INTRODUCTION

Traumatic eye injuries are common in the prehospital setting and may occur as isolated injuries or as part of more extensive maxillofacial trauma. Given that the scope of these injuries may range from the minor to the sight-threatening, prehospital providers must be prepared to rapidly identify serious ocular disorders that could cause blindness or other significant complications. Once serious eye injuries are recognized it is important that the patient is stabilized, given appropriate treatment, and transported to a trauma center or hospital with adequate access to ophthalmologic services to provide definitive care.

EPIDEMIOLOGY

Each year in the United States an estimated 2 to 3 million people seek medical care for eye injuries. In general, eye injuries in males outnumber those in females almost 4 to 1, and most serious injuries occur in those under the age of 30. Among all patients with significant trauma, 16% have serious ocular or orbital injuries, whereas over 50% of patients with serious facial trauma have associated eye injuries that could threaten sight or lead to loss of vision. Trauma is the second leading cause of monocular blindness after cataracts; eye injuries are the number one cause of ophthalmologic hospital admissions in the each year in the United States.

EVALUATION

History and Physical Examination

As with all trauma patients, attention should be focused on the ABCs of trauma resuscitation, and any life-threatening injuries should be addressed first. Eye injuries can be distracting to the EMS provider, and it is important not to allow them to divert attention from other sources of serious injury early in the trauma survey process. It is important to remember that associated facial trauma and swelling may affect airway patency: The airway should be secured, if appropriate, before further examination of the orbit.

Once the patient is stabilized attention turns toward the ocular injury, and a thorough evaluation can be performed, including a more complete history and eye examination. In the case of known or suspected chemical contact to the face and eye, immediate irrigation with normal saline or water (if saline is not available) should be performed before completing the full assessment process.

The most important component in the evaluation of traumatic eye disorders is a thorough history and careful eye examination. The history should focus on key points surrounding the event and should record the type of injury, the time of onset, and any specific symptoms reported by the patient. Mechanism of injury should be noted and may include blunt or sharp trauma and thermal or chemical burns to the eye or periorbital region. Other important points to document are the
The physical examination of the eye begins with assessment of visual acuity, and it is important to document this to establish a baseline level of function and provide assessment of possible damage to the eye. In the field this test can be performed using a handheld Snellen chart, documenting the smallest objects or letters identifiable at a specific distance from the eye. Visual acuity results should be recorded for each eye individually, and then using both eyes simultaneously. If no such chart is available, a newspaper or other source of small print is useful to establish a rough estimate of visual acuity. Patients who normally wear prescription glasses for reading should perform the task with those same glasses if possible, but those who use contact lenses should not have those replaced specifically for this examination. If the patient’s glasses are unavailable, it is possible to use a piece of paper with a small pin-sized hole through which the patient can view the chart and complete the examination. This “pin-hole test” corrects for the refractive error of the patient’s eyes and should allow completion of the examination. For those who are unable to read the Snellen chart due to their injury or underlying ocular disease, other options include the assessing the patient’s ability to visually count fingers, detect hand motions, or perceive the presence or movement of light. The mode of testing and patient performance should be documented for each eye. Even information such as “able [or unable] to count fingers or see colors at a distance of one foot” is helpful in definitive diagnosis and management.

After documenting visual acuity, the examination moves to the external examination of the eye and surrounding structures. Each globe should be evaluated for protrusion or proptosis and for any external signs of penetration or foreign-body presence (Figures 13.1 to 13.3). Ocular movement in the cardinal directions of gaze (vertical up-down, horizontal right-to-left and diagonal left-to-right and right-to-left) should then be tested and any deficit recorded. The pupil and iris should then be inspected for size, shape, and reaction to light, with special attention to comparing results between eyes. The presence or absence of a hyphema (blood in the anterior chamber that may obscure the iris or pupil) is especially important to document (Figure 13.4). Finally, the conjunctiva should be inspected for erythema, subconjunctival hemorrhage, chemosis (conjunctival swelling), or subconjunctival emphysema. If there a foreign body sensation in the eyelid (Figure 13.5) or any suspicion of an intraocular foreign body or a punctured globe (Figure 13.6), it is best to end the examination and cover they affected eye with a commercially available or improvised eye shield to protect the globe from external pressure before transport to a hospital setting for more definitive care. An EMT should never remove a protruding foreign body (such as a nail) lodged in the globe. A cup may be used to cover the eye with the foreign body in place.

