The management of open globe eye injuries: a discussion of the classification, diagnosis and management of open globe eye injuries

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Abstract
Eye injuries occurred in 10% of UK military major trauma cases in Iraq and Afghanistan between 2004 and 2008, with 33% of these eye injuries open globe in nature(1). This article will consider the diagnosis, classification and management of open globe injuries in the role 1/ pre-hospital environment.

Introduction
British military ophthalmologists have not been deployed in support of operations since 2003 (1) with British forces receiving definitive eye injury treatment on return to the UK. Despite the injuries sustained by British forces being more severe than in civilian practice, and casualties receiving primary repair on average at 1.9 days post-injury, the outcomes are deemed to be comparable to previous reports (1). However, it must be noted that those casualties with minor overall injury severities but with visual or hearing loss have a higher discharge rate from the Royal Navy (RN) than those without sensory loss (2), and so correct initial management may improve outcomes and therefore future employability.

With the British military moving towards contingency operations the current casualty evacuation (CASEVAC) chain from point of wounding back to the UK from Afghanistan may not be possible to replicate, extending timelines still further. It is also worth noting that RN vessels are often isolated and that timelines experienced from Afghanistan may be difficult to achieve in future expeditionary operations.
For this reason all RN medical personnel delivering primary care should be able to recognise, classify and initiate management of open globe eye injuries.

**Classification of eye trauma**

A non-specialist will normally undertake the initial management of open globe eye injuries. Understanding a recognised classification system and using the correct terminology will allow those in primary care to commence the correct initial management and communicate with specialists effectively, facilitating optimal management of the injury. Box 1 shows the definitions of ocular trauma, the Birmingham Eye Trauma Terminology (BETT), whilst Box 2 gives a flow diagram to assist in identifying the correct diagnostic terms.

This paper is concerned with only the description, classification and management of open globe eye injuries, with further information on closed globe eye injuries forthcoming in a future paper.

Open globe injuries are defined as ‘full thickness defects’ (3) of the eye wall. If a full thickness eye wall injury is identified then the mechanism by which it occurred should be determined.

**Rupture**: If the object causing the eye wall injury was blunt, then rupture is the likely injury. If the object causing injury was sharp, then a laceration will ensue and further distinction must be made:
**Penetration**: If the entry and exit wound are the same (e.g. if the wound was caused by a single stab with a knife that has since been withdrawn) then the wound is described as penetrating.

**Perforation**: If the entry and exit wounds are caused by the same object but are distinct from one another (e.g. fragmentation passing from the inferior pole, through the globe and out of the superior pole of the eye), then this is considered a perforating injury.

**Intraocular foreign body**: If an entry wound is present and the object causing it remains in the eye then this is considered an intraocular foreign body.

In reality injuries may actually be a mixture of all of the above open globe injury subtypes.

Insert Box 1
Insert Box 2

**Clinical picture and diagnosis**

In the military environment ocular trauma is often associated with major trauma, and is less likely to be isolated in nature (1). In the event of open globe trauma being sustained, assessment and treatment must follow Battle Field Advanced Trauma Life Support (5) (BATLS) principles and be consistent with Clinical Guidelines for Operations (6) (CGOs), with identification and initial management of eye injuries likely to take place during secondary survey only when life threatening injuries have been managed.
The clinical history is vital in determining likely injury patterns; if time allows it is preferable that a thorough general medical history (including tetanus status and any drug allergies) be taken with the integration of the ophthalmic history. Initial information may be limited to the ATMIST (Adult/Child, Time, Mechanism of injury, Injuries sustained, Signs, Treatment given) (5)(6) report format but, if possible, additional concise information using the AMPLE format (Allergies, Medications, Past Medical history, Last oral intake, Events leading up to the injury) should be obtained.

