Ocular trauma: classification, management and prognosis

Introduction

Ocular trauma remains an important cause of blindness and visual impairment globally. It continues to pose a challenge because of its significant morbidity in terms of visual impairment and diminished quality of life. Although vision is our primary sensory organ, there still remains limited documentation on the incidence, prevalence and management of ocular trauma (World Health Organization, 1997). While the incidence of serious work-related eye casualties has reduced in the last 40 years as a result of government legislation introducing appropriate standards for eye protection, the impact of visual loss cannot be overestimated (Canavan et al, 1980; Hall et al, 1985). This article reviews the aetiology, management and prognosis of ocular trauma.

Epidemiology

While the actual figures for ocular trauma remain elusive, the World Health Organization estimates that about 148 million people live with visual impairment (Thylefors et al, 1995). Ocular trauma and corneal ulceration are significant causes of corneal blindness that are often underreported but may be responsible for 1.5–2.0 million new cases of monocular blindness each year (Whitcher et al, 2001).

The advent of effective health programmes aimed at reducing corneal blindness has led to an increase in the diagnosis of ocular trauma cases (Anderson and Foster, 1989). Until then, ocular trauma was not considered an important cause of visual impairment and blindness. However, towards the end of the 20th century, Négrel and Thylefors (1998) documented that up to 5% of all worldwide blindness was the result of ocular trauma, affecting approximately half a million people.

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Classification

The Birmingham Eye Trauma Terminology System was created to provide a concise and clear definition of all ocular injuries, which would be understood by all practitioners. This uniform classification system enables accurate transmission of clinical data, as well as facilitating the optimal delivery of patient care (Kuhn et al, 2002). The Birmingham Eye Trauma Terminology System is unique in ocular traumatology in that it ensures that in terms of description:

- All terms relate to the whole eyeball as the tissue of reference
- No injury is described by different terms, as each term has a unique definition (Kuhn and Pieramici, 2002; Kuhn et al, 2002).

Figure 1 is a modified Birmingham Eye Trauma Terminology System classification for ocular trauma. Globe injuries are divided into those that are open (full thickness eye wall wound) and those that are closed (intact eye wall or partial thickness eye wall wounds). The aetiology of either open or closed globe injuries depends on the mechanism of injury, which is discussed below.

Mechanisms of injury

The most important factor in determining the severity of ocular trauma is the type of object that caused the injury. As a general rule, the resulting damage from an ocular assault depends on several variables:

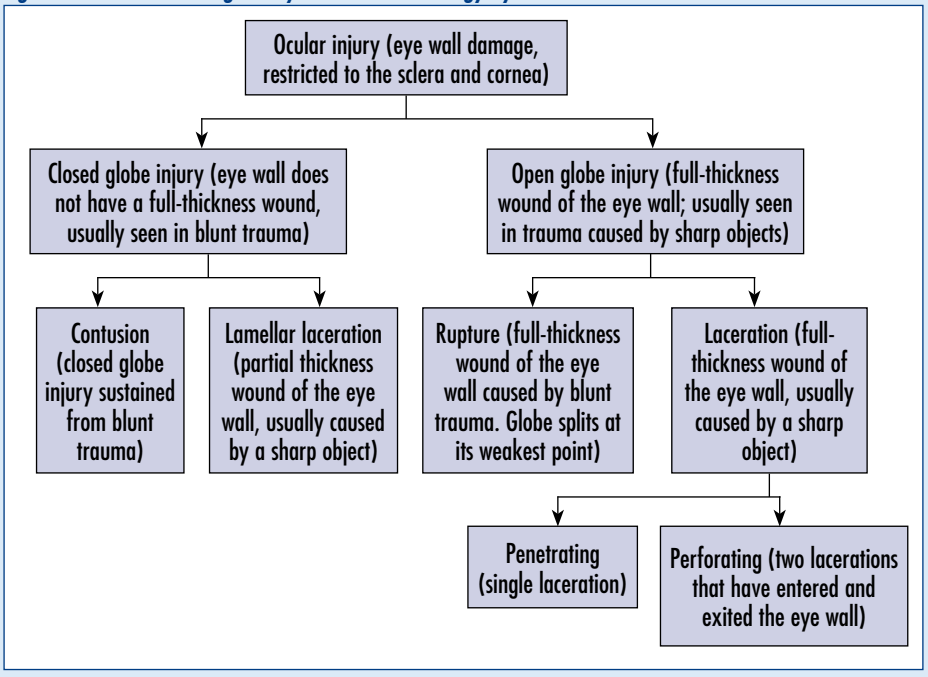
- The physical characteristics of the agent, which determine the energy transferred to or through the globe
- The area over which the impact is applied
- The amount of force applied.

