
Time to presentation (days)			
1 or less	479 (55.5)	207 (27.0)	13.8 (9.4, 20.4)
2	196 (22.7)	102 (13.3)	11.5 (7.5, 17.7)
3	102 (11.8)	118 (15.4)	5.2 (3.3, 8.1)
4–6	45 (5.2)	96 (12.5)	2.8 (1.7, 4.7)
>7	41 (4.8)	245 (31.9)	1.0
Presenting visual acuity			
6/6–6/9	714 (82.7)	469 (61.1)	6.6 (4.2, 10.4)
6/12–6/18	94 (10.9)	108 (14.1)	3.8 (2.2, 6.4)
6/24–6/36	28 (3.2)	47 (6.1)	2.6 (1.3, 5.1)
6/50 or worse	27 (3.1)	117 (15.2)	1.0
Unilateral eye involvement			
Yes	43. (95.0)	95 (12.4)	2.7 (1.8, 4.0)
Consultation outcome			
Admitted to SGH	28 (3.2)	71 (9.2)	1.0
Follow-up SNEC	216 (25.0)	383 (49.9)	1.4 (0.9, 2.4)
Discharged from follow-up	619 (71.7)	314 (40.9)	5.0 (3.1, 8.1)

SGH, Singapore General Hospital; SNEC, Singapore National Eye Centre.

Trauma cases generally presented earlier, had better presenting visual acuities, were more likely to have unilateral eye involvement and less likely to require follow-up or hospital admission than non-trauma cases.

For the trauma group, superficial injuries, including superficial foreign body and corneal abrasion, were the most common diagnoses, while open globe injury occurred in only 17 cases (2%) (Table 2). Comparison with the 10% random selection of ocular trauma cases

seen in the last 9 months ($n = 284$) revealed no significant time variation in the type of injuries ($p = 0.63$). Only 28 (3.2%) cases of ocular trauma required hospital admission, including: 13 cases of open globe injury, 11 cases of blunt trauma, 3 cases of chemical burns and 1 case of severe lid laceration. Among the non-trauma-related conditions, acute infective and inflammatory conditions (e.g. conjunctivitis) were the most common group of diagnoses ($n = 357$, 46.5%). There were 49 cases

Table 2. Clinical diagnosis of patients with ocular trauma, comparing the study period (August to October 1997) with a random selection of patients from the previous 9 months (September 1996 to July 1997)

	Number (%)		<i>p</i> value ^a
	Study period (n = 863)	Random selection of patients from previous 9 months (n = 284)	
Superficial foreign body	502 (58.2)	168 (59.2)	0.63
Corneal abrasion	215 (24.9)	59 (20.8)	
Blunt trauma	109 (12.6)	44 (15.5)	
Open globe injury	17 (2.0)	5 (1.7)	
Lid and adnexal injury	7 (1.0)	2 (1.0)	
Others	13 (1.5)	6 (2.1)	

^aBased on a chi-square test.

Fig. 1. Distribution of ocular trauma (n = 863), by setting.

of acute glaucoma seen during this period (6.4%), but 32 required hospital admission for treatment (32.3% of all hospitalisations).

Work-related injury was the most common cause (Fig. 1), accounting for 590 (71.4%) cases of ocular trauma, followed by home-related, sports-related and assault-related injuries. For work-related injuries, the construction industry was the most common setting for ocular trauma (Fig. 2) and grinding, cutting metal and drilling were the specific activities in more than 90% of cases (Fig. 3).

An analysis of EPD use was conducted among patients with work-related injury. Of the 590 cases, 61 were excluded because EPD use was not considered appropriate for the activity at the time of injury (e.g. injury from falling at the work site). Overall, only 115 (21.7%) used some form of EPD, another 231 (43.7%) were provided with EPD but did not use them at the time of injury and the remaining 183 (34.6%) reported that they were not provided with EPD for that activity. We did not find significant variations of EPD use among different age groups, gender or race (data not shown). However, use of EPD was associated with less likelihood of needing either hospital admission or outpatient

follow-up (11% required hospital admission or follow-up) compared with patients who did not use EPD (20%). Specific activities associated with frequency of EPD use were also analysed and are presented in Table 3. When performing construction-related activities (such as cement mixing), none of the patients reported using EPD, and 70% reported that they were not given any EPD. On the other hand, nearly 50% of those involved in welding were using EPD at the time of injury and only 10% reported that they were not given EPD for welding.

Discussion

Scant information is available regarding ocular trauma epidemiology outside of the United States and other developed countries.^{1–13} In particular, limited information on this condition is available in Asia.^{1,14,15} Our prior investigation on ocular trauma in Singapore was based on an analysis of hospital discharge and surgical procedures database.¹⁶ While this provided an overall perspective of severe ocular trauma in Singapore there are inherent limitations with information based on hospitalisation and surgical procedures data.¹⁷ This present study therefore provides additional useful

Fig. 2. Distribution of work-related ocular trauma (n = 590), by industry.

Fig. 3. Distribution of work-related ocular trauma (n = 590), by specific activity at time of injury.

information regarding the epidemiology of less severe, non-hospitalised ocular trauma in Singapore from the emergency service setting.

