

Pediatric Ocular Trauma in Taiwan

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Background: Ocular trauma is a significant problem in pediatric patients. The aim of this investigation was to evaluate the demographic, etiologic and prophylactic factors of pediatric ocular trauma in a tertiary center in northern Taiwan.

Methods: A retrospective review of medical charts of patients aged 15 years or younger who visited the emergency department of Chang Gung Memorial Hospital, Taoyuan for ocular trauma between July 2003 and June 2004 was undertaken.

Results: Of the 228 children in this study, ocular trauma occurred more frequently in boys than in girls (151:77 patients, $p < 0.0001$). Twenty-one patients (9.2%) presented with bilateral trauma. The most common ocular injury was closed globe injury (178 patients, 78.1%). The next most common ocular injuries were burns (35 patients, 15.4%), open globe injuries (8 patients, 3.5%) and orbital injuries (7 patients, 3.1%). Falling was the most common cause of ocular trauma in these children, followed by trauma caused by a fist or other part of the body. Sharp objects such as knives or scissors were the most common cause of open globe injuries. Visual impairment (visual acuity less than 20/50) occurred in three open globe injury patients.

Conclusions: Ocular trauma in children is associated with visual loss. Many of the cases were preventable. Public education, general awareness and aggressive primary management may be indicated to optimize visual outcome.
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Key words: ocular trauma, closed globe injury, rupture, penetrating eye injuries

Ocular trauma that leads to visual loss is a significant problem in pediatric patients.⁽¹⁾ In the United States, a population-based study reported that the annual incidence of ocular trauma in children was 15.2/100,000.⁽²⁾ Worldwide, the incidence of severe visual impairment or blindness caused by ocular trauma in children varies from 2% to 14% in different studies.⁽³⁻⁷⁾ Various studies have reported that 12.5% to 33.7% of eye injury admissions are children.⁽⁴⁾ According to a search of published studies, there are no data of pediatric ocular trauma in

Taiwan in the current literature. This study examined the frequency and causes of ocular trauma in young patients who presented at the emergency room (ER) of Chang Gung Memorial Hospital (CGMH), Taoyuan, Taiwan. We present specific recommendations for the establishment of primary prevention measures.

METHODS

Pediatric patients aged 15 years or younger who

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visited the ER of CGMH for ocular trauma between July 2003 and June 2004 were included in this study. We retrospectively reviewed the ophthalmology department consultation records and medical charts of all patients. Demographic information, date of injury, type and extent of injury, cause of injury and visual outcome were recorded for each patient.

The definitions and classifications of ocular trauma in our study were modified from the Ocular Trauma Classification Group guidelines and Birmingham Eye Trauma Terminology (Table 1 and Fig. 1).^(8,9) Two more categories (orbital injuries and burns) were included in our classifications to increase comprehensiveness because previous literature disclosed that the incidence of orbital injury within total eye injuries ranged from 5%~22%.^(2,4) The incidence of burn injury within total eye injuries ranged from 5%~24%.^(1,2,4-7) The types of open globe injury were classified as rupture, penetrating injury, intraocular foreign body injury or perforating injury. The types of closed globe injury were classified as superficial foreign body, anterior segment injury (limited to conjunctiva, sclera, cornea, anterior chamber and lens) or posterior segment injury (all internal structures posterior to the posterior lens capsule). The types of orbital injury were classified as canalicular disruption, orbital fracture or intraorbital foreign body. Ocular burns, including thermal and chemical burns, were graded using the classifications for ocular surface burns by Dua.⁽¹⁰⁾

Visual acuity was measured at a distance of 6 meters using the Landolt C chart for school-aged children. For preschool children, visual acuity was assessed with the fixation and follow-test patterns.

