

Ocular Injuries: New Strategies In Emergency Department Management

November 2015
Volume 17, Number 11

Abstract

Ocular injuries are common in the emergency department, and they are the most frequent cause of noncongenital monocular blindness in children and adults. This review provides evidence-based recommendations for the diagnosis, treatment, and disposition of patients with all types of ocular trauma, including pain management, the use of antibiotics, cycloplegics, steroids, antifibrinolytics, and patching. Bedside ocular ultrasound has profoundly expanded diagnostic capability, particularly for the multiply injured patient, and routine management and disposition of patients with corneal abrasions has evolved significantly as well. Diagnosis and management of patients with retrobulbar hemorrhage is discussed in detail, with resources for performing vision-saving lateral canthotomy. Systematic evaluation and management of ocular trauma patients will ensure these patients have the best chance for a favorable final visual outcome.

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CME Objectives

Upon completion of this article, you should be able to:

1. Diagnose traumatic ocular injuries and order proper imaging studies as necessary.
2. Treat traumatic ocular injuries with the most current recommendations.
3. Identify which patients require admission to the hospital, which patients should follow up with ophthalmology, and when disposition will be at the discretion of the treating ophthalmologist.

Prior to beginning this activity, see "Physician CME Information" on the back page. **This article is eligible for 4 Trauma CME credits.**

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Opening Cases

Your shift begins and you pick up your first chart: "eye irritation." You talk to the patient and discover that she felt the sudden onset of left eye pain and irritation while she was applying her eye makeup this morning; she is worried she may have scratched her eye with her fingernail. You give the patient's eye a drop of topical anesthetic and perform a fluorescein examination, which reveals a single corneal abrasion. You plan to discharge the patient home with a prescription for a topical antibiotic and a topical cycloplegic. The patient asks if she can have the bottle of topical anesthetic because it was so helpful in relieving her pain. You wonder whether this is safe...

While you are considering this, you are called into the resuscitation area for a patient involved in a severe motor vehicle crash. The patient was apneic and was intubated by EMS. The right side of his face is extremely swollen and you are unable to examine his right eye, and he is unable to provide any information about the vision in his right eye. His eye seems mildly proptotic, and you wonder if you need to be concerned for a retrobulbar hemorrhage. Is there anything that can be done at the bedside to evaluate for this possibility? Should treatment for retrobulbar hemorrhage be initiated presumptively in this patient?

After your trauma patient is stabilized, you see your next patient: another eye complaint! This patient was at work when an unknown chemical splashed into his left eye. He immediately began irrigation, but he continues to complain of pain and decreased vision in the eye. You wonder if you should examine the eye first, or initiate irrigation of the eye immediately. If the patient feels better, does ophthalmology need to be consulted in the ED? What medications should you send home with this patient?

Introduction

Ocular injuries can be anxiety-provoking for both the patient and the emergency clinician. Eye injuries are the leading cause of monocular blindness in the United States.¹⁻³ They are the most common cause of noncongenital unilateral blindness in the pediatric population.⁴

Fortunately, most eye injuries are minor and the overwhelming majority are not associated with significant morbidity.⁵ Even most ocular burns tend to be mild and inconsequential in the long term.⁶ In patients with mild injury, pain management and prevention of secondary infection are the mainstays of treatment.

The polytrauma patient poses a particular clinical challenge because a proper eye examination may be difficult or impossible. This issue of *Emergency Medicine Practice* provides a systematic review of best-practice recommendations based on the available evidence.

Critical Appraisal Of The Literature

A literature search was performed using PubMed and the Cochrane Database of Systematic Reviews. Search terms included: *ocular trauma, corneal abrasion, ocular burn, traumatic iritis, open globe, traumatic hyphema, retrobulbar hemorrhage, retrobulbar hematoma, lens subluxation, lens dislocation, subconjunctival hemorrhage, vitreous hemorrhage, retinal detachment, treatment, diagnosis, trauma, and medicolegal*. References listed in relevant articles were also used, if not previously identified. The search was limited to articles in English. The search yielded 2 relevant Cochrane reviews and 87 relevant PubMed articles

The National Guideline Clearinghouse was also queried (www.guideline.gov), with 1 relevant article noted. Guidelines from the American Academy of Ophthalmology and from the American College of Emergency Physicians were queried; however, there were no relevant guidelines.

Generally speaking, the evidence related to ocular trauma is of intermediate quality. Trials were often underpowered and had significant selection bias, making the findings difficult to apply to the general population. Studies were also affected by poor patient follow-up. Several reasons account for these issues. Ocular trauma is relatively rare, making recruitment into a study and the ability to have an adequately powered study difficult. Poor follow-up was often an issue because the patient's symptoms may have resolved, decreasing the likelihood of following up and completing the study; this was especially true in some studies of corneal abrasion treatment.

In other ocular disease states, no studies were identified (eg, in the treatment of iritis). Case reports have been published, but no quality research has otherwise been performed. It appears that the treatment of this entity is based on dogma and tradition.

Etiology And Pathophysiology

Ocular trauma can occur as a direct consequence of either blunt or penetrating injury. It can also occur secondary to a blast injury; this is of particular importance in the setting of combat. Blast injury victims are particularly prone to conjunctival laceration, subconjunctival hemorrhage, vitreous hemorrhage, and, occasionally, retinal tears and detachments.⁷

Although it is important to discern the mechanism of injury, it is also important to note that many injuries can be caused by both blunt and penetrating trauma. For example, although open-globe injuries may be thought of as secondary to penetrating trauma only, the emergency clinician must be aware that blunt trauma can cause an open-globe injury. For a basic schematic of the anatomy

of the eye, see **Figure 1**. See **Figure 2** for a summary of many common ocular injuries.

Patients at particular risk for ocular trauma appear to be those at the extremes of age (ages 5 to 25 years and older than 70 years), men, and individuals of low socioeconomic status.⁵ Children aged 5 to 8 years are at particularly high risk and tend to have more-serious injuries.^{5,8} The workplace is a common environment for injury to occur, accounting for roughly 20% of all ocular injuries.^{5,9} A prospective study of 5671 cases of ocular trauma in the United Kingdom revealed that no form of eye protection had been worn in 84.6% of cases.⁸ Most cases of eye injury are preventable.⁹ Preventive measures are both extremely important and extremely underutilized.

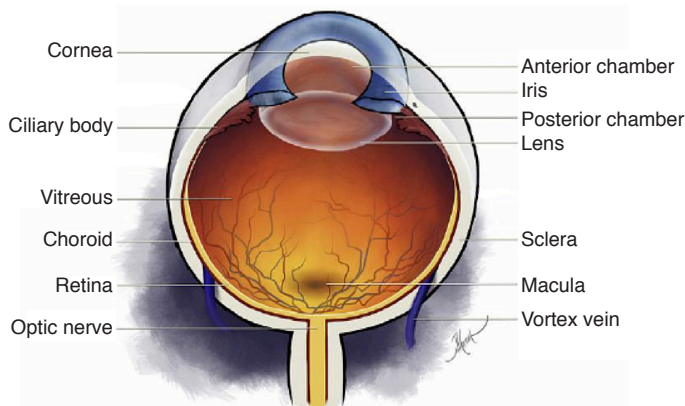
From a pathophysiological standpoint, ocular injuries generally cause direct damage to the injured structure. This can cause bleeding in various locations in and around the orbit, lacerations and abrasions, as well as contusions that can damage the iris and ciliary body.⁷ In other cases, the damage is indirect, such as retrobulbar hemorrhage. Although retrobulbar hemorrhage involves bleeding, the real damage is due to optic nerve ischemia. However, the mechanism of this ischemia has yet to be elucidated.¹⁰

Links To Color Images



To view full-color versions of the images in this issue, scan the QR code with a smartphone or go to www.ebmedicine.net/ocular.

Figure 1. Eye Anatomy

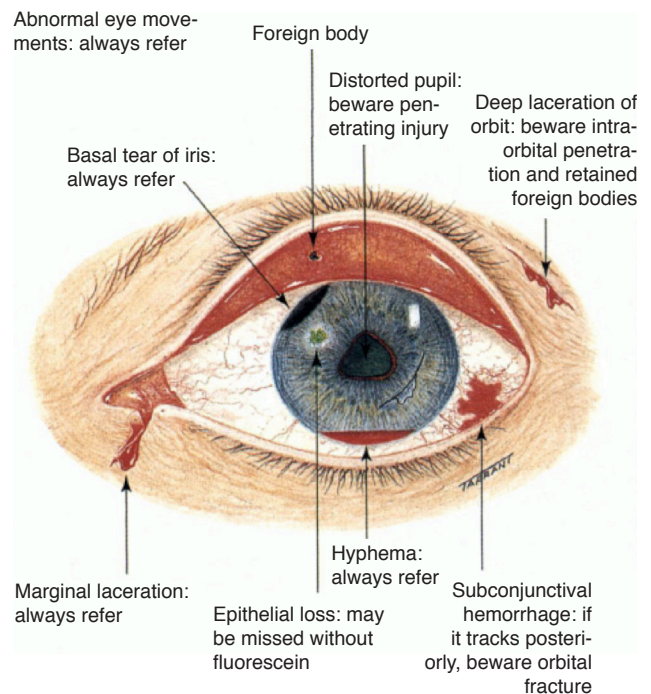


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Differential Diagnosis

Ocular injuries themselves will not cause mortality, but they do have the capacity to cause morbidity. **Table 1** lists possible diagnoses as a result of ocular trauma, grouped according to their ability to threaten the patient's vision. The majority of ocular injuries have the capacity for permanent vision loss, although not all vision-threatening injuries will cause permanent visual loss and not all non-vision-threatening injuries are innocuous.

