Eye Injuries

Eye injuries are a common cause of emergency department attendances. Eye trauma should always be fully assessed, as penetrating injuries are otherwise easily missed but can rapidly lead to sight-threatening infections.

This article covers the assessment of eye injury including blunt trauma, orbital fracture, lid laceration, glue in the eye, chemical and deterrent spray injuries and signs suggesting non-accidental injury (NAI). Specific practical techniques are explained in the last section. Also see separate related articles Examination of the Eye, Corneal Foreign Bodies, Injuries and Abrasions, Corneal Problems - Acute and Non-acute, Diagnosing Conjunctival Problems, Contact Lens Problems and Red Eye.

Definitions of terms

The Birmingham Eye Trauma Terminology System (BETTS) was designed to standardise terminology in eye trauma to better enable the sharing of information and advances in treatment on a global scale. It defines terms as follows[1, 2]:

- **Eye wall injury**: injury restricted to the sclera and cornea:
  - **Closed globe injury**: eye wall wound is not full-thickness.
  - **Open globe injury**: full-thickness wound of the eyeball (wound occurs at the impact site by an outside-in mechanism).

- **Contusion**: no full-thickness wound; injury is due to direct energy delivery by the object (eg, choroidal rupture) or to changes in the shape of the globe.
- **Lamellar laceration**: partial-thickness wound of the eye wall caused by a sharp object.
- **Rupture**: full-thickness wound of the eye wall caused by a blunt object: since the eye is filled with incompressible liquid; the impact causes momentary increase in intraocular pressure (IOP) and the eye wall gives at the weakest point, which may be the impact site, or elsewhere.
- **Penetrating injury**: single laceration of the eyeball, usually caused by a sharp object.
- **Intraocular foreign body (IOFB) injury**: retained FB which caused entrance laceration. This is technically a penetrating injury but the clinical implication is different, so it is grouped separately
- **Perforating injury**: two full-thickness lacerations (entrance and exit) of the eye wall, due to a sharp object or missile - both wounds caused by the same agent.

Assessment[3, 4]

The aim of assessment is to:

- Understand the mechanism and nature of the injury.
- Identify associated injuries.
- Identify factors that could worsen outcome.
- Decide whether referral is necessary and, if so, immediately or later.

History[3]

A detailed, accurate history is important: how the injury was sustained is crucial, as any history of high-velocity injury raises the possibility of penetrating injury. Forceful blunt injuries such as a punch raise the possibility of blowout injury. The circumstances of the injury should be recorded.

Where no clear history is available from the patient, full assessment to exclude ocular emergencies is essential.
History should include:

- Time elapsed since injury.
- Circumstances of injury:
  - Establish what the patient was doing at the time.
  - Consider whether this could be a high-velocity injury with risk of open globe injury or IOFB (eg, power tools, metal on metal work, hammer and chisel, grinding, lawn mowing, glass injuries, explosion).
  - For young children or unconscious patients - obtain history from a witness.
  - Note whether glasses or goggles were worn and what type they were (eg, hugging the eye or with a space where an object could have entered).

- Mode of injury:
  - Physical, chemical, thermal.
  - Nature and size of object: sharp or blunt.
  - Speed of impact.
  - Possible FB (on the surface or penetrating).

- Other injuries sustained.
- Treatment received so far.
- Previous acuity (even if just a rough estimate) and any existing eye problems.
- Current symptoms - pain, reduced vision, diplopia, flashes/floaters, FB sensation.
- If there is severe eye pain with progressive visual loss ± proptosis, consider retrobulbar haemorrhage - an emergency (see 'Worrying findings and reasons to refer', below).
- Past medical history, tetanus immunisation, medication and allergies.

Examination

The examination will be dictated by the patient’s ability to co-operate (level of consciousness, pain, intoxication, age) and, to a certain extent, your confidence. Your examination must be complete - assume the worst until you have ruled it out. Note that the degree of pain or visual impairment in ocular injuries does not necessarily correlate with the seriousness of the injury.

NB: if you suspect or find signs of an open globe (penetrating) injury, stop the examination and follow process in 'Open globe (penetrating) eye injuries' section, below. **DO NOT** manipulate the eye or apply any pressure to the globe or patch the eye.