Extra information which should be obtained includes the origin, physical characteristics (including blunt or sharp), composition, direction and speed of the object causing the injury, and whether multiple objects were involved, including organic matter or grease. If contact lenses or glasses were worn at the time of the incident, their condition following it should be noted. The key points of the history are outlined in Box 3.

With a history likely to produce an open globe injury (sharp object/ high velocity injury), thorough examination of both eyes and surrounding structures is vital to determine whether open globe injury has occurred; examination should continue until open globe injury is ruled out. It is worth noting that the examination may be limited by the patient’s inability to co-operate and instillation of local anaesthetic drops may be required following visual acuity assessment. If signs consistent with an open globe injury are discovered, then the examination should be stopped and management of the injury should commence. If there is an obvious intra ocular foreign body there should be no attempt to remove it, as this is likely to cause more damage to the eye.
The examination of both eyes should be prompt and include: visual acuities, orbits, lids, conjunctiva, cornea, anterior chamber, iris, pupils, fundus and a functional examination.

Features consistent with open globe injury are listed in Box 4.

Insert Box 4

**Management**

The casualty must first be assessed and treated according to BATLS principles. If an open globe eye injury is then identified, no matter what the sub-type (in reality the sub-type may be hard to distinguish) then in the Role 1/pre-hospital environment the management should consist of:

- An eye shield (can be fashioned from the bottom of a disposable cup), broad-spectrum antibiotics and urgent CASEVAC (1)(8). The antibiotic of choice in the Role 1/ pre-hospital environment will be ciprofloxacin 750mg twice daily orally (good ocular tissue levels) (11)(12) or, if the patient is unable to take oral medication, ceftriaxone 1g once daily by deep intramuscular or slow intravenous injection (12), both available in the British military ‘501’ primary care module.

- All foreign bodies must be left *in situ* and if necessary splinted until a specialist review is possible. It is vital no pressure is applied to the eyeball when securing an eye shield.

- It is also important to suppress nausea or vomiting with anti-emetics and advise the patient not to strain, cough, blow their nose or bend over as head movements and Valsalva-type movements can exacerbate the condition (7). If surgery is likely to
occur within 6 hours the patient should be kept nil by mouth (not including essential medications).

- Tetanus status should have been ascertained during history-taking. An open globe injury is considered a tetanus-prone wound (12), and as such prophylaxis should be instigated as soon as possible. If the patient is fully immunised (has had 5 doses) no further vaccine is required, but a single dose of tetanus immunoglobulin should be given. If the patient has been partially or never vaccinated, a dose of tetanus vaccine is required along with tetanus immunoglobulin, with further vaccination doses to complete the schedule (13).

- Definitive hospital management is surgery, with outcomes very much dependent on the specific injuries sustained (1).

A summary of management is shown in Box 5.

Insert Box 5

**Conclusion**

Open globe eye injuries occurred in a third of British troops suffering with eye injuries secondary to major trauma, and as such any patients suffering with open globe eye injuries must first be assessed and treated according to BATLS principles.

Open globe injuries can be sub-classified into: rupture penetration, perforation or intraocular foreign bodies, with history and examination vital in ascertaining the specific diagnosis. In reality distinguishing the sub-types may be difficult in forward locations, and a mixed picture may exist.

Role 1/pre-hospital treatment principally consists of an eye shield, prophylactic antibiotics and urgent CASEVAC with tetanus status assessment and control of emesis.
The current doctrine of optimisation of the patient prior to delayed ophthalmology review has not been shown to detrimental to outcomes (1). However, as time-lines may become stretched in the future, it is essential that non-specialists can promptly identify and instigate initial appropriate management for open globe injuries.