The physical characteristics of the agent relate to the nature of the agent, and this could be blunt, sharp (including a flying particle) or a chemical agent.

Blunt trauma

A direct blow to the eye usually presents with severe pain and bruising in the form of a contusion or 'black eye'. Subconjuctival haemorrhages may also appear because of the breakage of subconjuctival blood vessels.

Figure 1. Modified Birmingham Eye Trauma Terminology System classification for ocular trauma.



The energy from the blow typically results in an anteroposterior compression with simultaneous expansion in the equatorial plane. Most of the force is absorbed by the lens–iris diaphragm. Damage to the highly vascular iris results in a hyphema, with a characteristic 'fluid level' of red blood cell sediments seen in the anterior chamber (Edwards and Layden, 1973) (*Figure 2*). Traumatic mydriasis may occur secondary to tears in the iris sphincter. In some cases, dis-insertion of the iris from the scleral spur results in iridodialysis (MacEwen, 1999).

If the blunt trauma is of sufficient force, a commotio retina (a countercoup injury which occurs when a large enough force is applied to the globe causing disruption of the photoreceptors by travelling shock waves) is noticed in the form of retinal whitening, macula oedema and secondary concussion of the sensory retina. In severe cases, frank intraocular disruption occurs if a large enough force is applied, resulting in a globe rupture.

In cases of hyphema or posterior pole involvement, the patient will complain of decreased visual acuity. Traumatic optic neuropathy should be suspected if a new afferent pupillary defect occurs in the traumatized eye.

The shear force alone in blunt trauma to the globe could result in a rapid rise in the intraocular pressure because of the confining nature of the bony orbit, and subsequently lead to a blow out fracture as a result of the decompression of the orbit into the maxillary antrum (Deutsch and Feller, 1985; Kuhn et al, 2002). In such cases, the patient will have restricted eye movements. Furthermore, increased intraocular pressure may also occur secondary to damage of the trabecular meshwork following the injury, which can predispose to glaucoma at a later date.

Cataract formation is also quite common (*Figure 3*). Typically in ocular trauma, this is either a stellate or rosette-shaped posterior axial opacification (Pieramici et al, 1996). Direct trauma to the eye may also result in a partial rupture of the lens zonules, causing a subluxation of the lens or dislocation. Traction on the anterior retina by the vitreous humour may result in retinal dialysis.

Sharp objects

This encompasses all ocular trauma caused by intraocular foreign bodies, penetrating trauma and perforating trauma. Injuries caused by sharp objects are three times more common in males than females, and carry the worst prognosis of all ocular trauma cases (Kuhn et al, 2002).

The diagnosis of an intraocular foreign body is often suggested by the history given, e.g. hammering metal. Intraocular foreign bodies cause damage by the high velocity with which they are travelling and penetrate the eye. Most particles lose momentum on penetrating the cornea and reaching the anterior chamber. Those with much higher velocities get as far as the posterior segment, and remain suspended in the vitreous (Hasnain and Kirmani, 1991).

Depending on the nature of the particle, the material may cause an inflammatory reaction in the eye, as is seen typically in injuries caused by ferrous metals (e.g. steel) (Williams et al, 1988). These cause mechanical damage as they pass through the eye and can introduce infection (particularly if organic matter, e.g. wood or soil) as well as exert other toxic effects on the intraocular structures (Ehlers and Shah, 2008).