RESULTS

Two hundred and twenty eight cases were reviewed and ages ranged from 0.5 years to 15 years (6.48 ± 3.96 years). Among all the cases, 21 patients (9.2%) had bilateral trauma. For those with unilateral trauma, there was no difference between the laterality of trauma (right:left = 103:104, $p = 0.95$). The distributions of age and gender are illustrated in Fig. 2. Boys were more likely to have ocular injury than

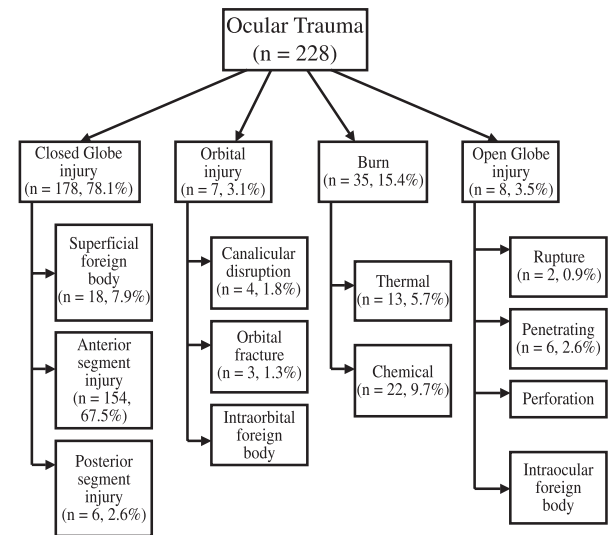


Fig. 1 A total of 228 patients were classified according to their type of injury. The number of patients and percentage are listed in each box. The classification of ocular trauma in this study was modified from the Ocular Trauma Classification Group guidelines and Birmingham Eye Trauma Terminology.^(8,9)

Table 1. Ocular Trauma Definitions*

| Term | Definition |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Closed globe injury | Corneosclera (eye wall) does not have full-thickness wound |
| Open globe injury | Corneosclera has full-thickness wound |
| Rupture | Full-thickness wound caused by blunt object |
| Penetrating injury | Single, full-thickness wound of the eye wall, usually caused by a sharp object |
| Perforating injury | Two full-thickness lacerations (entrance and exit) of the eye wall, usually caused by a sharp object |
| Contusion | Closed-globe injury resulting from a blunt object; injury can occur at the site of impact or at a distant site secondary to changes in globe configuration or momentary intraocular pressure elevation |
| Lamellar laceration | Closed-globe injury of the eye wall or bulbar conjunctiva usually caused by a sharp object |
| Superficial foreign body | Foreign body lodged in conjunctiva and/or corneosclera but does not result in full-thickness eye wall defect |

*: Adapted from Kuhn F, Morris R, Witherspoon CD, Heimann K, Jeffers JB, Treister G. A standardized classification of ocular trauma. *Ophthalmology* 1996;103:240-3.⁽⁹⁾

girls (151 : 77, $p < 0.0001$).

In our study, the most common ocular injury was closed globe injury (178 patients, 78.1%). Other common ocular injuries in descending order of occurrence were: burns (35 patients, 15.4%), open globe injuries (8 patients, 3.5%) and orbital injuries (7 patients, 3.1%). The distribution of trauma type by patient age is shown in Fig. 3.

Of the 178 closed globe injury patients, 154

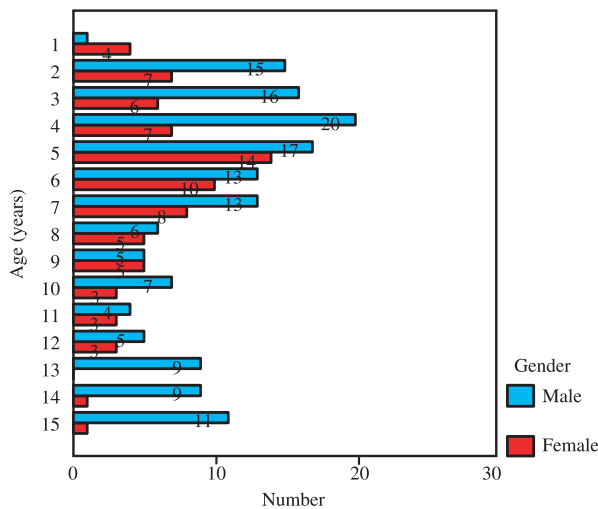


Fig. 2 The bar graph demonstrates the distribution of ocular trauma by age and gender in 228 children in Taiwan from 2003-2004.

