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## Invited Mini Review

# Trauma of the globe: State of art in global and in China

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## ABSTRACT

Current states of traumatic eye injury are reviewed in terms of epidemiology in the developing countries and developed countries, causes of the trauma, eye injury types, traumatic eye injury diagnostic methods and treatments. Trauma-caused vision-threatening conditions such as open globe injury, traumatic optic neuropathy and proliferative vitreoretinopathy are particularly discussed. Also the most updated clinic research in China as Eye Injury Vitrectomy Study is discussed. At the end, the current achievements and research in traumatic eye injury in the world are summerized.

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Traumatic eye injury is the leading cause of unilateral blindness worldwide, especially in the developing countries. The World Health Organization in 1998 estimated that each year trauma can cause about 1.6 million binocular blindness, 2.3 million people with low vision in both eyes, 19 million monocular blindness, and 55 million people with eye injuries that result in restricted activities for more than one day a year.<sup>1</sup> In developed countries, the incidence of blindness due to eye trauma was 9/100,000 people, but in developing countries, the rate was 75/100,000. Each year more than 2.5 million eye injuries occur in the United States, and 50,000 people permanently lose part or all of their vision. The Baltimore Eye Survey in the USA reported at least one injury in a lifetime: by 22.5% of black men, 20.3% of white men, 12.2% of black women and 7.7% of white women.<sup>2,3</sup> In China, 20%–33% hospitalization patients are due to traumatic eye injuries. The Nepal Eye Study estimated that 860/100,000 population had eye trauma, among whom 62% had signs of eye injury but no visual impairment, 27% were unilaterally blind or severely visually impaired, 8% were bilaterally visually impaired and 3% were blind.<sup>4</sup> A study in India showed ocular trauma accounted for 1.03% in India. Male to female ratio was 10:1.21, and 12.7% of patients presented to the hospital within

2–7 days of injury. The causes of injury were road traffic accidents, sports playing & recreational activities and occupational in 32.7%, 25.5% and 20% respectively. Closed globe injuries accounted for 32.7%, open globe injuries (OGIs) for 45.4% and adenexal injuries for 21.8%.<sup>5</sup>

Although 95% of ocular trauma does not require admission such as chemical eye burn and laser/UV light injury, sudden blunt eye trauma can cause a blunt-out fracture inducing closed or open globe injury. Patients with trauma-related facial fractures are at an increased risk of associated eye injuries, and the incidence of vision loss and blindness. OGIs compared to closed globe injuries are more severe and associated with more complications and surgical procedures, longer treatment period and poorer prognoses. According to the Birmingham Eye Trauma Terminology (BETT),<sup>6</sup> OGIs constitute about 10% of all eye injuries, and among them 4% involves an intraocular foreign body. Most eye injuries are caused by various sharp objects (22%). Globally 60% of OGI happens at home and 40% at the work place. In Europe, 9.9% of eye injuries are work-related, 2.4% are contact lens-induced, and 2.3% occurred during sports, with soccer being the most common cause. Work-related traumatic eye injuries account for as high as 56%–72% in China.

The vision-threatening conditions following globe trauma from anterior to posterior can be listed as corneal laceration, corneal opacities, endophthalmitis, hyphema, sympathetic ophthalmia, toxicity due to chronic intraocular foreign body, lens dislocation, traumatic cataract, vitreous hemorrhage, retinal detachment, choroidal detachment, etc.

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In urgent eye care, the initial objective is to determine the nature and extend of the injury, which part of eye is injured, and whether or not the globe has been ruptured. The most urgent type of injuries can be listed as injury to the globe itself, compartment syndrome, optic nerve injury; and less urgent concerns as bony injury, foreign bodies in the orbit, and injury to the eyelids.

