Digital Journal of Ophthalmology

Review

Vol. 28

Video-based surgical curriculum for open-globe injury repair, I: open-globe injury

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Published August 15, 2022.

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doi: 10.5693/djo.01.2022.01.001

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As one of the most severe forms of ocular trauma, open-globe injuries (OGI) cause significant vision loss. Timely and meticulous repair of these injuries can improve patient outcomes. This video-based educational curriculum is intended to serve as a quick and efficient yet comprehensive reference for OGI repair. We hope that these video-based articles help surgeons and trainees from around the world find answers to specific surgical questions in OGI management. The curriculum has been divided into six separate review articles, each authored by a different set of authors, to facilitate a systematic and practical approach to the subject of wound types and repair techniques. The first article highlights pertinent terminology and standardized definitions for OGI trauma, which aids in communication, prognostication, and outcomes research.

Curriculum Editors

Definition of Open-Globe Injury

Globe injuries can be classified as either closed- or open-globe injuries, based on the integrity of the sclera and cornea. Closed-globe injuries (CGIs) occur in the absence of a full-thickness wounds of the ocular wall, whereas open-globe injuries (OGIs) are characterized by full-thickness wounds. With regard to mechanism of injury, CGIs are further divided into contusions, resulting commonly from blunt objects, and lamellar lacerations, where trauma leads to a partial-thickness wound. For OGI, a rupture is defined as trauma from a blunt object with a momentary increase in intraocular pressure and an inside-out mechanism of injury to the eye wall, whereas a laceration is caused by a sharp object, with the wound occurring at the impact site. See Video 1.

Rupture

Open-globe injury by rupture occurs often at the weakest point of the eyewall, which may or may not be at the actual site of injury. The rupture site is most commonly found in the sclera
concentric to the limbus, just posterior to the insertion of the extraocular muscles. Additionally, ruptures in postsurgical eyes can occur at the location of the prior surgical incision. The mechanism involved in these cases appears to be coup-contrecoup, with uveal prolapse largely unavoidable.

Laceration

Trauma from sharp objects tends to cause full-thickness lacerations; however, unlike ruptures, the damage suffered is directly at the impact site, such that intraocular tissue prolapse is commonly, but not always, present. Lacerations can be subclassified into penetrating and perforating injuries based on the presence of an entrance and/or exit wound. Penetrating OGI is defined as a single full-thickness laceration creating an entrance wound but no exit wound. In cases with more than one entrance wound present, each of the wounds would be defined as a laceration resulting from a separate insult. Perforating OGI is defined as two full-thickness lacerations caused by the same insult: one being the entrance wound; the other, the exit wound. This type of injury is also known as a “through-and-through” injury. Finally, an intraocular foreign body injury is considered a penetrating OGI laceration, with the presence of retained intraocular foreign matter. This subtype of OGI is categorized separately due to different clinical implications regarding management and prognosis.
Classification of Open-Globe Injury

In the evaluation of ocular trauma, OGIs are categorized by the anatomical location, known as zones of the injury, which can provide prognostic information regarding injury and repair.\textsuperscript{5,6} Zone I injuries are isolated to the cornea. Zone II injuries involve the region from the limbus up to 5 mm posteriorly into the sclera. Zone III injuries are defined as starting more than 5 mm posterior to the corneal limbus. See Video 2 for examples of injury in each of the three zones. (KMW, XW)

![Video 2. Classification of open-globe injuries by zone.](image)

Epidemiology

OGI are considered a preventable type of ocular injury. The annual incidence varies among developed and developing countries, with the former reporting lower rates than global average. In the United States, the annual incidence is estimated at 4.6 per 100,000 persons, accounting for over 12,000 cases annually.\textsuperscript{7}

Overall, OGIs disproportionately affect young males, elderly females, and African Americans.\textsuperscript{8} In addition, it is well established that prior ocular surgeries, such as cataract extraction, make the eyes more vulnerable during blunt ocular trauma.\textsuperscript{4} Within the pediatric population, males <18 years of age have a higher incidence of OGI than females, with male-female ratios varying from 1.9:1 to 5.1:1.\textsuperscript{9} Notably, it has been demonstrated that the majority of
pediatric OGIs occur at home and are usually caused by sharp objects, projectile weapons, abuse, or assault.\(^9\)

(VPD, KAAD)

**Ocular Trauma Score**

The ocular trauma score (OTS), developed by Kuhn et al\(^{10}\) in 2002, was designed to prognosticate a patient’s final visual outcome during the initial evaluation of an OGI. The OTS uses a point system that takes into account initial visual acuity at presentation and the presence of different anatomical outcomes, including endophthalmitis, perforating injury, retinal detachment, and relative afferent pupillary defect, to predict the final visual outcome after repair. This grading system can provide useful prognostic information, with a 77% likelihood of predicting final visual outcome within one visual category.