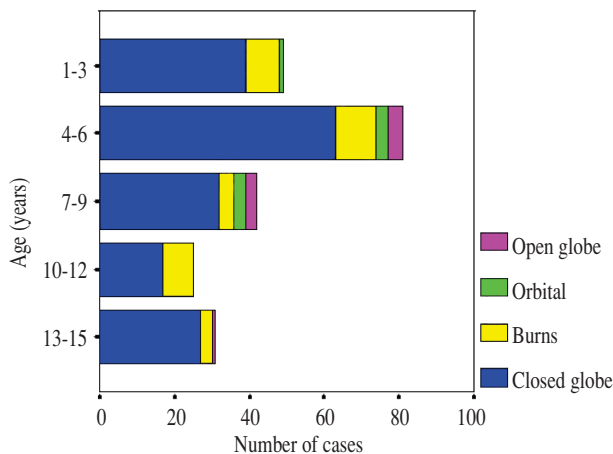


Fig. 3 The highest incidence of ocular injury occurred in the 4- to 6-year-old age group, as shown in this bar graph. Among the various types of ocular trauma, closed globe injuries were predominant.

(86.5%) had injuries limited to the anterior segment, six (3.4%) patients had posterior segment injuries and the remaining 18 (10.1%) patients had superficial foreign bodies lodged on the conjunctiva or corneosclera. The most common anterior segment closed globe injuries were subconjunctival hemorrhage and corneal abrasion. Usually, subconjunctival hemorrhage resolved within 2 weeks and corneal abrasion healed after 24 to 48 hours without visual sequelae. Two patients had partial thickness corneal lacerations that healed without sutures. The posterior segment closed globe injuries included peripheral retina edema in 4 patients, vitreous hemorrhage in one patient and retinal hemorrhage in one patient. Those patients with vitreous or retinal hemorrhage also had hyphema. All patients experienced resolution of hemorrhage within 2 weeks. Foreign bodies included sand, iron dust and particles from fireworks or incense, which were removed under slit-lamp examination in older children. For younger, uncooperative children, the procedure was completed in the operating room under general anesthesia.

There were 6 patients in the closed globe injury group who had traumatic hyphema. This was associated with anterior segment injury in 4 patients and posterior segment injury in 2 patients. Transient elevation of intraocular pressure was noted in two patients with hyphema. All of these cases finally resolved without surgical treatment.

Among the 35 patients with ocular burns, 13 (37.1%) patients had thermal burns and 22 (62.9%) patients had chemical burns. In those patients with chemical burns, irrigation of the eye was performed for at least 30 minutes before further ocular examination. Fortunately, all patients had only mild injuries that were grade 1 in Dua's ocular burns classification. In all patients, the damaged corneal epithelium healed within one week.

Of the 7 patients with orbital injuries, orbital fracture occurred in 3 patients and canalicular disruption in 4 patients. Two patients with computed tomography (CT)-confirmed orbital fracture had no functional disturbance. One patient who presented with vomiting, diplopia and pain upon eye movement was diagnosed with trapdoor fracture and inferior rectus muscle incarceration. The patient received emergent surgical repair and the diplopia disappeared post-operatively. Patients with inferior canalicular disruption had emergent surgery to repair the

canalicular duct.

Open globe injuries yielded the worst visual outcome in this study. According to Serrano's grading system, visual acuity was classified as no visual impairment (20/20 to 20/50), moderate visual impairment (20/60 to 20/100), severe visual impairment (20/200 to 20/400) and blindness (< 20/400 to no light perception).⁽¹¹⁾ Upon arriving at the ER, only 2 open globe injury patients had moderate visual impairment, the other 6 patients experienced no visual impairment. All of the 8 patients had injuries limited to the anterior segment and the corneoscleral wounds underwent emergent repair. Four patients needed additional surgical intervention. Two patients with penetrating injuries required lens removal during the emergent surgery and underwent intraocular lens implantation a few months later. One patient with globe rupture due to blunt injury underwent cataract surgery and intraocular lens implantation 5 months after the trauma. Final visual acuity in this patient was 20/30. Another patient with blunt injury globe rupture underwent corneal transplantation for the resultant central corneal scar 21 months after the trauma, then scleral buckle for retinal detachment 35 months following the trauma. This patient's final visual acuity was 20/200, which was graded as severe visual impairment. Apart from this patient, two patients with penetrating injuries had moderate visual impairment at the end of follow-up. One was due to residual corneal opacity and the other was due to amblyopia.