Figure 2. A Schematic Of Grossly Visible Common Ocular Injuries



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Table 1. Ocular Trauma Diagnoses

Vision-Threatening Injuries

- Open globe injury
- Retrobulbar hemorrhage
- Ocular burns
- Traumatic iritis
- Traumatic hyphema
- Retinal detachment
- Vitreous hemorrhage
- Posterior vitreous detachment
- Lens dislocation

Non-Vision-Threatening Injuries

- Corneal abrasion
- Subconjunctival hemorrhage
- Corneal foreign body

Prehospital Care

The overriding goal of prehospital care in the patient with ocular trauma is ensuring that the eye does not suffer any further damage during transport to the hospital.² Perhaps the most important patient group in which prehospital workers can affect visual outcome is in those with ocular chemical burns. Many authors have cited the immediate irrigation of the chemically burned eye as the most important factor in determining the patient's final visual acuity.^{6,11,12} Chemical and conjunctival erosion is much more common in patients who are not irrigated before arrival (86%) than in those who are irrigated before arrival (24%).¹³

Fluids available to irrigate a chemically burned eye include lactated Ringer's, normal saline, normal saline adjusted to pH 7.4 with sodium bicarbonate, balanced saline solution, and tap water. If tap water is all that is available, it should be used immediately.² A study of 11 patients (12 eyes) found that balanced saline solution was tolerated the best by patients, followed by normal saline with sodium bicarbonate, lactated Ringer's, and finally normal saline; however, there have not been any sizeable trials to necessarily recommend one fluid over another. Consideration must also be given to the fact that balanced saline solution requires reconstitution prior to irrigation and is significantly more expensive than normal saline and lactated Ringer's.¹⁴

There are particular principles that should be employed to irrigate the eye properly. First, the irrigant should be directed toward the ipsilateral temple to avoid splashing into the contralateral eye. The irrigation should continue for 30 minutes, and the pH of the eye should be checked 5 to 10 minutes later. If the pH is not neutral (7.5-8) at that point, irrigation should recommence.^{2,15} Indirect methods of irrigation (eg, with a Morgan Lens) are unlikely to be performed in the prehospital setting, and will be discussed in the treatment section.

If particulate matter is seen, it should be removed with a moistened cotton swab.² If a penetrating foreign body is noted, it should be left in place and not removed.^{2,16} If an open-globe injury is noted or suspected, the affected eye should be protected without direct pressure on the globe itself. This can be accomplished with a commercial eye shield or a Styrofoam or plastic cup. Additionally, the head of the bed should be elevated to 30°, and pain, vomiting, agitation, hypertension, and Valsalva maneuvers should be controlled, as these can all raise intraocular pressure. If a traumatic hyphema is seen, open-globe precautions should be observed, as traumatic hyphema may be associated with open-globe injury.²

Emergency Department Evaluation

History

A detailed history and physical examination should be obtained in the ocular trauma patient. The only exception to this is in the case of ocular chemical burn, in which case irrigation is performed prior to a detailed history and physical examination. A list of pertinent historical questions is presented in **Table 2**. If the patient did not receive any irrigation in the prehospital setting, it should be started immediately and continued for 30 minutes. If the patient was irrigated in the prehospital setting but remains symptomatic, irrigation should be restarted. If the patient was irrigated in the prehospital setting and no longer complains of pain or burning in the eye, the pH can be checked, and if it is neutral, no further irrigation is necessary.

For all other patients, and for ocular burn patients who have completed irrigation, a specific set of questions needs to be addressed. In the patient with an ocular burn, ask the patient what the offending substance was, if known. In general, alkalis have a worse prognosis than acids and cause more ocular damage. An exception to this is hydrofluoric acid, which acts like an alkali.^{2,17}

Determining how the injury occurred and what the patient was doing when the injury occurred will help guide the physical examination.¹⁸ The circumstances surrounding the event should be carefully questioned. For example, was the patient hammering or performing any other metal-on-metal activity? If so, there should be a very thorough examination for a foreign body, as metal is the most common ocular foreign body.¹ It must also be elicited whether the patient was working with organic or vegetable material at the time of the injury. These particles tend to have less momentum and are more likely to embed in the anterior globe, and they may not be visible on CT.¹⁹ It should also be considered that strenuous physical activity (eg, lifting heavy boxes) can cause a retinal detachment; in this case, the heavy lifting was "traumatic," although it does not fit the traditional

Table 2. Pertinent Historical Questions For Ocular Trauma Patients

- How did the injury occur?
- What are the circumstances surrounding the injury; ie, what was the patient doing when the injury occurred?
- Was eye protection used?
- When did the event occur?
- Is there any history of previous eye surgery?
- What medication(s) is the patient currently taking?
- Is there any history of hemoglobinopathy, especially sickle cell disease?
- Are there any subjective visual complaints?
- For ocular burns: What was the offending substance?

definition of trauma.²⁰

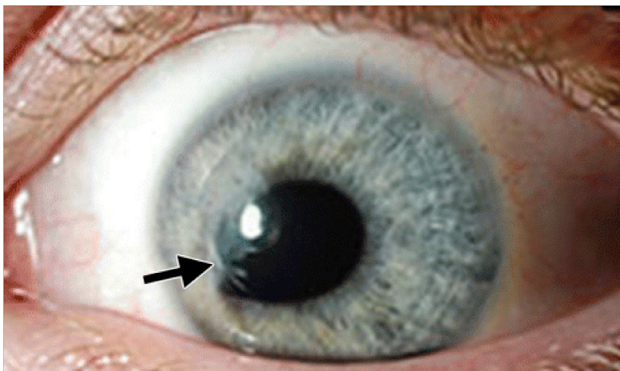
The patient should be asked whether eye protection was used.⁷ This has potential medicolegal implications and should be recorded in the patient's history. The patient should be asked when the injury occurred, as the timing may help narrow the differential diagnosis.¹⁵ Traumatic iritis can present up to 3 days later, whereas retinal detachment may not appear until weeks after the injury.²¹ Determining whether the patient has had an eye surgery in the past is important, as it has been noted that, for elderly patients after a fall, the rupture of wounds from prior surgery is a significant source of open-globe injury.³

Finally, an accurate list of the patient's current medications and whether the patient has a history of any hemoglobinopathies should be obtained.²² Anticoagulated patients are more likely to bleed and may suffer traumatic hyphema, retrobulbar hemorrhage, subconjunctival hemorrhage, and vitreous hemorrhage more easily than nonanticoagulated patients. Patients with sickle cell disease should not be given carbonic anhydrase inhibitors (a common component in the treatment of hyphema) because they increase the tendency of the red blood cells to sickle in the anterior chamber.^{15,23} The patient should also be asked if they are subjectively having any visual problems, such as decreased visual acuity, or whether they are seeing any floaters.

Physical Examination

The eye examination begins with a general observation, looking for evidence of trauma, deformity, or asymmetry. Visual acuity should be obtained and recorded on all patients.^{7,18} It should be documented both initially as well as periodically throughout the patient's time in the ED, as deterioration may occur over time. Strong consideration should be given

Figure 3. Irregularly Shaped Pupil Secondary To Globe Rupture



Edward K. Sung, Rohini N. Nadgir, Adkifumi Fujita, et al. *RadioGraphics*. Injuries of the globe: what can the radiologist offer? Volume 34, pages 764-776. Copyright 2014, with permission from the Radiology Society of North America.

to consulting ophthalmology if there is deterioration of visual acuity, either initially or over time, as it is a sensitive sign of injury.²⁵ If a patient wears contact lenses or glasses, visual acuity should be measured with these corrective devices in place. If the patient's corrective device is not available, visual acuity without the device should be obtained and then performed again with a pinhole device; visual acuity abnormalities due to a refractive error should improve with a pinhole device.²⁶ If it is not feasible to obtain a formal visual acuity measurement, a rough estimate of the patient's visual acuity should be obtained. For example, ask if the patient can count fingers, see a hand waving, or perceive light. It is important to note that normal visual acuity does not exclude serious injury.¹⁸

The pupil should be examined, specifically looking at the shape, symmetry, red reflex, and reaction to light. An irregularly shaped pupil may indicate globe rupture, as seen in **Figure 3**. Extraocular movements should be examined to ensure that the eyes can move freely in all directions. The anterior chamber should be examined for the presence of blood, which indicates a traumatic hyphema. (See **Figure 4**.)