We confirmed the universal pattern that ocular trauma occurred in young adult males, irrespective of the severity of ocular trauma and country of origin.^{1–15} The higher risks in young men appear to reflect a combination of a higher risk of work-related, assault-related, sports-related and motor vehicle crash-related ocular injuries.¹⁷

Work-related eye injury was the most common setting for ocular trauma in Singapore, accounting for more than 70% of our ocular trauma cases. The proportion of ocular trauma occurring at work varies between studies, with figures ranging from as low as 15% of all ocular trauma cases at an urban trauma centre in Los Angeles (where the most common aetiology was related to assault)⁶ to as high as 70% reported in the United Kingdom.¹¹ Beyond the medical implications, including the risk of blindness, work-related eye injuries are associated with socioeconomic costs, including the direct cost of medical care and indirect costs such as time off work, loss of income and long-term disability.^{18–20} For severe injuries requiring hospitalisation, one study estimated annual hospital charges (excluding professional fees) of US\$14.6 million in the United States when work-related ocular trauma was the principal admitting diagnosis, and US\$40 million when ocular trauma was either a principal or secondary diagnosis.¹⁸

Of greater public health significance, we found that the majority of work-related injuries were among non-resident ‘foreign workers’ in Singapore. In Singapore, as in many other affluent countries in East Asia (e.g. Hong Kong, Taiwan, Japan), a rising proportion of the workforce is composed of foreign labour from less developed countries employed on temporary work permits.²¹ As of 1997, there were approximately 500 000 foreign workers in Singapore, nearly one-third of the entire labour force.²² Most of these workers were employed in high-risk injury settings such as construction, shipyard and metal-related industries. In our study, we could not estimate the incidence of ocular trauma to determine whether foreign workers were at higher risk of ocular trauma compared with similar workers who were Singapore residents. However, the magnitude of work-related ocular trauma among foreign workers deserves attention from industrial safety agencies in Singapore (e.g. Industrial Safety Division of the Ministry of Manpower) and perhaps similar agencies in other countries in East Asia that depend heavily on foreign labour.

Another disturbing fact was that only 20% of patients with work-related eye injuries used EPD. The low prevalence of EPD use has been a consistent finding in almost every ocular trauma survey in different settings^{5,11–13,20,23} and in different industries.^{24–27} At least in theory, prevention strategies focusing on the use of EPD in the work place should have a high likelihood of

Table 3. Frequency of utilisation of eye protective devices among patients with work-related ocular trauma, by specific activity

	Use of eye protective devices by specific activity			
	Number (%)			Total
	No			
	No, not provided for that activity	No, provided but not used at time of injury	Yes	
Grinding	30 (17.8)	71 (42.0)	68 (40.2)	169 (100)
Construction-related activity	43 (70.5)	18 (29.5)	0	61 (100)
Drilling	7 (11.9)	25 (42.3)	7 (11.9)	59 (100)
Cutting metal	8 (16.7)	13 (27.1)	8 (16.7)	48 (100)
Hammering	4 (9.3)	22 (51.2)	4 (9.3)	43 (100)
Welding	14 (48.3)	12 (41.4)	14 (48.3)	29 (100)
Total	147 (35.9)	161 (39.4)	101 (24.7)	409 (100)

success. First, work practice policy and legislation allow implementation of strict guidelines, including mandatory use of EPD. Second, most work-related ocular injuries occur in well-defined, predictable and consistent settings and activities. For example, grinding, welding and cutting metal, drilling and hammering were the specific activities in 62% of our work-related injuries and more than 75% of work-related injuries in a UK study.⁷ This therefore allows precise identification of specific work-related activities in which EPD should be used. Third, the vast majority of work-related eye injuries are minor (superficial foreign body and corneal abrasions made up 80% of ocular trauma cases) and are therefore amenable to prevention with relatively lightweight EPD.

However, as our study and others²³⁻²⁷ have indicated, EPD have not been effective in preventing work-related eye injuries. Our data showed that non-availability of EPD was a common problem (44%) while non-compliance was another (35%). We felt that the language barrier between foreign workers and supervisors was an important factor influencing the low prevalence of EPD use. Supervisors often had the difficult task of explaining the requirements of EPD use (among other safety instructions) to a diverse group of workers from different countries with different languages. Other factors reported elsewhere include use of inappropriate EPD or non-safety eye-wear,¹⁹ and failure of existing EPD in preventing injuries.²⁴ A behavioural analysis of similar EPD use in the military setting indicated that provision of EPD without organisational and community involvement was ineffective in the prevention of ocular trauma.²⁸ Similar analysis may be needed to identify factors to increase effectiveness of EPD use in the workplace.

Our data indicate that annually about 3400 ocular trauma cases are managed by the emergency service in SGH (863 ocular trauma cases were seen in our 3 month study). Based on the fact that SGH handles approximately 25% of all emergency cases in Singapore, about 13 000 ocular trauma cases are seen annually in the emergency service setting in our country, an incidence of 400/100 000 per year (using the combined Singapore resident and non-resident population data as the denominator²⁹). As only about 3% of these cases require hospital admission (3.2% in our study), we further estimate an annual incidence of 12.8/100 000 ocular trauma cases requiring hospitalisation in Singapore, which closely approximates the data from our previous study based on hospital discharge records (12.6/100 000 per year).¹⁶ In addition, as each emergency room visit costs a minimum of US\$40, the annual direct cost of ocular trauma to Singapore is approximately US\$500 000. The total cost, however, is likely to be significantly higher when costs of hospitalisation, surgery, outpatient care, time off work and workmen compensation claims are included.

In conclusion, our present study showed that ocular trauma cases seen at the emergency service level in Singapore involved predominantly young non-resident men, were work-related in association with well-defined

activities, and were generally minor and potentially preventable. The high proportion of ocular trauma cases among foreign workers is a source of concern, and has implications for other countries that rely heavily on these people in their workforce. The low frequency of eye protective device use reinforces the need for a better understanding of the limitations of existing occupational eye safety programmes.

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