- **Start with visual acuities of both eyes:**
  - Preferably use a Snellen chart; if this is not possible, document what the patient can see - eg, signs in the waiting room, finger counting and light perception (if the eye cannot be opened, check light perception through closed lids). Document what you find: this is invaluable when assessing how things are evolving.
  - Acuities of 6/6 do not necessarily exclude serious problems, including penetrating injury.

- Examine the eye from front to back, doing as much as your equipment allows.
• You may need local anaesthetic if the patient cannot open their eyes due to pain:
  • **Orbits and lids**: lacerations, subcutaneous emphysema, bruising, deformity of the orbital rim, oedema. Evert lids:
    • If you think there may be a fracture, measure the medial intercanthal distance (this should be 35-40 mm in adults).
    • Consider whether bilateral bruising could actually be due to a base of skull fracture rather than an eye injury. (Conversely, rule out eye injury in the patient with 'panda eyes' from a base of skull fracture.)
  • **Conjunctiva**: look for haemorrhage and lacerations (small lacerations can be subtle - they may show up on staining with fluorescein) - these can indicate an open globe injury.
  • **Cornea**: lacerations may be small and missed:
    • Perform a Seidel's test first (to assess for leakage from the cornea - see 'Techniques', below) and then assess for corneal abrasion with dilute fluorescein.
  • **Anterior chamber**: look for hyphaema (the patient needs to be upright to see level).
  • **Iris and pupils**: check shape, size, reactive and equal. Pupil or iris damage is a serious sign.
  • **Fundus**: loss of red reflex could be due to opacification from blood in the vitreous or a large retinal detachment.
  • **IOP**: should also be assessed - if possible - unless you suspect an open globe injury.

• Perform a functional examination:
  • **Movement** of the eyes (ask about diplopia before and during examination).
  • **Pupil reactions** test **visual fields**.
  • **Test for** relative afferent pupillary defect if possible.

Time may be of the essence where a peri-ocular haematoma develops: if this is severe, the window of opportunity to examine the eye may close quickly and not re-open for several days. If unable to examine fully, refer.

The separate Examination of the Eye article may be helpful. Techniques are outlined at the end of this article.

**Worrying findings and reasons to refer**[^5]

**Most urgent eye injuries (which may rapidly lead to permanent impairment of sight)**

• Chemical burns.
• Retrobulbar haemorrhage.
• Open globe injuries including IOFBs.

**Serious/red flag symptoms**

• Reduced **visual acuity**, particularly if progressive.
• Pain unrelieved by local anaesthetic drops.
• Diplopia.
• Flashes and (new) floaters which can indicate retinal injury.

**Serious/red flag signs**

• Deep lid laceration: there may be damage underneath it.
• Subconjunctival haemorrhage/conjunctival laceration: in the context of eye trauma, can indicate open globe injury, especially if there is severe or diffuse haemorrhage. If it tracks posteriorly, it may indicate fracture[^6].
• Pupil, iris or fundal abnormalities:
  • Hyphaema, irregular pupil or decreased IOP would suggest that an object has gone at least into the anterior chamber.
  • Hyphaema indicates significant eye injury.
  • Teardrop-shaped pupil indicates open globe injury.
  • Vitreous haemorrhage suggests injury to the posterior segment of eye.

• Positive Seidel's test (see below) - indicates open globe injury.
• Abnormalities of eye movements, proptosis or enophthalmos - indicate damage in the orbital area or to extra-ocular muscles.

Injuries requiring urgent referral to an ophthalmologist

• Chemical burn, open globe injury or retrobulbar haemorrhage.
• Difficulty in making a full assessment - eg, unclear history, lid swelling, a young child or reduced conscious level.
• Any of the 'serious symptoms and signs', above.
• IOFB - known or suspected
• Corneal FB which cannot be removed.
• Corneal opacities, rust rings or large corneal abrasions.

Investigations[^7]

• CT scan is usually the first choice for evaluating orbital trauma and orbital fractures and for detecting IOFBs.
• Plain X-rays:
  • Rarely used now for orbital injuries, as CT is more accurate.
  • Plain X-rays of the orbit/face can be used to rule out known radiopaque FBs - eg, if there is a clear history of hammering metal and an apparently superficial wound of the periorbital area[^8].
  • Ultrasound is useful for evaluating the globe and its contents but is contra-indicated if open globe injury is suspected.
  • MRI is less used and is contra-indicated if a metallic FB is suspected.