A fluorescein examination should also be performed to identify both corneal abrasions as well as a possible ruptured globe via the Seidel test. The Seidel test involves instilling a large amount of fluorescein and examining the eye for a dark stream interrupting the fluorescein, an indication of globe rupture.¹⁷ Corneal abrasions are identified by uptake of fluorescein. If vertical or multiple linear abrasions are noted during the fluorescein examination, the eyelid should be everted to search for foreign bodies that may be trapped under the eyelid, causing repeated abrasions. Multiple linear abrasions

Figure 4. Traumatic Hyphema



Robert Scott. The injured eye. *Philosophical Transactions B*. 2011, Volume 366, Issue 1562. By permission of the Royal Society.

identified on fluorescein examination are depicted in **Figure 5**.

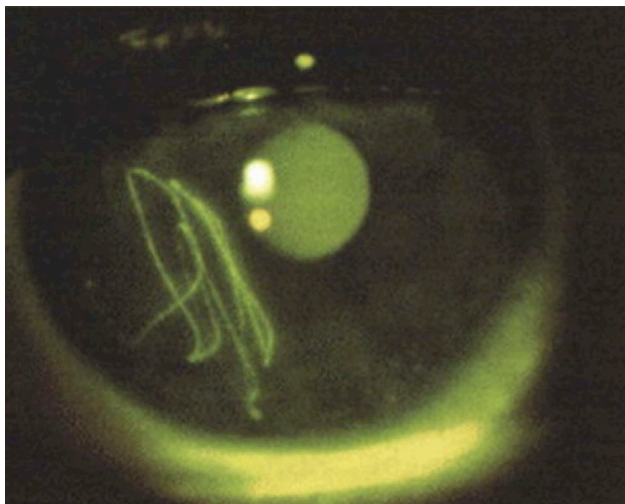
Fundoscopy and a portable slit-lamp examination can be performed to examine the retina, looking for foreign bodies, and cells and flare seen in traumatic iritis. The eye should be grossly inspected for any evidence of proptosis, which may indicate an underlying retrobulbar hemorrhage (as seen in **Figure 6**). Finally, intraocular pressure should be obtained via tonometry or by palpation of the globes if tonometry is not available.

There are some caveats to physical examination maneuvers. First, the physical examination of the patient should be tailored to that patient's specific complaint, and not all elements need to be performed on all patients. Also, if an open-globe injury is suspected or diagnosed, no pressure should be placed on the orbit, meaning that tonometry or palpation of the orbit should not be performed.^{16,17} If rupture is obvious, no further examination of the eye needs to be performed.¹ Finally, a high index of suspicion must be maintained for open-globe injury, as it may not be obvious. The defect may seal itself off, making the diagnosis on physical examination problematic.³ In this case, the Seidel test will be negative, so emergency clinicians must be particularly vigilant.²⁷

The Multiply Injured Patient

The multiply injured trauma patient poses particular challenges. There may be life-threatening injuries present that preclude an assessment of the patient's eyes. The patient may be obtunded and unable to answer questions regarding his or her vision, pain,

Figure 5. Corneal Abrasion With Multiple Linear Abrasions



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or ongoing changes in vision. There may also be significant swelling around the orbit, making evaluation of the orbit difficult or impossible.

Vision-threatening injuries should be considered at the end of the primary examination. Although orbital injuries tend not to affect mortality, they can have a profound impact on the patient's quality of life and treatment of some injuries is time-sensitive.²⁸

In general, a brisk reaction to direct and consensual light stimuli in a round, concentric pupil is reliable in excluding a vision-threatening injury requiring immediate intervention.²⁸ However, if you are unable to examine the pupil or if the pupil is abnormal, the possibility of vision-threatening injury needs to be explored further. One option is to obtain an orbital CT, although the patient must be stable enough to leave the ED. Another option is a bedside ocular ultrasound, which will be discussed in detail in the "Diagnostic Studies" section, page 7.

Proptosis And Retrobulbar Hemorrhage

Although retrobulbar hemorrhage is the most common cause of traumatic proptosis, other causes include bony displacement into the orbit (blow-in fracture) or swelling of the retrobulbar contents.^{28,29} Differentiating between these 3 causes of proptosis is critical because retrobulbar hemorrhage is the only one of the causes of proptosis that can potentially benefit from a lateral canthotomy. (See the **Clinical Pathway For Management Of Retrobulbar Hemorrhage**, page 14.)

There are different ways to distinguish between the causes of proptosis. If the patient is able to communicate, a decrease in visual acuity would be worrisome and point toward a diagnosis of retrobulbar hemorrhage.^{29,30} The same is true of an afferent

Figure 6. Proptotic Eye Secondary To Retrobulbar Hemorrhage



Reprinted from *Journal of Emergency Medicine*, Volume 22, Issue 3. Susi Vassallo, Morris Hartstein, David Howard, Jessica Stetz. Traumatic retrobulbar hemorrhage: emergent decompression by lateral canthotomy and cantholysis. Pages 251-256. Copyright 2002, with permission from Elsevier.

pupillary defect, which can be obtained in a nonresponsive patient.^{29,30} Other cardinal signs of retrobulbar hemorrhage are worsening proptosis, pain, and papilledema. Serial examinations are required to monitor for any of these changes. Measuring intraocular pressure may be helpful; intraocular pressure > 40 mm Hg in a proptosed eye indicates that urgent treatment is required.²⁹

From an imaging standpoint, beside ultrasound or orbital computed tomography (CT) can diagnose retrobulbar hemorrhage.^{28,29} In any case, imaging should not delay treatment if the diagnosis has been made clinically.

Diagnostic Studies

In many cases of ocular trauma, the diagnosis will be made after a detailed history and physical examination are performed, and specific diagnostic testing will be unnecessary.

Laboratory Studies

Laboratory studies have limited utility in the patient with ocular trauma. In coagulopathic patients or patients unable to provide a reliable history, obtain prothrombin time (PT) and partial thromboplastin (PTT) time. If a black patient presents with a traumatic hyphema, inquire about or screen for sickle cell disease or sickle cell trait, as patients with these conditions have a higher incidence of secondary hemorrhage.³¹

Computed Tomography And Magnetic Resonance Imaging

CT of the orbit is the modality of choice for traumatic globe injury in the ED.³² Helical CT is often recommended over conventional CT because it is quicker and has less radiation exposure.³³ **Figure 7** shows a CT of an eye with a glass intraocular foreign body.

Although CT is often considered the gold standard, it has limitations. First, vegetable foreign bodies can be missed on CT. If a vegetable foreign body is suspected but not identified on CT, surgical exploration may be indicated.³³ Magnetic resonance imaging is also an option in this situation (assuming a metallic foreign body has been excluded).¹⁹ Finally, although CT has been found to be 100% sensitive for foreign bodies larger than 0.06 mm³, it is only 65% sensitive for foreign bodies smaller than this.¹⁹

Ultrasound

Bedside ocular ultrasound is easily accessible, inexpensive, well-tolerated, and does not require patients to leave the ED.²⁹ It is particularly useful in blunt trauma when there may be too much soft-tissue swelling to retract the eyelids and examine the orbit properly.³⁴ It can be performed quickly, typically in 60 to 90 seconds even in difficult cases,

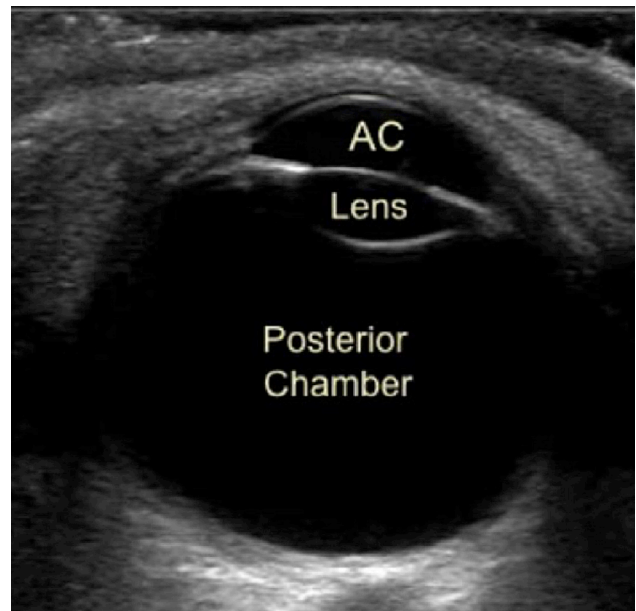
and is also very accurate.^{17,34} One prospective observational study of 61 patients with ocular trauma showed 100% sensitivity and 97.2% specificity when compared with CT, with minimal training of the emergency physician.³⁴ A normal ultrasound of an uninjured orbit can be seen in **Figure 8**. **Figure 9** (page 8) is an ocular ultrasound of retrobulbar hemorrhage, and **Figure 10** (page 8) is an ultrasound showing retinal detachment.