Finally, examination of the surrounding structures of the eye includes evaluating for any associated maxillofacial trauma or related complications. The periorbital
soft tissues and eyelids should be inspected for lacerations, ecchymosis, edema, foreign bodies, and cutaneous evidence of thermal or chemical burns. The orbital rims should be similarly inspected and palpated for any crepitus or obvious bony deformities. If injuries are unilateral, it is important to compare the affected side to the normal side because normal foramina of the surrounding eye rim may be mistaken for fractures. If the patient has obvious periorbital trauma, a major concern would be an orbital blowout fracture, especially if there is associated diplopia (double vision) or inability to move the eye superiorly. Finally, the patient should have a sensory examination of the skin around the eye; any numbness or paresthesias could indicate damage to the infraorbital nerve.

**SPECIFIC OCULAR INJURIES**

**Chemical Burns and Exposures**

Ocular chemical burns and injuries are true ophthalmic emergencies and require immediate treatment in the field with copious irrigation with water. Delays in irrigation have been associated with increased risks to visual acuity and higher rates of subsequent complications when compared with immediate irrigation of the eye. Tap water and normal saline work equally well initially, with the keys being the volume of the fluid and duration of irrigation rather than the type of fluid. Irrigation should continue during transport to the hospital and last for at least 30 minutes for significant exposures. Important parts of the history to record include the type of chemical, the pH of the substance,
and the duration of the exposure to the eyes. If the chemical is an industrial source, a Material Safety Data Sheet (MSDS) is particularly helpful to identify and categorize the substance in question.\(^{10}\) In general, injuries from acid exposures tend to be less serious than alkali substances,\(^ {11}\) but this varies by the particular type of chemical involved. In addition to irrigation, proper prehospital management includes pain control and transport to an appropriate center for immediate ophthalmologic evaluation and consultation.

**Ocular Trauma**

Direct trauma to the eye can be divided into open- and closed-globe injuries. Open-globe injuries have a full-thickness defect in the ocular wall and include lacerations, penetrating wounds, intraocular foreign bodies, and rupture of the globe from blunt trauma.\(^ {12}\) An open globe signifies a high-energy mechanism of injury, is frequently associated with other ocular or periorbital injuries, and should always be suspected if clinical findings include significant head trauma, a hyphema, lacerations to the eyelids or periorbital structures, or a history of a projectile to the eye. Symptoms include decreased visual acuity, decreased ocular motility, and abnormal or absent pupillary reflexes, but these are of variable severity depending on the site and extent of damage. Open-globe injuries may be evident on gross inspection, as with a visible foreign body, a large scleral laceration with clear penetration, or an obvious deformity of the eye or the pupil. However, many penetrating injuries can cause negligible outside damage to the sclera or globe and a small intraocular foreign body may cause minimal pain after the initial event.\(^ {13}\) The key point for the prehospital provider is to consider an open globe. Once an open globe is suspected given the history and examination findings, all further evaluation of the eye should be postponed until definitive care is available.\(^ {7}\) The eye should be protected with a hard eye shield and the patient should be transported immediately to an emergency medical center for evaluation and potential surgical repair by an ophthalmologist. Other appropriate prehospital care includes pain control, elevation of the head of the bed to 30 to 45 degrees, and antiemetic medication to reduce potential increased intraocular pressure during vomiting.

Closed-globe injuries occur when there is incomplete penetration of the eye and include closed intraocular injuries like hyphema, damage to the retina, superficial abrasions and lacerations, and nonpenetrating foreign bodies. These injuries can cause significant eye pain, loss of visual acuity, and decreased ocular function, but they vary by the type and location of injury.

**Traumatic Hyphema**

A traumatic hyphema is a collection of blood in the anterior chamber of the eye caused by blunt or penetrating injury. The highly vascular ciliary body or iris is usually the source of bleeding for a hyphema and is often associated with head trauma or other eye injuries to the cornea, iris, lens, or globe.\(^ {14-16}\) Signs include decreased visual acuity, poor pupil reactivity, and potentially dangerous increases in intraocular pressure. The severity of a hyphema is graded on a scale of 1 to 4 based on the amount of blood that collects in the anterior chamber when the patient is in a seated position, ranging from a minimal layering (grade 1) to a complete filling of the chamber with blood (grade 4).\(^ {14,16}\) This grading is important because higher grades have an increased risk of complication and present a potential long-term threat to visual acuity.\(^ {17}\) Major complications include rebleeding into the hyphema, staining of the cornea with blood, and increased intraocular pressure that can lead to damage of the optic nerve or retina.\(^ {15-17}\) Prehospital treatments should focus on elevation of the head of the bed from 30 to 45 degrees, covering of the eye with a shield or other protective device, providing pain management, and arranging prompt transport to a medical facility for further ophthalmologic evaluation and management.\(^ {15,16}\)

