Ocular and Orbital Injuries

Contents:
- Blunt Trauma
- Penetrating Trauma
- Ocular Foreign Bodies
- Chemical Injuries
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- Shaken Baby Syndrome

Objectives:
- By the end of this chapter, the undergraduate student should be able to;
- Evaluate the common ocular and orbital injuries and determine whether the problem requires a prompt attention of a specialist.
- Know how to take specifically relevant history and how to examine the traumatized eye and record the visual acuity as accurately as possible.
- Institute immediate therapy in situations of true ocular emergency, such as chemical injuries.

Eye Trauma Terminology and Classification

I. Closed globe injury: is commonly due to blunt trauma. The corneoscleral eye wall of the globe is intact.
   A. Contusion: There is no (full thickness) wound. i.e. closed injury. Damage may occur at the site of impact or distant to it.
   B. Lamellar laceration: Partial thickness wound of the corneoscleral eye wall.
II. **Open globe injury:** Full thickness wound of the corneoscleral eye wall.

   A. **Rupture:** Full thickness wound of the corneoscleral eye wall, caused by a blunt object.

   B. **Laceration:** Full thickness wound of the corneoscleral eye wall, caused by a sharp object, this may be:
      1. **Penetrating injury:** it is a single full-thickness wound, usually caused by a sharp object, without an exit wound. The causative object may or may not be retained in the eye.
      2. **Perforating injury:** Entrance and exit wounds. Both wounds caused by the same agent
      3. **Intra-ocular Foreign Bodies (IOFB):** it is a penetrating injury with retained foreign object.

**Approach to a patient with ocular or orbital injury**

**History**

First, it is important to document the time, place, and type of injury (e.g. blunt or sharp trauma; acid or alkali burn), the patient's history of eye conditions, drug allergies, and tetanus immunization. A high level of suspicion should be maintained for an open globe based on the mechanism of trauma.

**External Examination**

- Palpation of the orbital rims should be performed to detect any fracture.
- A penlight is used to inspect the eye for hyphema which usually accompanies blunt injury or signs of perforation, such as reduced depth of the anterior chamber or iris prolapse.
- Eyelid eversion (retraction and eversion of the upper and lower eyelids) will facilitate inspection for a foreign body or chemical burn.

Do not evert the eyelids if you suspect an open globe injury.
If the patient has a foreign-body sensation or if there is a history of blunt or sharp injury, fluorescein is used to stain the cornea to identify any corneal epithelial defects.

**Pupillary Reactions**

Always check pupillary reactions in trauma cases. Diminished direct pupillary reaction to light with an intact consensual response (a relative afferent pupillary defect) may indicate an *optic nerve injury*.

**Ocular Motility Testing**

Movement of the eye may be generally restricted in the case of orbital hematoma. If there is a history of blunt trauma, vertical restriction combined with diplopia should make you suspect a *blowout fracture* (see later).

**Ophthalmoscopy**

- Pupillary dilation to permit evaluation of the fundus should be routine. The only exception to this rule would be in patients with head trauma where pupillary signs might be important for neurologic evaluation.

**Remember** that pupil dilation should be done cautiously in patients whose shallow anterior chamber predisposes them to narrow-angle glaucoma.

- The normal red reflex from the fundus is evenly colored and not interrupted by shadows (Figure 1). Absence of the red reflex may be due to vitreous hemorrhage.
- If the fundus is visible, look for retinal hemorrhages, edema or retinal detachment. In the event of a positive finding an urgent referral to a specialist is indicted.
Radiologic Studies

Radiologic evaluation is suggested if there is a suspicion of orbital fracture or ocular/orbital foreign body. An orbital computed tomography (CT) scan is the appropriate test to order.

Magnetic resonance imaging (MRI) should not be ordered for ocular or orbital trauma in any case of suspected intraocular foreign body e.g. in gun shot injuries and if the trauma occurs during hammering.

Immediate Primary Care Management:

Ocular and orbital injuries are true emergencies. This often means that proper treatment should be initiated immediately, before referral to specialists. Examples for this are:

1) Chemical burn of the conjunctiva and cornea represents one of the true ocular emergencies. Therapy must be instituted within minutes. All chemical burns require immediate and profuse irrigation with water or saline even before referral to a specialist.