Figure 7. Computed Tomography Image Showing Glass Intraocular Foreign Body



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Figure 8. Normal Ocular Ultrasound



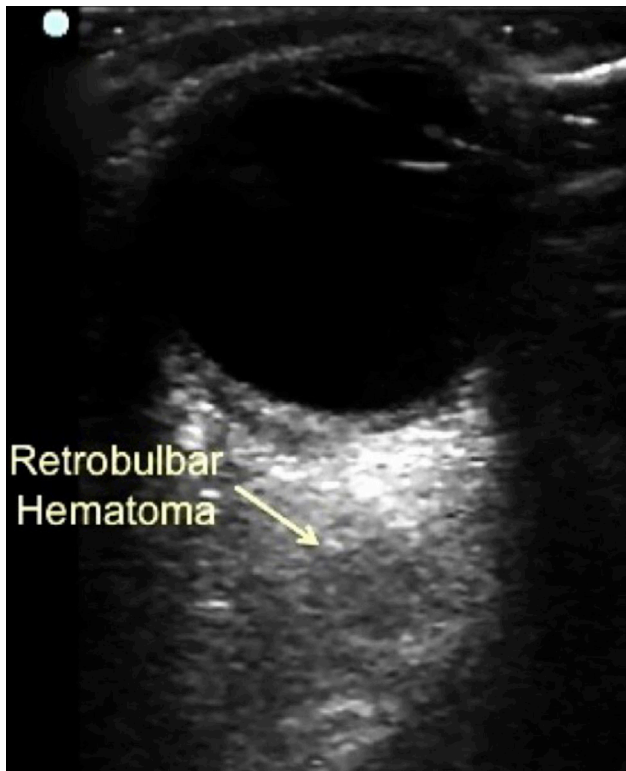
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If bedside ocular ultrasound is undertaken, it is recommended to use a 7.5 to 10 MHz linear array transducer, and the orbit should be scanned in both the long and short axes.³⁵ A large amount of gel should be used over a closed eyelid; sterile gel is not necessary.³⁶ If globe rupture is a concern, ocular ultrasound is still safe, given the large amount of gel that is used, although there are some who feel ultrasound usage is contraindicated in these patients.^{1,35,37}

The indicator on the ultrasound probe should be oriented either towards the patient's head or the patient's right side. The gain may need to be increased during the examination to diagnose more-subtle findings. If the patient is cooperative, it may be helpful to have them look in different directions so that no pathology is missed.³⁶ **Table 3** lists conditions that may be diagnosed by ocular ultrasound, and their associated ultrasound findings.

When using ultrasound to identify possible foreign bodies, a false positive may be obtained if there is intraorbital air, as it may mimic a solid foreign body.¹⁹ The patient should be examined while upright, although this may not be possible for trauma patients.³⁶

Figure 9. Ocular Ultrasound Of Retrobulbar Hemorrhage



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Treatment

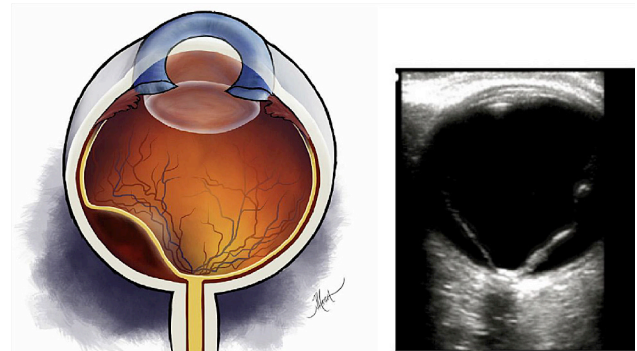
Corneal Abrasion

Traditional treatment of corneal abrasion includes some combination of topical antibiotics, cycloplegics, pain management, and eye patching. These presentations also provide an opportunity to ensure that a patient's immunization status is up to date.

Patching

Many studies have concluded that patching may be harmful because it decreases the rate of healing and

Figure 10. Ocular Ultrasound Of Retinal Detachment



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Table 3. Conditions Diagnosable By Ultrasound And Their Characteristic Findings

Condition	Ultrasound Finding
Vitreous hemorrhage	• String-like echogenicities throughout the vitreous
Retrobulbar hemorrhage	• Hypoechoic fluid behind the globe (see Figure 9) • The posterior globe may have a conical deformation that resolves after lateral canthotomy ³⁸
Lens dislocation	• Lens will be seen in an abnormal location in the globe
Intraocular foreign body	• Not always visible, but if seen, will be distinct echogenic area in or around the globe
Retinal detachment	• Thick, irregular band seen at the area of detachment in the globe (see Figure 10) ⁴⁰
Globe rupture	• Loss of intraocular volume with a distorted size and shape of the globe ³⁶
Posterior vitreous detachment	• Thin, smooth membrane that may remain attached to the retina. High gain is required ³⁹

decreases binocular vision.⁴⁰⁻⁴² A Cochrane review of randomized and quasi-randomized studies on the effects of patching in the treatment of corneal abrasion analyzed 11 trials dating from 2007 and prior. No trial found that patching had a favorable outcome on pain management. Seven trials with dichotomous healing outcomes found more favorable healing in the nonpatched groups on day 1, although there was no significant difference in healing on days 2 and 3. Their final recommendation was against the application of an eye patch in the treatment of simple corneal abrasions.⁴³

Although the general recommendation goes against patching in the treatment of corneal abrasion, it may be useful “as a protective barrier for patients who might continue to rub their eyes (eg, children or persons with cognitive disabilities).”⁴⁴ Some ophthalmologists also still recommend patching for corneal abrasions larger than 10 mm, and the Cochrane review admits that more research is needed regarding patching large corneal abrasions.^{43,44}

Topical Nonsteroidal Anti-Inflammatory Drugs

Corneal abrasions can be extremely painful, and patching has not been shown to decrease pain. However, topical nonsteroidal anti-inflammatory drugs (NSAIDs) have been studied extensively and have been found helpful in decreasing pain in the first 24 hours without adverse effects on healing of the abrasion. They also appear to decrease the necessity of oral pain medication in these patients. No significant adverse effects were reported when used as prescribed.⁴⁴⁻⁴⁶ A summary of studies on NSAID use for corneal abrasions is presented in **Table 4**.

Topical Antibiotics

One study examined the outcomes of 94 patients with corneal abrasions after removal of a corneal foreign body and found that there was no difference in healing in those who received antibiotics and those who did not; however, this study was limited by size and had indeterminate power.⁵³ A review article from 2013 admits that the evidence to support the use of topical antibiotics in uncomplicated corneal abrasions is lacking, but they recommended that antibiotics should be given if the patient wears contact lenses, had a foreign body, or had a history of trauma with infectious or vegetable matter, because of the risk of bacterial keratitis.⁵⁴ Because of a lack of concrete evidence to suggest otherwise, erythromycin ophthalmic ointment should be used 4 times per day for 3 days to treat uncomplicated corneal abrasions.

Patients who wear contact lenses require a topical antibiotic with antipseudomonal coverage, typically a fluoroquinolone.¹⁵ Contact lens wearers should be evaluated every day until their abrasion has healed. Additionally, if contact lens wearers or any other patients have developed a corneal ulcer, they must be evaluated urgently, as these ulcers may cause permanent damage.⁵⁴ If urgent evaluation by an ophthalmologist cannot be guaranteed, then ophthalmology should be consulted in the ED, or the patient should be admitted for ophthalmology evaluation.