(KMW, XW)

**Key Learning Points**

- Knowledge and utilization of a common language of ocular trauma terminology is key for ensuring accurate and timely diagnosis and management. Inability to communicate effectively may impede clinical care and lead to unnecessary delays, which cause significant morbidity in terms of visual impairment and decreased quality of life.

- OGIs are classified by their anatomical location and zone of injury.

- The ocular trauma score should be calculated at initial evaluation after injury. It is a useful prognostic tool to predict final visual outcomes and can be used to guide decision making and to inform counseling of the patient.
References


Appendix 1: Video 1 Transcript

00:06 Globe injuries can be classified as either closed or open, based on the integrity of the sclera and cornea. Closed-globe injuries occur in the absence of a full-thickness ocular wall trauma, while open-globe injuries are characterized by full-thickness trauma. Herein, we will be talking about open-globe injuries.

00:33 Open-globe rupture occurs due to blunt injury, often at the weakest sites of the eyewall and away from the actual site of injury. This is an example of an open-globe rupture secondary to blunt injury from a garage door spring, there is a significant rupture of the cornea and sclera. This type of injury is a result of an inside-out mechanism, and as a result, tissue prolapse is largely inevitable. Globe repair was performed.

01:08 A penetrating open-globe injury is defined as a single full-thickness laceration creating an entrance wound but no exit wound. Here is an example of a penetrating injury in the right eye, which was caused by a nail gun. At presentation, scleral laceration and vitreous expulsion were apparent and Weck-Cel vitrectomy was performed to clear the vitreous from the wound in order to allow for closure.

01:39 A perforating open-globe injury is defined as two full-thickness lacerations where both entrance and exit wounds are present and are caused by the same insult. This type of injury is also known as a through and through injury. This is a case of a perforating injury following a pellet gun injury. Notably on the initial CT scan, the metallic pellet was identified in the posterior orbit near the superior orbital fissure. From the outset during exploration, we can see a scleral penetrating injury, which is repaired, but upon exploration for the exit site, it is too far posterior to visualize and repair.

02:21 While technically intraocular foreign body injuries are considered a penetrating open globe injury laceration with the presence of retained intraocular foreign matter, it is often grouped separately due to different clinical implications regarding its management and overall prognosis. Here's an example of an intraocular foreign body. A small fragment of wood was found in the interior chamber and later removed.
Appendix 2: Video 2 Transcript

00:06 Zone I injuries involve the cornea and limbus. This patient had a corneal laceration from a piece of glass during a motor vehicle accident. The cornea was damaged but the laceration did not cross the limbus. Here we see the result after sutures were placed and the AC was reformed.

00:25 Zone II injuries involve the anterior 5 mm of the sclera. This is a patient who had a metal wire strike and embed in his left eye nasally. The wire entered the eye 2 mm from the limbus and was easily removed. The residual scleral wound was repaired with nylon sutures. And here the conjunctiva is being closed with microstructures.

00:50 Zone III injuries include full thickness lacerations, or ruptures, that extend more than 5 mm posterior to the limbus. This is a patient who fell and hit the right eye with blunt force. The only clinical finding on initial exam was 360° bullous subconjunctival hemorrhage. However, after exploration, the patient was found to have a superiortemporal zone III rupture. 8-0 nylon sutures were placed in the sclera to repair the globe.

01:34 This is a zone I, II, and III globe rupture. The patient was hit in the left eye with a paintball gun bullet. During exploration, the patient was found to have a laceration involving the cornea limbus and posterior sclera. Here the posterior sclera is being repaired. Then the corneal laceration was repaired. Here is the eye repaired completely.