2) Open globe injury, whether actual or suspected, necessitate the protection of the eye by an eye shield. Neither a patch nor ointment is advisable. The patient should be prevented from eating or drinking anything in anticipation of urgent surgical intervention, that should be initiated within a few hours.
BLUNT TRAUMA

If a large object (such as a football) hits the eye, most of the impact is usually taken by the bony orbital margin. If a smaller object (such as a tennis ball) hits the area, the eye itself may take most of the impact.

Effect of Blunt Injuries on The Orbital and Ocular Structures

THE ORBIT:

1. Orbital hemorrhage causing proptosis (Figure 2).
   An orbital hematoma is a potentially sight-threatening situation (because of possible central retinal artery compression). The patient may present with proptosis and decreased ocular motility. This is an urgent situation, treated with a lateral canthotomy which expands the orbital volume and thus decreases the orbital pressure.

2. Orbital fracture: The orbital floor is very thin and blunt trauma may "blow out" the floor into the maxillary sinus. Orbital contents, including the inferior rectus and inferior oblique muscles, may become trapped, restricting vertical eye movement and causing double vision (diplopia) (Figure 3).
Figure 3: Left figure: blow out fracture to the globe. Right figure: CT scan of the orbit sagittal cut, showing fracture of the left orbit with prolapse of the orbital fat and inferior oblique into the maxilla.

A medial fracture affecting the thin ethmoid bone causes communication between the orbit and the peri-orbital sinuses and may be associated with subcutaneous emphysema of the eyelids. So, the patient should avoid blowing the nose (Figure 4).

Figure 4: CT scan of the left orbit showing fracture of the medial orbital wall.

Computed tomography (CT scan) of the orbit is mandatory to diagnosis those fractures. Eyes with established diagnosis of orbital fractures should be examined meticulously and urgently to rule out any associated globe trauma, however, treatment of orbital fractures in adults is usually non urgent.

THE EYELIDS:

1. Lids Hematoma: A “black eye” consisting of a hematoma (focal collection of blood), is the most common blunt injury to the eyelid (Figure 6)
Bilateral eyelid haematomas (ring haematomas) give rise to the characteristic “Panda eyes” may be encountered in patients with basal skull fracture (Figure 7).

2. Lid lacerations: An eyelid laceration should be repaired by surgical closure whenever possible, since this affords the best functional and cosmetic results (Figure 8).

3. Traumatic ptosis:
   Early, this may be mechanical from blood or edema (heaviness of the lid). After resolution of the edema or hematoma, persistent
Ptosis may be due to injury of the levator aponeurosis (dehiscence) or rarely injury to the muscle itself or its nerve supply.

**THE CONJUNCTIVA:**

1. **Sub-conjunctival hemorrhage:**

   Blood under the conjunctiva (due to ruptured conjunctival vessels) from blunt injury should be differentiated from that leaking from a fracture of the base of the skull due to severe head injury.

   Sub-conjunctival hemorrhage with indistinct posterior limit, accompanied head trauma, and/or disturbed conscious level may indicate basal skull fracture injury with blood trickling to the subconjunctival space. This is a situation that necessitates prompt fundus examination and referral to neurologists.

   In contrast to spontaneous subconjunctival hemorrhage which is usually benign (see chapter 7), in the setting of trauma one should have a suspicion of underlying globe injury, including globe rupture or intraocular hemorrhage. If other signs of possible ruptured globe are present, surgical exploration under general anaesthesia may be essential (Fig.9)

![Figure 9: Sub conjunctival Hemorrhage.](image)

**THE CORNEA:**

**Corneal abrasions:** Corneal abrasions, manifested with pain, photophobia, and lacrimation are common in blunt trauma eyes. Central abrasions over the pupillary area may significantly affect patient’s vision.
Corneal abrasions commonly diagnosed with fluorescein stain to enhance the view (Figure 10)

![Figure 10: Corneal abrasion stained with fluorescein.](image)

Corneal abrasions are treated by prophylactic topical antibiotic drops or ointment. Short-acting cycloplegic (tropicamide or cyclopentolate) drops may be helpful for the relief of pain. An eye patch to maintain eyelid closure for 24 hours, may be applied.