Patients with intraocular foreign bodies may also present with excessive lacrimation, as well as reduced visual acuity and photophobia, especially if there is corneal involvement. A feeling of a 'foreign body sensation' in the eye may also occur, particularly if there is a breach of the corneal epithelium following an abrasion. This was seen in the study by Oum et al (2004), where corneal abrasion was the most common aetiology among 1552 (85.8%) closed injuries, and corneal laceration among 257 (14.2%) open globe injuries over a 6-year period in 1809 patients seen with ocular trauma in a Korean hospital.

Owing to the protective mechanism of the eyes known as Bell's phenomenon in 75% of the population (elevation of the globes when blinking or when threatened), a vast majority of penetrating eye injuries occur inferiorly (Deutsch and Feller, 1985; MacEwen, 1999). The energy transfer by a sharp object over a small area results in tissue penetration (Parver et al, 1993). If there is only an entry point the injury is said to be penetrating, whereas if it has both an entry and exit point in the eye wall it is said to be perforating (Kuhn et al, 2002). Patients often complain of pain and decreased visual acuity. The nature of the object which caused the injury also makes the diagnosis of a penetrating or perforating ocular injury more likely, particularly hammering (metal on metal or stone), working with power tools or any activity which may result in small, high velocity 'missiles' hitting the eye.

Chemical injuries

The majority of chemical burns are accidental. Ammonia, lime and sodium hydroxide are the most common alkalis involved, while sulphuric acid and hydrochloric acid are the commonest acids involved in ocular chemical injuries. Alkali burns are twice as common as acid burns as alkali is more widely used at home and in industry (*Figure 4*) (Kanski, 2003). Alkali burns are more severe because they penetrate the ocular tissues, causing a breakdown of the corneal epithelium and precipitation of glycosaminoglycans (Tielsch, 1995) (*Figure 4*).

Figure 2. Hyphema as a result of blunt injury to the eye. Some iris detail visible although a definite blood level cannot be seen.

Figure 3. Traumatic cataract with secondary glaucoma caused by an opaque and swollen lens.

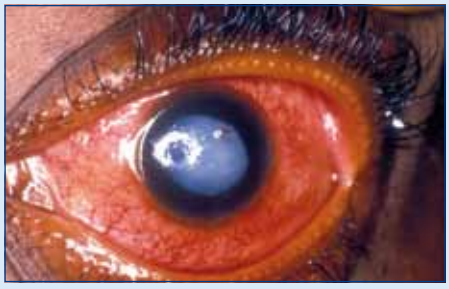


Figure 4. Corneal clouding and peripheral vascularization caused by lime burn.

The severity of a chemical burn is related to the properties of the chemical, the area of the affected ocular surface, and the duration of exposure. All patients with chemical burns present with severe pain and decreased visual acuity as a result of partial or total necrosis of the conjuctival and corneal epithelium. Those with mild to moderate burns present with varying degrees of corneal epithelial defects (from superficial punctate keratopathy to sloughing of the entire epithelium). There might also be focal areas of conjuctival chemosis and hyperaemia. In those presenting with severe burns, there is corneal opacification, corneal oedema, pronounced chemosis and conjuctival blanching as a result of significant peri-limbal ischaemia. There might also be first, second or third degree burns to the surrounding periocular skin (Kanski, 2003; Elhers and Shah, 2008).

Management

History

A comprehensive history regarding the nature of injury including the mechanism, the time of onset and the type of object that caused the trauma is essential. It is important to ask about specific symptoms of visual loss, pain, redness, photophobia, flashes and floaters, diplopia and swelling or bruising of the eye. The patient should also be questioned about past ocular and medical history including any relevant medications.