**Corneal Injuries**

Corneal injuries are extremely common and present with ocular discomfort ranging from pain to sensations of a foreign body in the eye, blepharospasm, and tearing.\(^ {18}\) Depending on the location of injury, patients may also report decreased visual acuity, blurred vision, and photophobia. Corneal abrasions generally result from blunt trauma to the eye and may be visible to the naked eye of the examiner, but often the lesion can only be seen on slit-lamp examination after staining with fluorescein dye. Similarly, corneal foreign bodies may be seen on visual inspection of the eye and should be suspected in any patient with eye pain associated with high risk activities like use of power tools, hammering, grinding, or sanding objects with or without use of protective eyewear.\(^ {11}\) If an object is visualized in the eye it should be removed by a skilled practitioner unless there is concern that it has penetrated the globe, in which case the eye should be covered or patched until appropriate evaluation by a physician. In general, prehospital care of corneal...
injuries focuses on taking a thorough history, pain management, and transport to a center with appropriate specialty care. Most superficial corneal injuries will heal within 24 to 72 hours, but the prognosis and potential for further complications depends on the depth and overall size of the lesion.\(^{18}\)

**Retinal Injuries**

Trauma involving the retina and posterior segments of the eye is less common than injuries to anterior structures but carries a higher risk of blindness and irreversible loss of vision.\(^{19}\) Generally presenting with decreased visual acuity, posterior segment injuries may also cause a sensation of “flashing lights” or of “floaters” in the visual field of the affected eye.\(^{20}\) Although there are a variety of retinal injuries that can occur after trauma, most require a complete fundus examination for definitive diagnosis and are beyond the scope of this review. For the prehospital provider, it is important to remember the signs of retinal and posterior segment damage and to obtain a brief but complete eye history and examination, including visual acuity, before transporting the patient for ophthalmologic evaluation and treatment.

### CLINICAL VIGNETTES

**Case 1**

A 25-year-old male falls from a scaffold at a construction site while hammering together a wood frame for a wall. On arrival at the scene, paramedics find him lying on his side with lacerations and abrasions to the side of his face and forehead and an obvious open fracture to the right femur. A quick primary survey shows that he is awake and alert, with an intact airway, normal bilateral breath sounds, and normal pulses and neurovascular function in both the broken leg and other extremities. He is mildly tachypneic, tachycardic, and has normal blood pressure. The patient is crying and is in obvious pain from his leg and facial injuries. Estimated time for transport to the closest trauma center is 20 minutes.

At the scene, the patient is placed in a cervical spine collar and positioned supine on a backboard. The broken extremity is immobilized in a traction splint and an IV of normal saline is placed in the right arm for venous access and morphine analgesia. Paramedics then load the patient and begin transport, but during transfer the patient becomes agitated and delirious with pain and hits himself on the side of his injured face. This causes more agitation and severe pain requiring significantly more morphine before the patient arrives at the hospital.

**Discussion**

In this case, the paramedic crew correctly treated the patient’s fractured femur and provided followed appropriate spine precautions given the mechanism of injury. However, the severity of the fracture and the erroneous assumption that this was the only injury caused the paramedics to completely miss the intraocular foreign body in the right eye. While hammering on the scaffold, a metallic foreign body flew into the eye and this caused his fall and subsequent injuries. The patient did not express a significant amount of eye pain given his other distracting injuries until he touched the side of his face and applied pressure to the eye, which caused significant pain and discomfort. Given the associated facial trauma, more should have been asked about ocular symptoms and the eye should have been patched or covered with a shield to protect it from further damage or pressure to the affected eye.

**Case 2**

A 17-year-old female working as a lifeguard at a local pool spills a full container of an unidentified pool chemical on her head and face as it falls off a shelf above her. A paramedic team quickly arrives and finds her in obvious distress with burning in both eyes and blurred vision. She is tachycardic, but has an otherwise normal vital signs and physical examination. The pool is only 10 minutes down the street from the local hospital, so paramedics quickly extricate her to the ambulance and transport her for further evaluation. During the brief transport, more history is taken and it is noted that the patient currently wears contact lenses and has no other history of eye problems. The patient is taken to the local ED.
Discussion
In this case of a chemical injury to the eye, the crew mistakenly chose a short transport time to definitive care over immediate irrigation of the eye. The patient was stable without further life-threatening injuries, so attention should have immediately turned toward copious irrigation with water to flush and dilute the chemical from the eye. Any source of water, including a faucet, water hose, or even the pool itself would have been appropriate and would have provided the best initial treatment for the patient. It would have also been helpful for the crew to try to acquire a MSDS to identify the chemical in question and provide more information for further treatment at the hospital. However, the importance of immediate irrigation in this case cannot be overstated regardless of the short transport time.

REFERENCES