THE SCLERA

_Scleral rupture:_

Because corneal tissue is much stronger than scleral tissue, a severe blunt trauma results in a scleral wound and not in a corneal rupture. (Figure 11). An anterior sclera rupture may be masked by extensive subconjunctival haemorrhage._(see above)._ An occult posterior rupture, however, can be associated with little visible damage to the anterior segment structures, but should be suspected if there is asymmetry of anterior chamber depth (the AC is deeper in the affected eye), and the intraocular pressure in the affected eye is low.

![Figure 11: Scleral rupture with iris prolapse.](image)

THE ANTERIOR CHAMBER:
**Traumatic hyphema:** Is blood in the anterior chamber due to ruptured iris vessels (Figure 12). If a sizable hyphema is present, it may cause increase in IOP. In persistent cases, blood staining of the cornea may occur.

![Figure 12: Hyphema with different levels, mild, moderate, and severe (Total).](image)

**Treatment:**
2. No aspirin or non-steroidal anti-inflammatory drugs. (to avoid rebleeding)
3. Topical steroids to control iritis.
4. Daily monitoring of the IOP and topical beta blockers to control IOP.
5. Oral aminocaproic acid, an antifibrinolytic to avoid rebleeding.
6. Immediate evacuation of the hyphema if there is high IOP or early blood staining of the cornea.

**No miotics and no mydriatics:**

- Although miotics will increase the iris surface and possibly help in rapid absorption of the AC blood, they may cause painful ciliary muscle contraction and increase chances of iritis.

- Mydriatics may help relieve pain and inflammation but they decrease the absorbing iris surface.
THE IRIS & THE PUPIL:

1. **Traumatic iritis**: Inflammation of the iris and ciliary body, showing signs of iridocyclitis and pupil shows miosis.

2. **Iris sphincter tears**: Defects in the constrictor pupillae muscle at the pupillary border (Figure 13). The pupil shows traumatic mydriasis, and poor dilatation.
   
   In blunt trauma, the pupil may be dilated irreactive secondary to traumatic paralysis of the 3rd nerve fibers.

3. **Irido-dialysis**: Separation of the root of the iris from the ciliary body (Figure 14). The pupil is typically D-shaped, and the dialysis is seen as a dark biconvex area near the limbus. The condition may be asymptomatic if covered by the eyelid. If exposed in the palpebral fissure, the patient will present with monocular diplopia, that necessitates surgical repair.

   ![Figure 13: Multiple sphincteric tears](image)

   ![Figure 14: Iridodialysis](image)

THE LENS:

1. **Lens subluxation** and **dislocation**: due to partial or total rupture of the zonules (Figure 15). Eyes with subluxated lens, show irregular anterior
chamber depth, tremulous iris (due to loss of the lens support), and monocular diplopia (If the subluxated lens crosses the pupil).

**Figure 15:** Left figure: Lens subluxation, right figure: Posterior lens dislocation

Complications:

- Pupil block glaucoma with anterior lens dislocation.
- Phaco- anaphylactic glaucoma with posterior dislocation.

Management:
Dislocated lenses should be removed to avoid complications.

2. **Traumatic cataract:**

- **Vossius ring:** A circle of iris pigment on the anterior lens capsule due to the impression of the pupillary border of the iris on the lens (Figure 16).

**Figure 16:** Vossius ring.
- **Rosette-shaped cataract**: is pathognomonic of blunt trauma (Figure 17).

![Figure 17: Rosette cataract](image)

**THE VITREOUS:**

1. **Vitreous hemorrhage.** (Absent red reflex)
2. **Vitreous prolapse** and loss through a ruptured globe with traction on the retina.

**THE CHOROID:**

- **Rupture of the choroid**: The condition is usually asymptomatic if it is peripheral. If the rupture is underlying the fovea, vision will be severely affected (Figure 18).

![Figure 18: Choroidal rupture](image)

**THE RETINA:**

1. **Commotio retinae:**
   - Retinal edema caused by the contre-coup injury to the posterior pole, causing swelling of the ganglion cells.
- **Fundus picture:** retinal opacification (usually grayish white) cherry-red fovea (Figure 19).

![Figure 19: Cherry red spot.](image19)

2. **Retinal hemorrhages** (Figure 20).

![Figure 20: Retinal hemorrhage.](image20)

3. **Retinal tears and retinal disinsertion (Retinal dialysis)** (Figure 21).