Chemical injuries[^5,9]

These are ocular emergencies. They can be so severe as to damage the pluripotent limbal stem cell, leading to opacification and neo-vascularisation of the cornea and to extensive scarring.

Acid burns

Acids precipitate tissue protein, creating a barrier to further ocular penetration, so they tend to be less severe than alkali injuries. An exception is hydrofluoric acid (used in glass polishing), which rapidly passes through cell membranes and enters the anterior chamber of the eye, where it reacts with collagen and causes a rapid increase in intraocular pressure.

• Common causes of acid injury are: sulfuric acid (car batteries), sulfurous acid (bleach), acetic acid (vinegar), hydrochloric acid (swimming pools) and hydrofluoric acid (glass polishing).
Alkali burns

Alkali burns are generally more severe and cause penetrating eye injuries. They cause corneal damage by pH change, ulceration, proteolysis and collagen synthesis defects. Alkalis are lipophilic and penetrate the eye much more rapidly than acids. They can quickly deposit within the tissues of the ocular surface, leading to saponification. The inflammatory response from the damaged tissue leads to further damage. Alkali can penetrate into the anterior chamber, causing cataract formation and damage to the ciliary body and trabecular meshwork.

- Common causes of alkali injury are: ammonia (fertilisers, refrigerants), potassium hydroxide (potash), sodium hydroxide (drain cleaners, car airbags), magnesium hydroxide (sparklers, flares) and lye (plaster, mortar, cement, whitewash). The alkali aerosol in car airbags can be released even if the bag does not rupture.

Presentation

- Pain, blurring, photophobia, FB sensation.
- Blepharospasm, red eye, cloudy cornea. NB: the eye may not be red if a severe burn causes ischaemia of conjunctival vessels.

Management

A chemical burn needs urgent irrigation before pausing for history or examination. Manage immediately, using three "I"s: IRRIGATE, IRRIGATE and IRRIGATE. This may be the single most important factor in determining visual outcome.

- Copious irrigation is crucial using isotonic saline or lactate ringer solution (if you have neither, use water).
- Local anaesthetic drops may be necessary in order to allow eye opening for irrigation.
- 20 L or more may be required to change pH to physiological levels.
- pH testing should be done - normal pH of the eye is 7.4. Once pH is neutralised, the eye can be examined and the patient transferred to specialist care.
- If the chemical contains particles, the lids should be spread widely, irrigation continued and a cotton bud used to lift out particles.
- If you need topical anaesthetic to help keep the eye open, add a drop every five minutes (as this will be washed away too).
- If non-sterile water is the only liquid available, it should be used.
- Refer the patient urgently while continuing irrigation.
- Whilst irrigating, obtain history, including chemical used and any thermal or blast injury (which may cause penetrating FBs as well as a burns). Specific information on poisons is available from the National Poisons Information Service.

How to irrigate following chemical eye injury

- A number of saline bags, a giving set and towels are needed.
- Sit the patient by a sink. Instil anaesthetic drops and gently tilt the patient's head back so that they are holding it over the rim of the sink, explaining what you are going to do (this is easy to forget in the rush - irrigation can be unpleasant in the first few moments, until a steady stream is achieved).
- Remove contact lenses if present.
- Use a 500 ml bag of saline and empty it into the conjunctival sac, using a purpose-built irrigator if you have one - or through a standard giving set (cut the end of the tubing if necessary to deliver the fluid more quickly).
- Ensure that both upper and lower fornices are irrigated. As a rough guide, check the pH between bag change-overs.
- You will need several bags; the volume required to reach a neutral pH varies but may be up to 20 L in severe cases, particularly where alkalis are involved.
- Carry on for 15-30 minutes at least, checking pH every five minutes or so.
- After irrigation, acuity should be recorded and the surface of the eye stained to look for epithelial defects.
- Note that CS gas injuries are treated differently to other chemical eye injuries, by blowing cool air on to the eyes (see under 'Deterrent spray injuries', below).
Further management

- Acute-phase treatment includes a broad-spectrum topical antibiotic, and cycloplegic and anti-glaucoma therapy. Various therapies to promote re-epithelisation, support repair and control inflammation are used, including tear substitutes, ascorbic or citric acid, and acetylcysteine and bandage soft contact lenses. Steroids are used cautiously.
- After chemical injury, the goal is to restore a normal ocular surface and clarity. If extensive corneal scarring is present, surgical debridement, limbal stem cell grafting, amniotic membrane transplantation and keratoprosthesis can help restore vision.