The causes of ocular trauma in this study are summarized in Fig. 4. A fall with or without collision with a fixed object, such as furniture, was the most common cause of ocular trauma in children. Trauma caused by a fist or other part of the body was the second most common cause of injury. In the children in this study who experienced chemical burns, the chemical agents included household cleaning products, hair spray, a family member's medication and some specialist acid/base chemicals. Open globe injuries were caused by sticks, including pencils, chopsticks or toothpicks, or by sharp objects like scissors or a knife. In addition to hot water and food as the sources of thermal burns in our patients, ignited cigarettes and incense were also common causes. In ocular trauma resulting from traffic accidents and sports, some injuries occurred from broken eyeglasses. We classified the following causes under miscel-

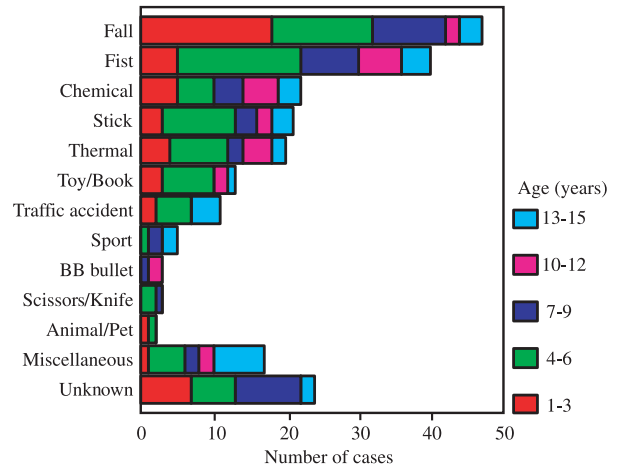


Fig. 4 Among the causes of ocular trauma, falls and force from fist blows were the major reasons for injury, as seen in this bar graph. The number of cases by age and cause are listed.

laneous: fireworks, paper or plastic sheets, zippers, elastic bands and clothes hangers. We could not determine the cause of injury from the patient history in 24 patients (10.5%).

In this study, 115 (51%) patients had documented follow-up, which ranged in duration from 1 week to 38 months. Their injury types were closed globe injuries (83 patients, 72.2%), orbital injuries (7 patients, 6.1%), burns (18 patients, 15.7%) and open globe injuries (7 patients, 6.1%). In the 113 patients lost to follow-up, the injury types were closed globe injuries (95 patients, 84.1%), orbital injuries (0 patient, 0%), burns (17 patients, 15.0%) and open globe injuries (1 patient, 0.9%).

Five out of the 115 patients who had documented follow-up were found to have amblyogenic factors in the fellow eye, such as high refractive error, anisometropia and strabismus.

DISCUSSION

In this study, pediatric ocular trauma occurred twice as often in boys as in girls, which is similar to other studies.⁽¹²⁻¹⁷⁾ The male-female ratio of ocular trauma was higher in the older age group and lower in the younger age group, similar to the findings of Serrano.⁽¹¹⁾ In our study, ocular trauma only occurred more frequently in girls than in boys at the age of

one year. This observation is presumably due to the high physical contact and aggressive nature of play among young boys. Additionally, our culture highly regards females who are quiet and move gently. This value probably reflects the decreased incidence of ocular trauma in older girls.

Closed globe injury was the major type of injury in this study, which was similar with other studies.^(3,4,6) The second most common injury in this study was burns. In other studies, penetrating injury was the second one.^(3,6) The major reason for this difference may be a difference in study population and severity. Our study population was those who visited the ER but the populations of MacEwen et al. and Rapoport et al. were admitted patients.^(3,6) The prevalence of penetrating injuries might increase in the admitted group as they have more severe injuries.

The incidence of injury classified by age showed that children in the 0- to 7-year-old age group were at greatest risk, which was similar to the results of Moreira et al.⁽⁵⁾ Conversely, Strahlman et al. concluded that those in the 11- to 15-year-old age group were at greatest risk.⁽²⁾ The incidence of ocular trauma in different age groups needs further study with larger populations.