Examination

The examination should be systematic and thorough in any case of ocular trauma in order not to miss subtle signs which may indicate serious pathology. The visual function should be assessed by determining the visual acuity, checking for a relative afferent pupillary defect, colour vision and visual fields to confrontation.

The orbit should be palpated to check for continuity and the presence of any tenderness. Examine the external eye looking for periorbital bruising, oedema, lacerations and surgical emphysema. Assess the extraocular muscles by examining for normal and full eye movements.

The conjunctiva should be examined under the slit lamp for haemorrhage, laceration and ischaemia. Check for corneal involvement which may reveal an abrasion, full thickness laceration, foreign body and infiltrate. It is also important to perform Siedel's test to check for a perforation. (Siedel's test – stain the cornea with 2% fluorescein, ask the patient to blink a few times to evenly distribute the stain and then hold the eyelids open, check for any aqueous leak which will appear as a thin stream which clears the dye at the point of leaking.) Look for cells within the anterior chamber and any pupillary distortion, including the lens for cataract, sublaxation or dislocation. It is important to check the intraocular pressure and compare with the other eye. However, this requires ophthalmic expertise and therefore the eye pressure can be grossly checked by gently palpating each globe with the eyelids closed.

The final part of the examination is to conduct a dilated fundoscopy to check for vitreous haemorrhage, retinal oedema (commotio retinae), haemorrhage, tear or detachment, foreign body and choroidal rupture (Denniston and Murray, 2009). If there is any suspicion of globe rupture, manipulation of the eye should be kept to a minimum and senior help sought.

Investigations

All severe ocular trauma should be referred to an ophthalmologist, particularly if there is a possibility of perforation or penetration. Radio-opaque intraocular foreign bodies may be visualized with orbital X-rays or even better by a computed tomography scan. A computed tomography scan is also useful if a facial fracture is suspected and will demonstrate a blow out fracture. Magnetic resonance imaging should be avoided if there is any suspicion of a metallic foreign body (Kanski, 2003; Elhers and Shah, 2008).

Treatment

Corneal abrasions and foreign bodies

Superficial corneal abrasions and partial thickness lacerations will heal with topical antibiotics (e.g. chloramphenicol four times a day for 5–7 days). More extensive abrasions may require a bandaged contact lens. Most corneal foreign bodies are metallic and can be removed at the slit-lamp with a 26-gauge needle after instillation of topical anaesthesia (e.g. tetracaine or proxymetacaine). Rust rings should be removed in order to prevent siderosis. Once removed the patient should be prescribed topical antibiotics as above for 5–7 days in order to prevent secondary infection.

Chemical injury

All chemical injuries should be managed initially with copious amounts of irrigation using normal saline and the pH monitored until it normalizes to 7.0. It may be necessary to contact a poisons centre to find out the exact nature of the chemical agent involved. Injuries with a corneal epithelial defect will require topical antibiotic prophylaxis (e.g. preservative-free chloramphenicol four times a day). They may also require topical cyclopegic agents (e.g. cyclopentolate 1% 2–3 times/day). Topical lubricants and oral analgesia can be used. Ascorbic and citric acids have been documented to hasten recovery in patients with chemical burns (Verma et al, 1997).

Severe chemical injuries may require the use of topical steroids (e.g. dexamethasone 0.1%, prednisolone 0.5–1%) between 4 and 8 times/day. However, this should only be done under expert ophthalmic advice as inappropriate use of topical steroids in these cases can cause significant corneal damage and melting.

Blunt trauma

If the patient has a globe rupture, primary repair may be needed. Initial management should involve patching the eye without putting any pressure on the globe and giving systemic antibiotics (e.g. ciprofloxacin 750 mg orally twice a day). Topical antibiotics may also be considered, along with tetanus toxoid if indicated. The patient will need admission under the ophthalmology team for surgery. Lens injuries such as a significant opacity or subluxation and raised intraocular pressure (lens-related glaucoma) may warrant removal of the lens. Retinal tears or detachment should be referred for urgent vitreo-retinal assessment as laser therapy or surgery may be required as an emergency. Other injuries such as commotio retinae and choroidal rupture may not need urgent surgical intervention although specialist advice is required in all cases.