Deterrent spray injuries\textsuperscript{[11, 12]}

**CS gas (tear gas or \textquoteleft mace\textquoteright) injuries**

- CS gas produces ocular irritation - this typically lasts only 15 minutes, although it can be prolonged (up to three days).
- Injuries can also result from the mechanical force or powder involved when the spray is used at close range. This can cause powder infiltration of the conjunctiva, cornea and sclera and there may be tearing or oedema of the cornea.
- Illegal sprays such as \textquoteleft mace\textquoteright may contain other chemicals - eg, chloroacetophenone (which is the active ingredient in mace spray).
- Mechanical injuries can also occur from fragments of powder or from the aerosol cartridge.

**Management**

- Blow dry cool air on to the patient's eyes to vaporise the CS gas (unlike other chemical injuries where irrigation is used); attending staff should not be downwind of the patient.
- Decontamination: seal the patient's clothing in a plastic bag if possible; wash facial skin and hair in cool water; good ventilation is needed to avoid contamination of attending staff.
- Additional chemicals such as chloroacetophenone should be irrigated and particles removed with a cotton bud (see \textquoteleft Chemical injuries\textquoteright, above).
- Evaluate fully - there may be injuries other than simple irritation. Refer if in doubt.
- Contact the National Poisons Information Service for specific advice.

**Pepper spray exposure\textsuperscript{[13, 14]}**

Pepper spray containing oleoresin capsicum is sometimes used as a deterrent. This may cause corneal abrasions. Assess for retained particles and irrigate as necessary. Otherwise, treat as for corneal abrasion.

Pepper spray has the potential to cause severe and permanent damage to the corneo-conjunctival tissue. It is not clear whether the damage results from the irritative and lipophilic properties of the benzyl alcohol mixture or the pyrotechnical additives nitrocellulose and sinoxide.

**Mustard gas exposure\textsuperscript{[15, 16]}**

Mustard gas causes chronic and delayed destructive lesions in the ocular surface and cornea, leading to progressive visual deterioration and ocular irritation. Healing of injuries is usual over time, although permanent loss of vision can result.

After exposure, all contaminated clothes should be removed and destroyed. Rescue personnel are at risk of adverse effects if they have direct contact. Affected people should wash the body as soon as possible but the eyes should be irrigated as well as possible with fresh, clean water, normal saline, sodium bicarbonate solution 1.5% or other agents which may be supplied in the field. Topical anaesthetic drops should be avoided, as should local steroids unless there is marked oedema. Pads and bandages should not be used, as this may raise the temperature of the eye, which will exacerbate the effect of residual gas.

In cases of military exposure in the past, ground water has been used by those affected, without realising that the ground water had also been contaminated.
Chlorine exposure[17, 18]

Chlorine gas was first used as a weapon in World War I; however, although its use is banned by the Geneva Convention it has been used again recently as a weapon of war. Chlorine injuries can also occur as a result of industrial accident and tanker spills.

Chlorine is a yellow-green irritant gas, denser than air, that tends to settle along the ground and drift into basements where people are sheltering from bombardment. It has high water solubility, so it interacts with oral, nasal and ocular mucosa to produce hydrochloric acid, rapidly causing pain and discomfort. It can be recognised by its bleach-like smell.

Treatment of acute chlorine gas exposure includes:

- Moving away from the gas.
- Removing and disposing of contaminated clothing (not removing anything over the head).
- Washing the body.
- Irrigating the eyes with plain water for 10-15 minutes. Contact lenses should be removed and permanently discarded. Ground water in the area of gas attack may be contaminated with chlorine, as it is highly soluble.
- Further treatment is as for acid chemical burns for the eyes. In significant chlorine exposure, acute pulmonary symptoms are likely to dominate the picture and can be rapidly fatal.