References


<table>
<thead>
<tr>
<th>Term</th>
<th>Definition/ interpretation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye wall</td>
<td>Sclera and cornea</td>
<td>Though technically the eye wall has three coats posterior to the limbus, for clinical and practical purposes, violation of only the most external structure is taken into consideration.</td>
</tr>
<tr>
<td>Open globe injury</td>
<td>Full-thickness wound of the eye wall</td>
<td></td>
</tr>
<tr>
<td>Lamellar laceration</td>
<td>Partial-thickness wound of the eye wall</td>
<td>The wound of the eye wall is not 'through' but 'into'.</td>
</tr>
<tr>
<td>Rupture</td>
<td>Full thickness wound of the eye wall caused by a blunt object</td>
<td>Because the eye is filled with incompressible liquid, the impact results in momentary increase in the intraocular pressure. The eye wall yields at its weakest point. The actual wound is produced by an inside-out mechanism.</td>
</tr>
<tr>
<td>Laceration</td>
<td>Full thickness wound of the eye wall caused by a sharp object</td>
<td>The wound occurs at the impact site by an outside in mechanism</td>
</tr>
<tr>
<td>Penetrating injury</td>
<td>Entrance wound</td>
<td>If more than one wound is present, each wound must have been caused by a different agent</td>
</tr>
<tr>
<td>Intraocular foreign body</td>
<td>Retained foreign object(s)</td>
<td>Technically this is a penetrating injury but grouped separately because of different clinical implications.</td>
</tr>
<tr>
<td>Perforating injury</td>
<td>Entrance and exit wounds</td>
<td>Both wounds are caused by the same agent.</td>
</tr>
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Box 1. Birmingham Eye Trauma Terminology (BETT) pertaining to open globe injuries[2][4].
Box 2. Flow diagram for making appropriate ocular trauma diagnosis. Bold boxes indicate clinical entities[2][3].
Box 3

- Adult/ Child.
- Time of injury.
- Mechanism. What caused the injury? E.g. IED with irrigation ditch detritus, metal shard when hitting tent peg with hammer, slingshot.
- Injuries sustained e.g. fragmentation to face, laceration to eye-lid, open fracture to orbit, extrusion of eye contents.
- Signs <C>, A, B, C, D, E (can include key eye findings under E)
- Treatment given.

Additionally:
- ‘AMPLE’ history as a minimum.
- If time allows include:
  - Was the object sharp or blunt? Was it high or low velocity? How big and what shape was the object? Multiple or single objects?
  - Visual acuity now and pre injury (rough guess), current symptoms including pain, reduced vision, diplopia, flashes/ floaters, foreign body sensation.
  - Were contact lenses or eye protection worn? If so, what condition are they in post incident?
  - Past ophthalmic history.
  - Tetanus status.

Box 3. Key features of a history in ophthalmic trauma[5][7].
- Deep eyelid laceration.
- Distorted globe.
- Sub-conjunctival haemorrhage.
- Conjunctival laceration
- Protruding uveal (typically dark brown) tissue.
- 'Jelly roll' chemosis.
- Distorted iris or pupil/ teardrop-shaped pupil.
- Hyphaema (collection of blood in the chamber that lies in front of the iris)
- Loss of intraocular pressure- 'Soft eye' (DO NOT put pressure on the eye to test this).
- Shallow anterior chamber.
- Gas bubbles in the anterior chamber.
- Positive Seidel's test (leaking fluid from the anterior chamber is identified when concentrated fluorescein dye is applied to the cornea and viewed with cobalt blue light). NB a negative Seidel's test does not rule out an open globe injury.

Box 4. Clinical signs likely to indicate an open globe eye injury[7][8][9][10].
Box 5

- Assess and treat according to BATLS principles.
- Do NOT put pressure on the eye.
- Do NOT remove foreign bodies.
- Provide an eye shield (improvise if required).
- Give prophylactic antibiotics (ciprofloxacin or ceftriaxone).
- Assess and if possible provide appropriate tetanus prophylaxis.
- Avoid Valsalva or head movements.
- Provide antiemetic if required.
- Urgent CASEVAC to specialist care and surgery.

Box 5. Summary of the role in pre-hospital management of open globe eye injury[1][9][11][12].