   **Dialysis** is a break occurring at the ora serrata, and is caused by traction of the vitreous gel along the posterior aspect of the vitreous base with tearing of the retina.

![Figure 21: Retinal dialysis](image21)
4. **Retinal detachment** may be:
   
i. Rhegmatogenous due to retinal tears,
   
ii. Tractional due to vitreous changes secondary to its prolapse and incarceration in the wound of open globe injuries.

**THE OPTIC NERVE:**

Variable degrees of optic neuropathy can follow blunt ocular trauma. Patients may complain of decreased vision or field defects. Ocular examination usually reveals relative afferent pupillary defect.

A particularly severe type of optic nerve damage due to blunt trauma is **optic nerve avulsion**. This occurs in severe trauma to the eye and also in trauma involving the cranium such as the case in car accidents. The vision deteriorates to **no perception of light** with a **dilated pupil unresponsive** to light. The condition has no treatment.

**Penetrating Ocular Trauma**

**Corneal and scleral lacerations:**

Corneal and scleral lacerations are due to trauma to the eye with a sharp object such as a nail, knife, needle, scissors, or a piece of glass. Penetrating injuries may or may not be accompanied with an intraocular foreign body.

**Clinical effects:**

- Wounds of the lids, conjunctiva, cornea or sclera (Figure 22).
- Uveal prolapse with or without vitreous loss.
- Traumatic cataract.
In eyes with globe laceration, aqueous immediately leaks out of a corneal wound causing hypotony. The AC may be shallow or flat with or without hyphema, and the uvea may prolapse into the wound.

In eyes with a diagnosed or suspected globe laceration we should avoid topical medications. Immediate patching and prophylactic systemic antibiotics should be started immediately. X-ray or CT is done to exclude the presence of IOFB, and the patient should be prepared for surgical repair of the wound.

**Rupture of the cornea**: corneal wound caused by sharp object (Figure 23), presents with shallow anterior chamber, prolapse of parts of the uvea, abnormal site, size, and shape of the pupil, and hypotony.
Ocular Foreign Bodies

Foreign bodies may hit the eye and stay on the surface without penetrating the globe. This is a common type of injury, which can be usually managed in the emergency room. If the foreign body enters the eye in penetrating ocular trauma it is described as intraocular foreign body IOFB

1) Ocular surface foreign bodies:

The most common types of foreign bodies that hit the eye are metallic foreign bodies. They may be magnetic as iron or nonmagnetic as lead and copper. Metallic foreign bodies tend to affect the eyes of workers who operate high-speed grinders without goggles or those using a hammer and chisel without protection. (Figure 24).

![Figure 24: Conjunctival (Figure 24.A) or corneal (Figure 24.b) foreign bodies.](image)

The patient presents with pain, foreign body sensation, photophobia, tearing and red eye. Symptoms typically relieved significantly with topical anesthesia, however ocular anesthetics should never be prescribed for home use because they are toxic to the corneal epithelium when used repeatedly. Prolonged use could result in secondary infection and/or corneal ulceration.
Foreign body Removal

To remove a superficial foreign body from the cornea or conjunctiva, instill a topical anesthetic, such as proparacaine, and then gently roll a cotton-tipped applicator across the globe to pick up the object. A forceful stream of irrigating solution delivered from a squeeze bottle will often dislodge a superficial conjunctival or corneal foreign body. A sharper instrument may be required if the foreign body remains embedded, and the patient should be referred to a specialist for fear of corneal injury. Eversion of the upper eyelid is required to evaluate the upper palpebral conjunctiva (Figure 25).

![Diagram showing steps of lid eversion followed by removal of conjunctival foreign body by cotton applicator.](image)

**Figure 25:** Diagram showing steps of lid eversion followed by removal of conjunctival foreign body by cotton applicator.

2) Intraocular Foreign body:

Foreign body may penetrate globe through the cornea or sclera and retained inside the globe (Figure 26).

Intraocular lead pellets are seen in firearm injuries. Nonmetallic foreign bodies such as glass may result from car accidents or breakage of eyeglasses.
Effects of IOFB:

1. **Mechanical effects**: depending on the path, the IOFB may injure the cornea, sclera, uvea, lens, retina, or optic nerve.

2. **Infections**.