Super Glue® exposure[19]

Cyanoacrylate glue will only bond with dry surfaces, so tends to bond the lashes or to collect in the lower conjunctival fornix. The usual injuries it causes are glued lids or lashes, conjunctivitis or corneal abrasion.

If the eye can be opened

- Irrigate the eye if there is discomfort or conjunctival injection.
- Examine for glue on the eye surface (including under the lids), using local anaesthetic drops if needed. Remove glue with a cotton bud - fluorescein will help to show up the glue. Any remaining pieces may need removal using a slit lamp and fine forceps - refer if necessary.
- Use fluorescein to check for corneal abrasion.

If the eye is glued shut

- Moisten glue with warm water and remove as much as can be removed easily without causing damage to underlying tissue. Try to separate lids (the lashes may need to be cut).
- Ask if there is discomfort - if so, there may be glue on the external eye and it will need to be examined, so refer.
- Young children may also need referral to enable adequate examination.
- The lids will usually separate spontaneously within a week.
- If a child aged under 7 years has had the eye closed for several days, refer to an optometrist to check for amblyopia.

Retrobulbar haemorrhage[20, 21]

Retrobulbar haemorrhage is an ocular emergency which can occur from trauma (or surgery) to the orbital area. Bleeding in the orbital cavity compresses orbital structures, causing ischaemia of the eye and optic nerve. It needs immediate treatment (surgery) to prevent total loss of vision.

Key symptoms/signs are:

- Severe eye pain.
- Progressive visual loss.
- Progressive ophthalmoplegia.
- Proptosis.
Other possible signs are eyelid bruising, reduced pupillary response, a tense eyeball and pallor or venous dilation of the optic disc.

Management

- Refer immediately for surgery (requires a relaxing incision at the lateral canthus to relieve the high IOP).
- Medical management can buy time, using intravenous (IV) mannitol, IV acetazolamide and IV dexamethasone.

Open globe (penetrating) eye injuries\(^3, 5\)

This is an injury which penetrates the cornea or sclera. An accurate history is important; the mechanism of injury and composition of the object will dictate the degree of damage. A penetrating injury may not be visible and is sometimes suspected on history alone.

Penetrating injuries may seal themselves and the signs may be subtle. The history may be the only source of suspicion. In children it can be particularly difficult to detect due to lack of clear history; therefore, a high index of suspicion is needed\(^8\).

Features suggesting a possible open globe injury

- History of sharp/high-velocity injury.
- Deep eyelid laceration.
- Distorted globe.
- Subconjunctival haemorrhage.
- Conjunctival laceration (may be subtle).
- Black protruding uveal tissue.
- Distorted iris or pupil, teardrop-shaped pupil.
- Hyphaema.
- Loss of IOP (do not go on to measure it if suspecting open globe injury).
- Shallow anterior chamber.
- Positive Seidel's test (see 'Seidel's test', below).

Management

- Do not touch, manipulate or pad the eye.
- Do not check IOP.
- If an FB is present, do not remove it (this could cause prolapse of eye contents).
- Use a rigid eye shield (see 'Techniques', below) - if not available, make one from the bottom of a polystyrene cup.
- Refer immediately - will need antibiotic cover and surgery.
- Make the patient nil by mouth.
- Avoid any increase in pressure on the eye:
  - Tell the patient not to blow the nose, cough, strain or bend over.
  - Provide adequate analgesia and antiemetics (important to prevent vomiting which puts pressure on the globe).
- Treat as a high tetanus risk wound.

Intraocular foreign bodies\(^3, 5\)

- IOFBs result from sharp or high-velocity injures. Symptoms typically include decreased or double vision. However, in some cases patients may have no symptoms and the FB may remain undetected for years\(^22\).
- An IOFB must be excluded in high-velocity eye injuries or where the cause/history of injury is unclear. If in doubt, refer.
IOFBs may be
- Poorly tolerated - eg, organic matter (high rates of infection) or metals, particularly copper and iron (cause inflammation).
- Well tolerated - eg, inert materials such as glass or high-grade plastic.