Topical Cycloplegics

The use of cycloplegics to control pain in corneal abrasion is also in need of further research, as only

Table 4. Trials Examining The Use Of Topical NSAIDs To Treat Corneal Abrasion Pain

Study	Outcome
Topical ketorolac; prospective single-center randomized placebo-controlled double-blind trial of 100 patients ⁴⁷	Statistically significant pain reduction and fewer subjective complaints (photophobia, foreign body sensation) on day 1 but not on day 2.
Topical ketorolac; prospective single-center randomized placebo-controlled double-blind trial of 88 patients ⁴⁵	No statistically significant difference in pain or healing, but the ketorolac group required significantly less additional oral analgesics ($P = .001$).
Topical diclofenac; prospective randomized placebo-controlled double-blind trial of 49 of patients ⁴⁸	Statistically significant improvement of pain at 2 hours; patients receiving diclofenac were 50% as likely to take oxycodone-acetaminophen, although this was not statistically significant.
Topical indomethacin; prospective randomized double-blind trial of 123 patients ⁴⁹	Pain relief from day 0 to day 4 or 5 was significantly better in the indomethacin group ($P = .015$).
Topical indomethacin; randomized controlled trial of 347 patients ⁵⁰	Pain was decreased at 30 minutes, 12 hours, and 24 hours in the indomethacin group ($P < .001$).
Flurbiprofen; randomized controlled trial; 401 patients divided into 4 groups (control; homatropine only; flurbiprofen only; both homatropine and flurbiprofen) ⁵¹	The 2 groups that received flurbiprofen had significantly less pain at 24 hours ($P < .05$).
Topical NSAIDs; meta-analysis of 11 randomized controlled trials of 459 patients ⁴⁴	There was no restriction in the type of NSAID used in this study. Topical NSAIDs were found to reduce self-reported pain.
Topical NSAIDs; comparative study of 5 trials ⁵²	Topical NSAIDs improved pain and other subjective symptoms better than placebo, and likely decrease the need for oral analgesics.

Abbreviation: NSAIDs, nonsteroidal anti-inflammatory drugs.

1 study was found that examined this question. It showed no benefit to the use of cycloplegics, but more research is necessary before a definitive recommendation can be made.⁵⁵

Summary

The patient with a corneal abrasion should be treated with topical NSAIDs, with or without oral analgesics, and topical antibiotics. The patient should not have the affected eye patched, and should probably not be given a topical cycloplegic. A non-contact lens wearer can be prescribed erythromycin ophthalmic ointment to use 4 times per day for 3 to 5 days; contact lens wearers can be given levofloxacin 0.5% solution to be used (1-2 drops) every 2 hours, while awake, for 2 days then every 4 to 8 hours for 5 days.

Traumatic Hyphema

The management of traumatic hyphema is also controversial with regard to both treatment and whether these patients require admission. It has been traditionally recommended that all patients with traumatic hyphema be admitted to the hospital and placed on strict bed rest, with the eye patched.²²

The goal of treating hyphema is to prevent secondary hemorrhage (also called rebleeding). Rebleeding occurs in roughly 22% of cases and may result in permanent vision loss secondary to glaucoma, optic nerve damage, and corneal blood-staining.^{22,56} Topical miotics and cycloplegics have not been found to have a significant effect in preventing rebleeding, although they have been traditionally used.^{22,57} Eye patching may afford the patient with traumatic hyphema some benefit, according to some studies. One review article found patching to increase the patient's comfort and prevent re-injury, and advocates for its use in both the inpatient and outpatient settings.²² However, the Cochrane review of traumatic hyphema found no benefit to patching in terms of rates of rebleeding.⁵⁷ So, while patching may decrease subjective patient complaints, it does not necessarily have medical benefit.

Corticosteroids

Topical or systemic corticosteroid use is another area of controversy, and review articles provide conflicting recommendations regarding their use to prevent rebleeding.^{22,56} A randomized controlled trial of 43 patients found no difference in rebleeding or final visual acuity in patients receiving oral prednisone versus placebo.⁵⁸ The aforementioned Cochrane review did not find any benefit to the use of corticosteroids in reducing the rate of rebleeding; however, it notes that the studies examining this particular question are small.⁵⁷

Antifibrinolytics

Antifibrinolytics, specifically aminocaproic acid and tranexamic acid, are also commonly used in the

treatment of traumatic hyphema. It has been generally accepted that antifibrinolytics decrease the rate of rebleeding, but whether this has an effect on the patient's final visual acuity is questionable.^{22,56} One study of 215 pediatric patients found no significant difference in rebleeding rates between groups given oral tranexamic acid versus placebo ($P = .60$).⁵⁹

A common problem with systemic antifibrinolytics is that they have many adverse effects, including nausea, vomiting, dizziness, and syncope. These adverse effects can render the drug difficult or impossible to use, particularly in the outpatient setting. Oral aminocaproic acid is also very expensive, often more than \$500 for 30 tablets (www.goodrx.com), which may be cost-prohibitive for many patients.

Topical aminocaproic acid is an alternative to oral aminocaproic acid. One randomized controlled trial of topical aminocaproic acid versus placebo gel showed favorable trends towards decreasing rebleeding and improving vision, but neither was statistically significant, secondary to small sample size.⁶⁰ Although more research is required, topical aminocaproic acid appears to be a promising tool in the management of traumatic hyphema, as it avoids the adverse effects of the systemic antifibrinolytics.

A particular problem in the studies of topical and systemic antifibrinolytics is the patient population that is studied. In many cases, the patients were predominantly white. Because sickle cell disease is rare in this population, this may skew the results and render them inapplicable to the general population. For example, a study of 238 patients did show that oral tranexamic acid decreased rebleeding, but all of the patients in the study were white.⁶¹ However, the Cochrane review did find that systemic aminocaproic acid, topical aminocaproic acid, and tranexamic acid all reduced the rate of rebleeding, although it did not advocate for one particular treatment over another.⁵⁷

Summary

Antifibrinolytics may reduce rebleeding, and all other therapies have not been found to be helpful.⁵⁷ Systemic aminocaproic acid has many adverse effects and is very expensive, so this must be taken into consideration. Ophthalmology should be consulted for all cases of traumatic hyphema, and further treatment decisions should be made in conjunction with the treating ophthalmologist.

Ocular Chemical Burns

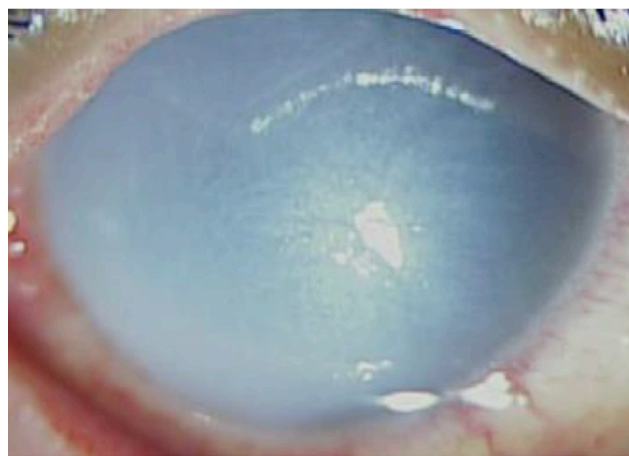
Copious irrigation is the mainstay of treatment of ocular chemical burns. The offending compound should never be neutralized.^{15,62} If irrigation is necessary in the ED, several options are available. The best option is the use of a Morgan Lens. To use the Morgan Lens, the eye is anesthetized and the lens is placed first under the upper eyelid, then the

lower eyelid. Fluid runs through the lens and then out of the patient's eye. It should not be used if it is suspected that a foreign body is present.⁶² Another option for direct irrigation is intravenous tubing, wherein one person holds the patient's eye open and another allows the fluid to run out of the intravenous tubing directly onto the patient's eye.⁶² The patient should be irrigated with at least 2 liters of normal saline, lactated Ringer's, balanced salt solution, or water.¹⁶ Five to 10 minutes after irrigation, the pH of the eye should be tested and irrigation should continue if the pH is not neutral. The length of time of irrigation, the solution used, the pH of the eye, and the number of times the pH of the eye was tested should all be recorded.⁶³

Once irrigation is complete, the severity of the burn should be assessed, as this will affect management and disposition of the patient. The Roper-Hall classification system is commonly used and is presented in **Table 5**.¹⁵ A photograph of a Roper-Hall grade IV injury is seen in **Figure 11**.¹⁵

Traditional treatment for grades I and II ocular burns has included topical antibiotics and artificial tears, whereas grades III and IV were treated with topical steroids, ascorbate, citrate drops, and hospital admission.¹⁶ Both ascorbate and citrate have been

Figure 11. Roper-Hall Grade IV Ocular Burn



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studied in depth in rabbits, and have proven to be beneficial; however, data regarding their efficacy in humans are lacking.^{11,64} Topical dexamethasone was studied in rabbits with alkali burns and results suggested that its administration may help endothelial healing; however, a review of human patients did not support this.^{65,66} The decision to use any of these medications should be made in conjunction with the treating ophthalmologist.¹⁵

In summary, for ocular burns in the ED, the eye should be thoroughly irrigated, a topical antibiotic should be applied, and all other medications given should be at the discretion of the treating ophthalmologist. The patient should receive a tetanus immunization as necessary.¹⁷

Retrobulbar Hemorrhage

Retrobulbar hemorrhage is a serious, vision-threatening injury and must be treated expeditiously. Once ischemia to the optic nerve begins, permanent vision loss can occur within 60 to 120 minutes.^{1,17} Treatment of retrobulbar hemorrhage can be both surgical and medical. Although most emergency clinicians are aware of the lateral canthotomy to surgically treat retrobulbar hemorrhage, a survey of emergency clinicians indicated that most of them did not know proper medical management of this condition.³⁰ The emergency clinician has several options, depending on the severity of the patient's symptoms and physical examination findings.