For traumatic eye injury patients who need immediate surgery, start an intravenous injection and do any needed ancillary lab studies including imaging and blood testing, manage prolapsed tissue to close the eyes and then repair the internal eye damage. Urgent, early and proper ophthalmologic evaluation is the key for prompt and appropriate management of globe trauma. However, because of surrounding periorbital soft tissue swelling and other associated injuries, physical examination of the globe may be difficult in the setting of acute trauma and patient cooperation may be limited by unresponsiveness, altered mentation or sedation. Therefore, radiologic imaging is necessary and crucial to identify any injuries of the globe in making accurate diagnoses and guiding proper patient treatment.

CT, Ultrasonography (US) and MR (Magnetic resonance) are first line imaging modalities for initial evaluation of globe trauma. CT has a high specificity for suspected intraorbital or intraocular foreign bodies. The disadvantages of CT are the presence of metallic foreign bodies will cause streak artifact that obscure some finding and increase CT ionizing radiation. US can be used to evaluate hyphema, lens dislocation, globe rupture, intraocular foreign bodies, and vitreous & retinal hemorrhage. US is less sensitive than CT in depicting intraocular foreign bodies. MR takes longer time and is most suitable for subtle open globe trauma or organic foreign body detection.

The treatments for globe trauma with better visual outcomes is associated with primary closure of globe and the use of systemic antibiotics, therefore the determination of the globe trauma wound characteristics is important. The successful treatment rate for OGI is 55% in developed countries and 15.5%–22.7% in developing countries. The prognostic factors in OGI are ocular trauma score (OTC), initial VA, eyelid injury, posterior involvement, long wound length, global rupture, lens involvement, presence of hyphema, vitreous prolapse, vitreous hemorrhage, and endophthalmitis & retinal detachment. OTC is developed based on the BETT classification system and is used to calculate prognosis.

The main purpose of surgical management for OGI is to repair the open globe and remove the intraocular foreign bodies. Systemic antibiotics need to be administrated against globe infection and endophthalmitis.

Traumatic optic neuropathy (TON) secondary to blunt head trauma is the main vision-threatening condition in closed globe injury. Steroid administration and surgical decompression are the main treatments for TON. Due to the difficult access to the optic canal anatomically, a lateral/medial orbitotomy, transcranial approaches,

endonasal transethmoid-sphenoidal approaches are used in TON management.

Eye Injury Vitrectomy Study (EIVS) is an evidence-based clinic research based on multiple clinical studies in China to explore the vision preservation with surgical timing after trauma. The study showed that the vitrectomy for OGI should be performed in less than 4 weeks. The incidence of traumatic proliferative vitreoretinopathy (PVR) will increase dramatically after a more than 4-week delay. The rates of eyeball removal and inflectional endophthalmitis are decreased by 10% and 5% with post-trauma vitrectomy. EIVS also showed that the eyeball of 25% of severe OGI patients with vision lost can be preserved by vitrectomy and filling of silicon oil to maintain the patient's normal appearance and keep the patient's life style. Application of silicon oil can maintain eyeball survival up to 52.8% and reduce the eyeball atrophy to 11% in OGI patients.

In OGI patients with no light perception, the ciliary body, choroid and retina are the key tissues deciding the management strategies. EIVS is performing further studies to figure out how to recover the ciliary body function, how to manage choroid rupture caused wide-area explosive hemorrhage and prevent PVR.

In recent five years, there are many research developments in the field of ocular trauma globally and in China, listed as the following: (1) Pattern-matched custom flex artificial iris prosthesis implants, which are used for iris and ciliary body repair after eye trauma, have been approved to applied in clinic trial by the US Food and Drug Administration. (2) The study of TON is from mechanism to regeneration and immune system. (3) Innovated foldable capsular vitreous body (FCVB) invented by Zhongshan Eye Institute might replace the silicon oil post-traumatically in the future. (4) Multiple clinic studies show that traumatic macular holes have the tendency to self-heal. (5) Microbiologic studies of endophthalmitis and their application to children post-trauma start to benefit millions of patients. (6) Amblyopia in children after OGI has been studied extensively and improved with vision therapy in long term care.

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