Investigation
- Plain X-rays of the orbit/face are useful in ruling out known radiopaque FBs - eg, if the patient has a clear history of hammering on metal and has what seems to be a superficial wound of the peri-orbital area\(^7\).
- More precise localisation of the FB often requires CT.

Management of IOFBs
- If a penetrating FB is lodged in the eye, do NOT attempt to remove it yourself - this could cause prolapse of eye contents.
- If there is a known or suspected IOFB, refer urgently. The FB may need urgent surgical removal to prevent infection and inflammation.
- Treat as an open globe injury (see above).
- Further management - this depends on the nature and location of the FB. Organic and most metal FBs require urgent surgical removal. Some inert objects may be allowed to remain in the eye if the ophthalmologist considers that removal would be more damaging.

Blunt injuries to the globe\(^3, 5\)

These can be caused in a variety of ways (eg, sports balls (especially squash balls), elastics snapping back, champagne corks, etc) or through fight injuries from, for example, a punch. A worrying development has been an increasing level of trauma due to paintball injuries, usually during unsupervised play\(^23\).

In blunt injury the globe is compressed antero-posteriorly and stretched equatorially. This primarily impacts on the lens and iris but can also cause damage at the posterior pole of the eye. Injuries seen include:

- Corneal abrasion (see separate Corneal Foreign Bodies, Injuries and Abrasions article).
- Acute corneal oedema: look for clouding of the cornea and a reduced visual acuity.
- Hyphaema: look for a fluid level of blood just anterior to the iris.
- Pupillary damage: transient miosis (small pupil) or traumatic mydriasis (dilated pupil).
- Iris damage: iridodialysis is the detachment of the iris from its root base, giving rise to a D-shaped pupil.
- Ciliary body damage: this results in abnormal aqueous production. Can have increased risk of glaucoma (see 'Complications and prognosis' section, below).
- Lens damage: there may be cataract formation, lens subluxation or dislocation.
- Posterior vitreous detachment.
- Retinal damage:
  - Commotio retinae (swelling giving it a grey/red appearance) or retinal breaks can occur.
  - Retinal detachment can occur some time after the injury - so symptoms of flashers/floaters need urgent referral.

  - Optic nerve damage: this is less common but a neuropathy may occur or even avulsion where there has been sudden extreme rotation or anterior displacement of the globe\(^24\).
  - Rupture of the globe: this results from very severe blunt trauma. The eye contents prolapse through the weakest part of the eye wall, causing an open globe injury (see above).

Management
All but the most minor blunt injuries should be referred, as the extent of the injury may not be visible on initial assessment.
Orbital fractures

See separate Zygomatic Arch and Orbital Fractures article. For other facial bone fractures see separate Maxillofacial Injuries article.

Lid injuries\(^3\)

**Haematoma**

This usually results from a blunt injury. It tends not to be serious; however, exclude:

- Trauma to the globe.
- Fracture of the orbit.
- Basal skull fracture.

**Lacerations**

In the UK, eyelid laceration repairs would normally be the preserve of the ophthalmologists or specialist cosmetic surgeons in secondary care.

- Superficial lacerations are sutured with very fine (6-0) sutures (if laceration is parallel to the lid aperture, Steri-strips\(^\circledR\) can be used).
- Lacerations which involve the lid margin are characteristically gaping: imperfect suturing will result in notching.
- Laceration with tissue loss needs specialist care - refer: the amount of tissue loss determines the outcome but may involve a reconstructive procedure.
- Lacerations involving the tear drainage system need to be repaired within 24 hours so it is best to make nil by mouth until the patient has seen an ophthalmologist.
- Lacerations which involve the levator palpebrae aponeurosis cause a ptosis and will require specialist surgery.

Give tetanus immunisation if needed.

Superficial conjunctival and corneal injuries and foreign bodies

See the separate articles Diagnosing Conjunctival Problems and Corneal Foreign Bodies, Injuries and Abrasions.

Be sure you have excluded a deeper or open globe injury, as the signs may be subtle - eg, a small conjunctival haemorrhage or laceration may indicate a penetrating injury\(^{25}\).