Ideally, ophthalmology is consulted emergently and the treating ophthalmologist can manage the retrobulbar hemorrhage, but this is not always available in a timely manner. If it is not, the emergency physician must be prepared to manage the patient's retrobulbar hemorrhage.¹⁰ If the clinical diagnosis is obvious and not in question, a lateral canthotomy with inferior cantholysis should be performed.²⁴

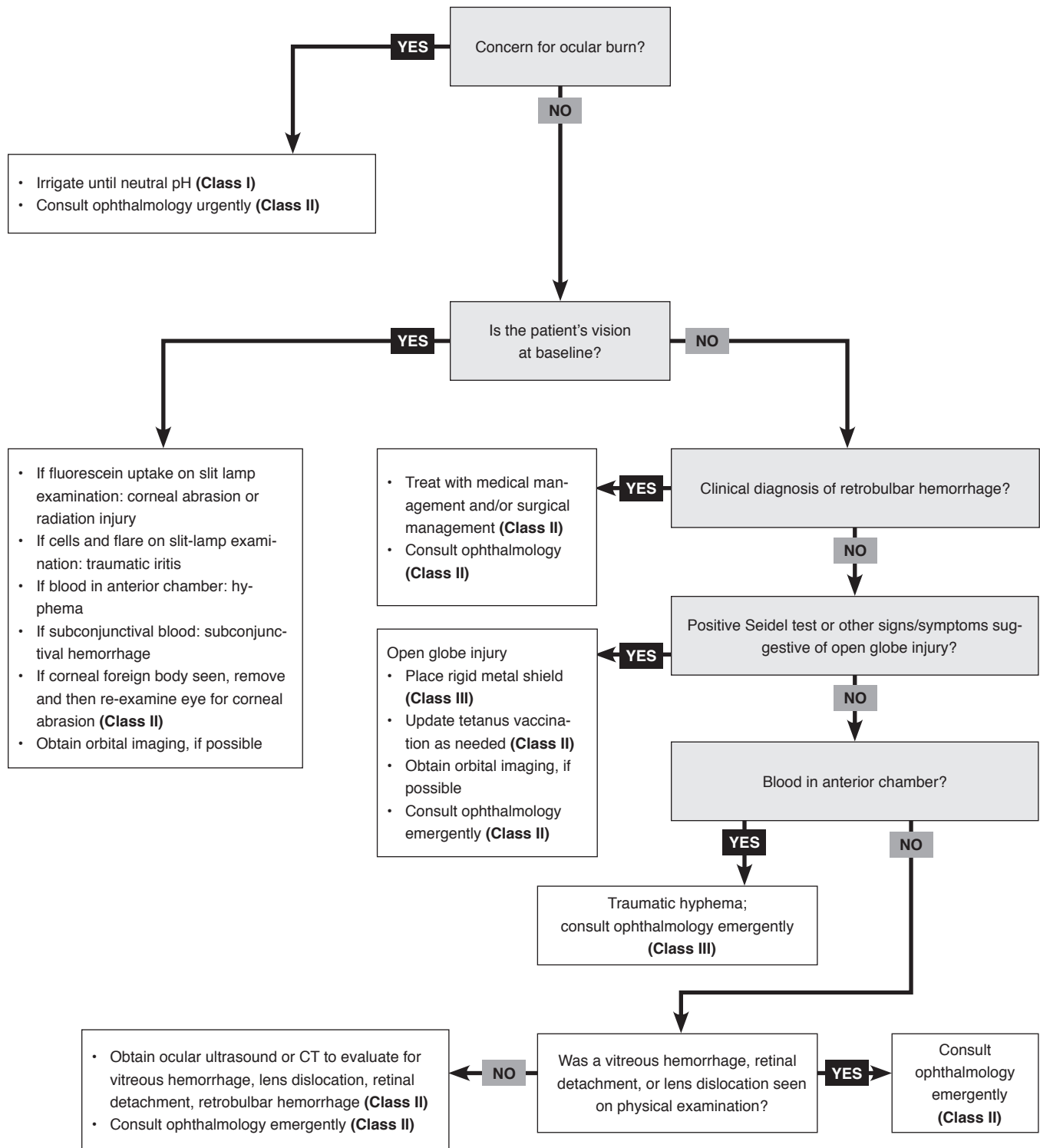
Permanent visual damage is unlikely if decompression is performed within 2 hours of symptom onset.²⁴ **Figure 12** (see page 13) contains a QR code and URL link to a video demonstration of a lateral canthotomy procedure. The lateral canthus should be anesthetized with lidocaine with epinephrine, then a tissue clamp is placed horizontally across the lateral canthus for 1 to 2 minutes. The clamp is then removed and sterile scissors are used to incise the

Table 5. The Roper-Hall Classification System

Grade	Prognosis	Corneal Condition	Conjunctival Limbus
I	Good	Corneal epithelial damage	No limbal ischemia
II	Good	Corneal haze and iris details visible	< 1/3 limbal ischemia
III	Guarded	Total epithelial loss, stromal haze, and iris details obscured	1/3 to 1/2 limbal ischemia
IV	Poor	Cornea opaque and iris and pupil obscured	> 1/2 limbal ischemia

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Clinical Pathway For Management Of Ocular Trauma



See class of evidence definitions, page 13.

skin, making an approximately 1-cm incision.^{10,24} Once the lateral canthotomy is performed, inferior cantholysis with incision of the inferior crus should be performed.¹⁰

Medical management is another branch in the treatment of retrobulbar hemorrhage. Some authors recommend that any patient receiving a lateral canthotomy should also be provided with medical management, including intravenous corticosteroids, mannitol, and acetazolamide.²⁴ Lateral canthotomy should never be delayed while awaiting medical management.

In the case in which the symptoms are equivocal and definitive testing is not possible (for whatever reason), medical management with mannitol, corticosteroids, and acetazolamide should be provided; surgical decompression should be performed if symptoms do not improve with medical management alone. Recommended dosages for these medications (all given intravenously) are: 20% mannitol, 2 g/kg; methylprednisolone, 250 mg or hydrocortisone, 100 mg; and acetazolamide, 250 to 500 mg.^{24,30,66} Care must be used if the patient is hypotensive, as mannitol and acetazolamide may worsen hypotension.^{28,29}

Open-Globe Injuries

Open-globe injuries are vision-threatening and require immediate ophthalmology consultation. One of the most important aspects of treatment is to prevent further injury. The head of the bed should be placed at 30°, a rigid metal shield should be applied, and analgesics and antiemetics should be given to control pain and nausea/vomiting.¹ Tetanus prophylaxis should be provided as needed.^{1,3}

Antibiotics are generally recommended for prophylaxis against posttraumatic endophthalmitis, despite the absence of strong evidence for benefit. Treatment regimens vary; we recommend ceftazidime 1 g every 8 hours and vancomycin 1 g every 12 hours, both for 48 hours, in addition to topical antibiotics.

Radiation Damage

Radiation damage can result from welding, snow blindness, direct viewing of the sun, and tanning beds.^{18,54} The treatment of radiation damage is identical to the treatment of corneal abrasion.^{18,54,68}

Traumatic Iritis

Most commonly, traumatic iritis presents following blunt trauma. The patient will generally complain of pain, decreased vision, tearing, and photophobia. The typical finding on slit-lamp examination in these patients is cells and flare in the anterior chamber; other findings include decreased vision and conjunctival injection around the limbus.¹⁵

Traumatic iritis has surprisingly little mention in the ocular trauma literature, and no relevant, quality clinical trials regarding its management in the ED were found. The traditional treatment for traumatic iritis has been topical cycloplegics and close ophthalmology follow-up (cyclopentolate 2%, 3 times per day until ophthalmology follow-up).^{7,15}

Retinal Detachment, Posterior Vitreous Detachment, Vitreous Hemorrhage, And Lens Dislocation

Retinal detachment, posterior vitreous detachment, vitreous hemorrhage, and lens dislocation may have similar features, making them difficult to distinguish

Figure 12. Link To Video Of Lateral Canthotomy Procedure



To view a video of a lateral canthotomy, scan the QR code with a smartphone or go to: <http://www.eyerounds.org/tutorials/lateral-canthotomy-cantholysis.htm>

Class Of Evidence Definitions

Each action in the clinical pathways section of *Emergency Medicine Practice* receives a score based on the following definitions.