Blunt trauma may also lead to formation of a hyphema. Treatment of traumatic hyphemas aims to prevent secondary haemorrhage, control intraocular pressure, and prevent complications such as corneal blood staining. Most hyphemas resolve spontaneously over a couple of days, but monitoring of intraocular pressure is necessary. Surgical evacuation may be required in patients who have corneal blood stain-

ing, failed reduction in hyphema after a week and those complaining of worsening visual acuity (Ehlers and Shah, 2008).

Penetrating trauma

As with blunt trauma, the priority with penetrating eye injuries is to repair the integrity of the globe. Intraocular foreign bodies should ideally be removed during the primary repair and may require vitreo-retinal input if there is a posterior segment foreign body. If surgery to remove the intraocular foreign body is delayed, intravitreal antibiotics may reduce the risk of endophthalmitis. Where there is no intraocular foreign body, initial management is similar to that of blunt injury with globe rupture. Small self-sealing corneal wounds may not require surgery and can be managed with intensive topical antibiotics (e.g. preservative-free topical ciprofloxacin hourly to 2-hourly) and a bandaged contact lens (Denniston and Murray, 2009). More extensive corneal wounds may require corneal glue or suturing. Anterior or posterior segment foreign bodies will require specialist input as mentioned above. For areas of conjunctival laceration and subconjunctival haemorrhage, surgical exploration may be needed to exclude a hidden scleral full thickness wound.

Orbital fractures

In cases of orbital fracture, patients should be advised not to blow their nose as this may result in surgical emphysema and herniation. There is limited evidence for the use of antibiotic prophylaxis (e.g. co-amoxiclav 625 mg three times a day) although this may be considered when the patient is first seen in the emergency department. If the patient has persistent diplopia or significant enophthalmos or infraorbital hyposthesia he/she may need surgical intervention and should be referred to the maxillofacial team (Denniston and Murray, 2009).

Prognosis and visual outcomes

The ocular trauma score estimates specific visual function 6 months after the injury, thereby providing useful guidance on treatment and rehabilitation of patients with ocular trauma (Kuhn et al, 1996). Ocular trauma score remains the most widely used predictor of visual outcome post ocular trauma because of its high sensitivity, specificity and predictive accuracy as demonstrated by Wai Man and Steel (2010).

Unver et al (2009) initially showed the reliability of this tool in predicting the visual outcomes in 114 patients who had a known open globe injuries between January 2001 and July 2006. Variables used to estimate prognosis included visual acuity, globe rupture, endophthalmitis, perforating injury, retinal detachment and relative afferent pupillary defect. They found that three of these variables (initial visual acuity, presence of a relative afferent pupillary defect and an open globe injury) were the strongest predictors of poor visual outcome. According to the score obtained from this scale, the traumatized eye may be placed into one of five categories, each of which has a distinct probability of reaching a range of visual function.

Conclusions

Ocular trauma remains an important and preventable worldwide public health problem with a devastating socioeconomic impact. Over the past three decades, dramatic improvements have been made in prevention, diagnosis and subsequent management of eye injuries. Standardizing the documentation of ocular injuries has helped to improve the treatment and prognosis of eye trauma. A comprehensive history and examination in all cases of ocular trauma remains essential to facilitate appropriate treatment and reduce the incidence of subsequent visual impairment. BJHM

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KEY POINTS

- Ocular trauma is an important cause of visual impairment globally and can manifest with a number of eye symptoms and signs.
- The advent of the Birmingham Eye Trauma Terminology System has ensured a uniform approach to terminology regarding eye injuries thereby improving patient care.
- A comprehensive history and examination in all cases of ocular trauma is vital to enable appropriate treatment and reduce the incidence of visual impairment as a result.
- The ocular trauma score is a very useful tool in predicting prognosis of visual function after ocular injury.