Non-accidental injuries\(^{26,27}\)

The possibility of NAI should be considered whenever a child presents with injuries in the absence of trauma or medical explanation (including birth injuries). Ocular features of NAI may include:

- Retinal haemorrhages.
- Peri-ocular bruising or lid laceration.
- Subconjunctival haemorrhage.
- Unexplained lens dislocation or cataract.
- Unexplained conjunctival or corneal injuries, particularly in the lower half of the eye.

Referral of suspected NAls is mandatory. These cases should be dealt with by senior paediatric and ophthalmic consultants, with the involvement of the child protection team.

Complications and prognosis\(^3\)

Superficial eye injuries generally have a good prognosis.
For injuries to the globe, the outcome depends on the precise nature of the injury and the availability of prompt treatment. Good recovery is possible from some serious injuries.

Injuries to the globe may be complicated by:

- Glaucoma - certain eye injuries increase glaucoma risk; patients may require more frequent glaucoma screening.
- Retinal damage - note that following blunt trauma, retinal detachment can occur some time later, so urgently refer anyone with blunt trauma history and flashes/floaters.

There are complications which may affect open globe injury:

- Infection (endophthalmitis) - this can be sight-threatening.
- Cataract.
- Sympathetic ophthalmia (inflammation of both eyes after a penetrating injury).
- With IOFBs, the prognosis after removal can be good if there was no damage to the visual axis, the object was small and infection was avoided. Generally, the more posterior the object is in the globe, the worse the prognosis.

Prevention

- Use of eye protection for hazardous occupations (health and safety requirement), during DIY, when handling harsh chemicals and for racket sports.
- Firework legislation has been proved to be effective.
- Airbags represent a significant safety feature in cars, in addition to seat belts, although they can themselves cause eye injuries. Depowered airbags are safer than powered airbags.
- Public awareness of hazards - for example:
  - The consequences of egg-throwing pranks.
  - Paintball injuries.
- Use of plastic rather than glass where assaults are likely - eg, in pubs.

A leaflet for the public on preventing eye injuries is available.

Techniques

**Irrigating**
This is discussed under 'Chemical injuries', above.

**Testing pH**
Litmus or pH paper can be used. Stop the irrigation for a moment and gently place the paper in the inferior conjunctival fornix. The colour will change immediately - read off the colour chart. When you record it in the notes, write what the pH was. Sticking the litmus or pH paper in the notes is not helpful, as the colour fades rapidly with time. Use of a control pH test has been suggested - test the pH of the uninjured or examiner's eye.

**Applying an eye shield**
A rigid shield is used if an open globe injury is suspected. Do not touch the eye or attempt to pad it. The shield is usually shaped so that one end rests more easily adjacent to the nose. Apply tape.

**Seidel's test**

- **Requirements**
  - 10% fluorescein (this is dark orange - a moistened fluorescein strip will do), a slit lamp with cobalt blue light source or Wood's light.
Procedure
Apply the fluorescein to the suspicious area, asking the patient not to blink. If aqueous fluid is leaking through a corneal laceration, a stream of fluid will be seen in the pool of dye, as the aqueous dilutes it. This is a positive Seidel's test - if found, treat for open globe injury (see above).

NB: a negative Seidel's test (no dilution of fluorescein) does not rule out a penetrating injury, as it may occur with small or spontaneously sealing lacerations of the cornea.

Further reading & references

- Common ocular emergencies and referrals; Eye Casualty website
- Snellen Chart; Living Well with Low Vision
- Facial Trauma and Closed Head Injuries in Sport
- Check independent learning program for GPs - ophthalmology, Royal Australian College of General Practitioners, July 2010

1. Best Practice: eye trauma, British Medical Journal, updated June 2014 (sign-in required)
2. Birmingham Eye Trauma Terminology System (BETTS); International Society of Ocular Trauma
6. Corneal superficial injury; NICE CKS, September 2012 (UK access only)
11. Gray PJ, Murray V; Treating CS gas injuries to the eye. Exposure at close range is particularly dangerous. BMJ. 1995 Sep 30;311(7009):871.
26. When to suspect child maltreatment; NICE Clinical Guideline (July 2009)
27. Procedures for the Ophthalmologist Who Suspects Child Abuse; Royal College of Ophthalmologists
28. Eye Protection in Racket Sports; Royal College of Ophthalmologists
32. Vision Safety; Canadian Ophthalmological Society