Class I

- Always acceptable, safe
- Definitely useful
- Proven in both efficacy and effectiveness

Level of Evidence:

- One or more large prospective studies are present (with rare exceptions)
- High-quality meta-analyses
- Study results consistently positive and compelling

Class II

- Safe, acceptable
- Probably useful

Level of Evidence:

- Generally higher levels of evidence
- Nonrandomized or retrospective studies: historic, cohort, or case control studies
- Less robust randomized controlled trials
- Results consistently positive

Class III

- May be acceptable
- Possibly useful
- Considered optional or alternative treatments

Level of Evidence:

- Generally lower or intermediate levels of evidence
- Case series, animal studies, consensus panels
- Occasionally positive results

Indeterminate

- Continuing area of research
- No recommendations until further research

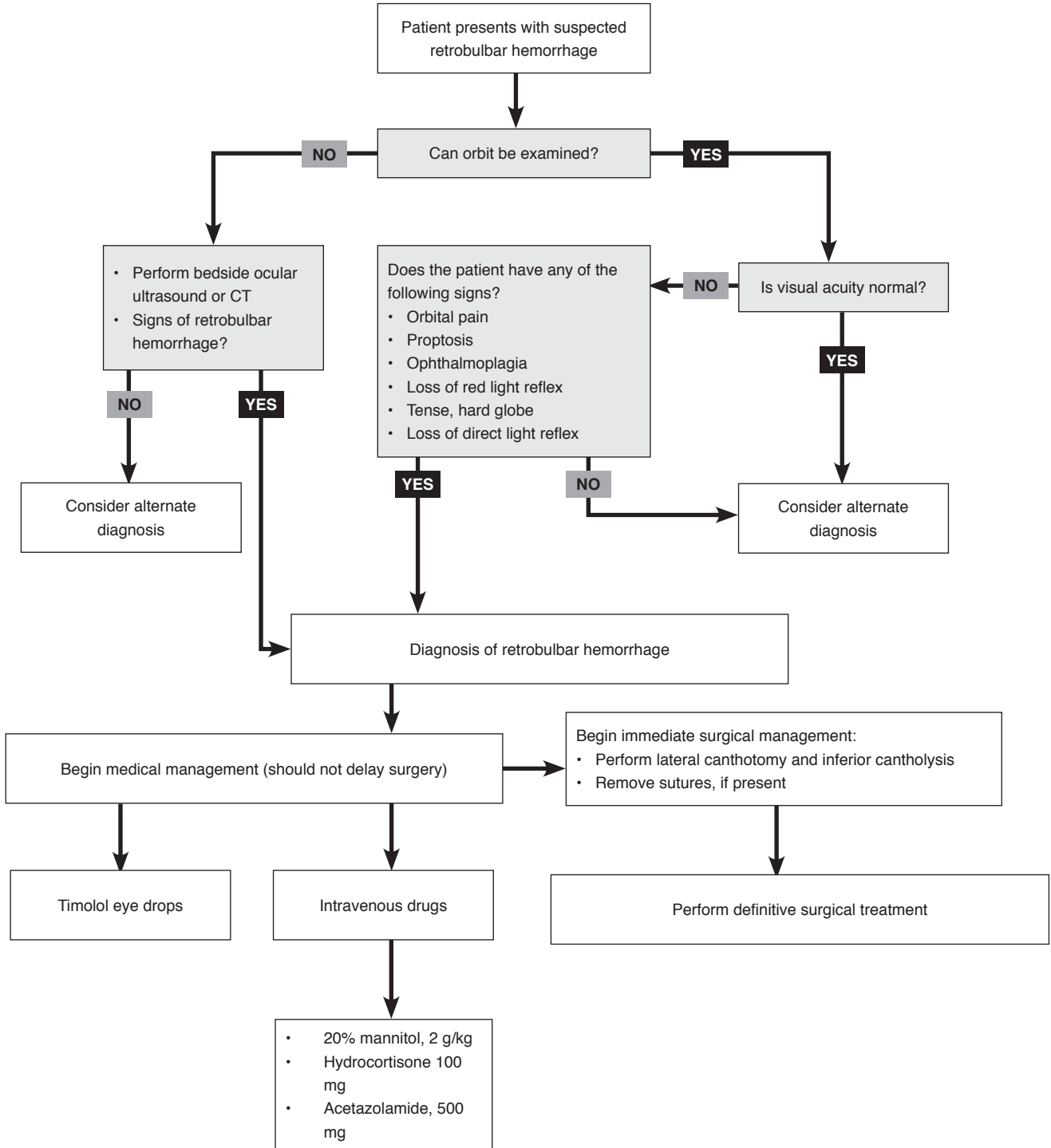
Level of Evidence:

- Evidence not available
- Higher studies in progress
- Results inconsistent, contradictory
- Results not compelling

This clinical pathway is intended to supplement, rather than substitute for, professional judgment and may be changed depending upon a patient's individual needs. Failure to comply with this pathway does not represent a breach of the standard of care.

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Clinical Pathway For Management Of Retrobulbar Hemorrhage



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on clinical grounds. Retinal detachment, posterior vitreous detachment, and vitreous hemorrhage can all cause the patient to see floaters or flashes of light, and can cause blurred vision or visual loss.^{37,69} Lens dislocation can cause pain, blurred or double vision, and photosensitivity.³⁷

Patients with complaints suspicious for any of these diagnoses should have a thorough ocular examination performed. As mentioned previously, advanced imaging (such as ultrasound) can help distinguish these entities. Although no particular intervention needs to be performed by the emergency clinician, ophthalmology should be consulted emergently if any of these diagnoses are suspected.^{1,70,71}

Subconjunctival Hemorrhage

Subconjunctival hemorrhage will present with a well-defined bright-red area on the sclera. Generally, the patient is otherwise asymptomatic and has, at most, mild pain and no visual defects. This injury is not vision-threatening, and will resolve on its own without any intervention.⁷² Irritation may be reduced by the use of artificial tears and warm compresses.^{68,72}

Corneal Foreign Body

If a corneal foreign body is identified, it should be removed, as long as it is not penetrating. Removal should be first attempted with irrigation. If this is unsuccessful, a moistened cotton swab can be used.^{1,18,62} If this is still unsuccessful, a 25-gauge needle can be used, but an experienced clinician should perform this.^{54,62} If a rust ring is present, it should be removed within 24 hours, but it does not necessarily need to be removed by the emergency clinician.⁶²

Special Populations

Pediatric Patients

Pediatric patients with ocular injuries can be particularly challenging, and a high index of suspicion must be maintained in this population so that injuries are not missed. One issue is the difficulty of obtaining an accurate history from the pediatric patient.¹⁸ Also, children frequently downplay the mechanism of action of their injury, which may lead to a false sense of reassurance to the emergency clinician that a serious injury is unlikely.³

Corneal abrasion should be evaluated as a possible diagnosis in the infant who is crying with an unknown etiology. Fluorescein examination is recommended if a cause for the crying cannot be elucidated.⁷³

Treatment of corneal abrasions is the same in the pediatric population as in the adult population, as are the management principles for other ocular traumas.^{74,75} An exception is topical fluoroquinolones, which should be avoided in patients aged <

12 months, as their use has not been approved in this population.⁷⁶

Patients With Sickle Cell Disease And Coagulopathies

The treatment of traumatic hyphema differs in patients with sickle cell disease versus the general population. Carbonic anhydrase inhibitors, frequently used in the management of traumatic hyphema, should be avoided in patients with sickle cell disease, as they increase the chance of the red blood cells sickling in the anterior chamber.^{15,23} Methazolamide can be used in these patients in place of carbonic anhydrase inhibitors.¹

Patients with coagulopathies are more prone to bleeding and therefore have an increased risk of traumatic hyphema and retrobulbar hemorrhage. As with any coagulopathic patient with unwanted bleeding, consideration must be given to whether reversal of the coagulopathy is warranted. There are specific recommendations to reverse vitamin K antagonists in the case of retrobulbar hemorrhage.⁷⁷ No specific recommendations have been made regarding reversal of other agents in the case of retrobulbar hemorrhage, or at all in the case of traumatic hyphema. These decisions are probably best made in conjunction with the treating ophthalmologist.

Controversies And Cutting Edge

Topical Anesthetics For Corneal Abrasion

The use of topical anesthetics, long regarded as dangerous and playing no role in the outpatient management of patients with corneal abrasion, has been called into question. Studies of topical anesthetics have yielded conflicting results. It appears that usage of topical anesthetics for < 48 hours is probably not harmful, but may not actually improve pain control.^{78,79} Prolonged use of topical anesthetics can be harmful and has the potential to cause blindness.⁸⁰ Given the conflicting data regarding topical anesthetics, more research is necessary before most practitioners will feel comfortable prescribing them for their patients.