The type of injury and its severity are known prognostic factors of final visual outcome following trauma.⁽¹¹⁾ Anterior closed globe injuries with hyphema, lens subluxation, cataract or glaucoma can jeopardize visual outcome. Posterior closed globe injuries, such as vitreous hemorrhage or retinal detachment, can even lead to blindness.⁽¹⁸⁾ Luckily, most of the cases in our study were not severe closed globe injuries and did not cause any visual impairment. Open globe injuries may lead to retinal detachment, cataract, endophthalmitis, and postoperative inflammation or scarring. Significant visual loss often occurs with this type of injury. Thus, open globe injuries are a leading cause of non-congenital unilateral blindness in children.⁽¹⁹⁾ The incidence of visual loss (less than 20/200) resulting from ocular trauma in children varies in different reports. Visual loss was higher (9% to 14%) in published studies before 1990 from Brazil,⁽⁵⁾ Canada⁽⁷⁾ and Israel.⁽⁶⁾ The cited incidence of visual loss was lower (2% to 3%) in research performed by Poon and MacEwen.^(3,4) MacEwen stated that prevention, as well as optimum management of trauma, are related to progress of visual recovery. Visual acuity of 4 cases (1.75%)

deteriorated to 20/50 or worse. This was similar to the experience in Scotland in 1999.⁽³⁾ In the open globe injury group, 2 out of 8 (25%) had visual acuity worse than 20/50. This outcome is better than that of the report from the United States in 1998.⁽²⁰⁾ Besides MacEwen's theories, there were some other explanations for our results. First, our information may be incomplete. For example, patients with severe head injury or those with neurological impairment were not seen by the ophthalmologist until the patients' general condition was stabilized on the ward. Thus ocular trauma with severe head injury or a shaken baby in a coma would not be included. Second, almost half of our patients were lost of follow-up. Therefore, possible late-onset of traumatic cataract, glaucoma or retinal detachment were also not included.

In general, children are more susceptible to eye injuries because of their immature motor skills, limited common sense and natural curiosity. The causes of eye injuries, therefore, are highly related to physical and psychosocial development. In our study, the most common cause of ocular injury in children under the age of 3 years was a fall against a wall or furniture; many of these patients were either alone or without adult supervision at the time of the event. This should remind us that children, and infants in particular, should be supervised at all times. A safe environment should be maintained for children. Children of kindergarten age (4-6 years) like to imitate adult behavior without the awareness of possible risks: pencils, chopsticks, toothpicks, knives and scissors should be regarded as dangerous, and kept from children. Children engaged in playing sports frequently experience ocular trauma due to body contact. School-aged children who are more physically active tend to take more risks to gain acceptance by their peers. Self-protection should be taught to children to prevent possible ocular injuries. For example, children should be told to avoid dangerous games, such as throwing objects, playing with BB guns or lighting firework. Also, safety goggles should be offered to children who engage in sports with possible body contact or when using sharp utensils.

In this one-year cross-section investigation, a view of pediatric ocular trauma in Taiwan is clearly depicted. A larger-scale investigation involving more medical organizations with longer duration should be

considered to reveal the general outcome of various ocular traumas in children.

Many eye injuries in children are preventable. Parental awareness, supervision and education emphasizing avoidance of specific hazards remain a priority in order to reduce the incidence of ocular trauma. For ophthalmologists, pediatricians and other professionals involved in the health care of children, understanding the fundamentals of eye trauma will help decrease associated ocular morbidity and visual loss. Also, it is the physician's responsibility to disclose any obscure factors, such as preceding ocular disease, coexisting systemic disease or child abuse, related to the ocular trauma.

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台灣兒童眼部外傷

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背景： 統計北台灣地區兒童眼部外傷之種類、發生率、病因。

方法： 回溯林口長庚醫院自西元2003年7月至2004年6月，因眼部外傷到急診求診之15歲以下兒童的病歷，記錄其外傷種類、病因，進一步分析其發生率並探討預防因子。

結果： 本研究共收錄228位病患，男女比例151:77人 ($p < 0.0001$)，21人(9.2%)兩眼同時受傷；最常見的眼部外傷依序為眼球鈍挫傷(closed globe injury, 178人, 78.1%)、燒傷(burn, 35人, 15.4%)、眼球破裂(open globe injury, 8人, 3.5%)、眼窩損傷(orbital injury, 7人, 3.1%)；跌倒為最常見的受傷機轉，拳頭或身體其他部位撞擊其次；尖銳物品如刀、剪刀是最常造成眼球破裂的原因；3位視力減退(小於20/50)病患皆因眼球破裂。

結論： 眼部外傷引起的視力損傷多半可以預防，公眾教育、注意兒童活動環境安全、早期積極的治療能減少眼部外傷的發生率並改善預後。
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關鍵詞： 眼部外傷，眼球鈍挫傷，眼球破裂，眼球穿刺傷

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