3. **Chemical effects**: are delayed and depend on the chemical nature of the FB whether iron or copper FBs.

In eyes with an IOFB; FBs should be localized by careful fundus examination, X-ray or CT scan (Figure 27).

Removal of the foreign body is indicated, except if it is small and inert e.g. small pieces of glass or plastic. In eyes with posterior segment IOFB, pars-plana vitrectomy and removal with a FB forceps is the procedure of choice. Any retinal injuries are repaired and retinal tears are sealed with laser photocoagulation or cryotherapy.
Chemical Injuries

Exposure of the eye to chemicals is rather common and could result in various effects that range from very mild to very severe.

Exposure may be accidental, including household material as detergents, or due occupational injury with strong chemicals as acids, alkalis and war gases.

**Alkali burns:**

The most serious chemical burns are produced by alkalis such as lime, cement, plasters, and ammonia, which are present in household detergents, fertilizers, and refrigerants.

Alkalis are more serious than acids because the latter tend to coagulate surface proteins which act as a barrier against further penetration. Whereas alkalis generally penetrate deeply and affect the deeper ocular structures. Besides the deep limbal vessels and the limbal stem cells are damaged by alkalis which gives very poor prognosis to corneal transplantation in alkali burns.

**Acid Burns:**

Such as battery fluid and laboratory glacial acetic acid and bleach.

**Emergency Treatment of Chemical Burns:**

- First aid for chemical injuries of the eye may demand the earliest possible irrigation using any source of water available, such as a garden hose, drinking fountain, or faucet.
- Lyme and cement chemical burns need special attention because the particles are not to be washed but must be picked first. Afterwards, washing may be done with a weak acid in Lyme burns and with profuse water in cement burns.
- Once the patient is in a healthcare setting, immediate copious irrigation of the eye with saline irrigation. **Irrigation should never be delayed for any reason.** Irrigation should be performed for 20 minutes with at
least 2 liters of the available aqueous solution (preferably, normal saline or lactated Ringer's solution).

- Do not attempt to buffer or neutralize the chemical substance
- It is better to place an eye speculum and topical anesthesia in the eye before irrigation. The lower lid is pulled down and the upper lid is everted to irrigate the fornices.
- Conjunctival pH should be tested 10 minutes after cessation of irrigation using litmus paper and irrigation should be continued until neutral pH is reached (7.0).
- Topical antibiotics, aggressive lubrication with eye ointments (steroid antibiotic combinations) to prevent symblepharon.
- Cycloplegics, topical steroids (in the absence of corneal abrasions) to reduce inflammation.
- Glass rod lysis of symblepharon.

**Radiation Injuries**

The eyes may be exposed to a wide variety of electromagnetic radiations such as:

- **LASER light injuries**: widespread availability of commercial laser lights is causing increasing eye problems whether self-inflicted (by looking directly into the light or friend inflicted)
- The laser beam causes a severe **foveal injury** or a **macular hole**.

- **Longer infrared waves**: Longer infrared waves cause cataract seen in glass blowers and furnace workers. It is prevented by the use of protective goggles.
- **Shorter wavelength (ultraviolet rays)**: Exposure to UV rays occurs with welding arcs and in skiing (snow blindness), if protective goggles are not used. After a latent period of 6-8hrs, severe photophobia and lacrimation (**photophthalmia**) occur due multiple corneal epithelial erosions. The photophobia lasts until the epithelium heals in 12-24 hrs., that may require patching until the corneal epithelium heals.
- **Microwaves** may cause cataract.
• **X-rays**: Therapeutic but not diagnostic doses of X-rays tend to cause cataracts and the eye should be suitably shielded during treatment.

• **Solar rays**: Looking directly at the sun may result in a burn of the central retina. This is particularly common at the time of the solar eclipse.

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**Shaken Baby Syndrome**

It is a form of physical abuse occurring typically in children under the age of 2 years. It is caused principally by violent shaking, often in association with impact injury to the head. The pattern of injury results from rotational acceleration and deceleration of the head.

The child is frequently presented with irritability, lethargy and vomiting, whereas, signs of impact head injuries, multiple rib and long bone fractures, may raise the suspicious of the condition.

**Ocular features:**

- Retinal haemorrhages: The most common
- Periocular bruising and subconjunctival haemorrhages
- Poor visual responses and afferent papillary defects.