Hospital Admission For Traumatic Hyphema

In addition to conflicting opinions regarding the optimal medical management of patients with traumatic hyphema, there is significant debate regarding whether patients with traumatic hyphema require routine admission to the hospital. Antifibrinolytics can be given topically, and other treatment modalities such as bed rest and eye patching can be done at home, leading some to argue that routine admission is no longer necessary, assuming the patient is able to follow up with ophthalmology.

The pediatric population has been of particular interest to researchers of this topic. A prospective

case series of 35 children with traumatic hyphema treated in the outpatient setting was examined.⁴ Of interest, elevated intraocular pressure was not an exclusion criterion; these patients were simply treated with timolol if their intraocular pressure was > 24 mm Hg and they were discharged home. The patients were not given antifibrinolytic agents. The rebleeding rate in this population was 8.6%, which is reasonable given that rebleeding rates in the literature range from 3.5% to 38%.⁵⁷ Patients did undergo daily follow-up examinations by an ophthalmologist. This study demonstrates that outpatient management of traumatic hyphema is possible, but close follow-up must be assured.⁴ A retrospective chart review of 138 pediatric patients with hyphema also supports the notion that hyphema can be managed in the outpatient setting. No one in this study experienced rebleeding; however, the study population was predominantly white.⁸¹

Oxygen Therapy For Ocular Burns

An interesting development in the treatment of ocular burns is the use of oxygen therapy. A prospective comparative case series of 22 patients (24 eyes) studied the effects of oxygen in patients with grade III to IV ocular burns that were a result of either thermal or chemical damage. The patients received 100% oxygen delivered via simple mask at a rate of 10 L/min for 1 hour, twice daily, in addition to "standard" medical therapy. The medical therapy was at the discretion of the treating physician and was not standardized. It was found that the patients receiving oxygen experienced quicker healing of their corneal defects (15.23 days vs 59.9 days, $P < .001$), quicker revascularization of ischemic areas (14.54 days vs 45.09 days, $P = .001$) and improved final visual acuity as measured by the logarithm of the minimal angle of resolution (0.40 vs 1.11, $P = .018$).⁸² Oxygen therapy may be a promising adjunct to the treatment of severe ocular burns.

Risk Management Pitfalls For Ocular Injuries (Continued on page 17)

1. "I didn't have time to do proper visual acuity testing."

Visual acuity is, essentially, a "vital sign" of the eye. Formal visual acuity testing with a Snellen chart or other device typically takes less than 2 minutes and is an essential component of the patient's physical examination. If the patient is unable to complete this, then a rough estimate of the patient's visual acuity should be obtained. Can the patient count fingers, see a hand waving, or read? There may be later medicolegal implications regarding visual acuity, particularly in cases of workers' compensation, so this must be documented.^{7,18,26}

2. "I thought I should examine the patient's eye prior to irrigation."

The patient's best chance of a favorable visual outcome following an ocular burn is immediate and copious irrigation. Even if other life-saving measures must be instituted simultaneously, irrigation should begin immediately. Whatever fluid is most readily available (normal saline, lactated Ringer's, tap water) should be used.^{6,11,12} Record the length of time of irrigation, the solution being used, the pH of the eye, and the times when the pH of the eye was tested.⁶³ Additionally, it is the responsibility of the emergency clinician to ensure that triage staff is aware of the time sensitivity of irrigation in these patients so that they are treated expeditiously.⁸⁶

3. "I didn't realize I had to record so much specific information about the trauma."

It is extremely important from a medicolegal standpoint to record specific information regarding the trauma. If the patient presented with visual complaints without a clear history of trauma, it should be ascertained what they were doing at the time of onset of symptoms, as heavy lifting may be the "trauma" that precipitated the ocular injury (eg, retinal detachment). This is also very important for workers' compensation cases.²⁰ Ocular pain while hammering or performing some other metal-on-metal activity is also important to elicit, as it places the patient at risk for an intraocular foreign body.¹

4. "The patient had severe trauma with other life-threatening injuries, so I didn't really examine his eyes."

The fact that a patient may have life-threatening injuries or a swollen face that precludes direct examination of the globe does not absolve the emergency clinician of the responsibility to evaluate for and treat vision-threatening injuries. CT of the orbit can be very helpful, particularly if the patient is already to receive a CT of the head. If the patient is not stable enough to leave the ED, bedside ultrasonography is a good way to evaluate for vision-threatening injuries.^{32,33,36}

Disposition

Corneal Abrasion

The vast majority of patients with a corneal abrasion can be discharged home. Circumstances under which ophthalmology should be consulted in the ED are: (1) the presence of significant visual deficits; (2) injury that is associated with a corneal infiltrate or ulcer, or (3) if the corneal abrasion is due to a penetrating eye injury. In general, the patient should be instructed to follow up with an ophthalmologist within 1 day; however, ophthalmology follow-up is generally unnecessary if the abrasion is smaller than 4 mm, provided there are not visual acuity deficits and the patient's symptoms are improving.¹⁵

Ocular Burn

Disposition of the patient with an ocular burn depends on the severity of the burn. A comparative study of 121 patients (177 eyes) showed that inten-

sive inpatient treatment with ascorbate and citrate was actually harmful in patients with grade I or II injury and recommends against routine admission of these patients.¹¹ Given that the optimal management of patients with ocular burns has not yet been established, it is prudent to make a disposition decision after discussion with an ophthalmologist. Patients with grades III or IV injury almost certainly require admission.

Traumatic Hyphema

As discussed in prior sections, there is a movement towards discharging home patients with traumatic hyphema. A retrospective study of 314 cases of traumatic hyphema supports this stance, stating that, "A case could be made for allowing patients who present with hyphema to go home with instructions to minimize physical activity and to return promptly should they develop symptoms of a rebleed."⁸³ This study did not find any factor (age, sex, mechanism of injury, grade of initial hyphema)

Risk Management Pitfalls For Ocular Injuries (Continued from page 16)

5. **"I already examined the eye once, why do I need to examine it again?"**

If the patient has any change in symptoms or if any procedure is performed on the eye (eg, corneal foreign body removal), the eye should be re-examined and these results should be recorded. Changes in the patient's symptoms may indicate an evolving pathology that requires attention, and the eye should be re-examined to evaluate for this possibility.⁸⁷

6. **"I thought that topical steroids were indicated!"**

Although topical steroids may be used to treat a myriad of ocular conditions, they can be potentially harmful to the eye and their effects need to be monitored closely.

7. **"The patient's eye injury occurred at work and I forgot to ask whether he was wearing any eye protection."**

Whether the patient was wearing eye protection is particularly important, especially if the trauma occurred at work.⁷ The patient may ultimately require workers' compensation.

8. **"My patient states that he cannot follow up with his ophthalmologist until next week. I thought that was soon enough."**

This depends on the ocular injury sustained. However, generally, the patient will need much closer follow-up, often within 24 hours. The inability to follow up must be taken into consideration when formulating a treatment plan for a patient.

9. **"I thought all corneal abrasions were the same."**

It must be discerned whether the patient with corneal abrasion wears contact lenses. If contact lenses are worn, then the patient will need a topical antibiotic that has antipseudomonal properties, and the patient must be told not to wear contact lenses until the corneal abrasion has resolved.¹⁵

10. **"The Seidel test was negative, so I didn't think the patient had a globe rupture."**

The Seidel test can be negative if the area of globe rupture or laceration is small and has sealed off. A high index of suspicion must be maintained, primarily based on the mechanism of injury.^{3,18,27} Ultrasound and CT can aid in the diagnosis of a globe rupture.^{32,33,36}

to increase the risk of rebleeding. Notably, the patients in the study who did experience rebleeding experienced no adverse effect on their visual outcome. Another study of 238 patients found low vision and elevated intraocular pressure to increase the chance of rebleeding.⁶¹

A retrospective chart review of 154 patients with traumatic hyphema also leans towards outpatient management, arguing that the patients in their study who did have adverse visual outcomes would not have had their clinical course improved with hospitalization. Again, this population was predominantly white and was very compliant with follow-up. Their final recommendation was to admit patients with intractable elevated intraocular pressure, rebleeding, or predicted poor compliance, and to consider admission in patients with severely decreased vision, total hyphema, or a history of sickle cell disease.⁸⁴ Another author advocates for the

Time- And Cost-Effective Strategies

- Many ophthalmic medications are quite expensive, and the emergency clinician should be aware of this, particularly if the patient is uninsured or has a high prescription copay. Some medications are on the “\$4 per month” list, available at many pharmacies, so local pharmacies should be consulted to see if any common ophthalmic medications are on this list. Many of these lists are available online. Erythromycin ointment, gentamicin solution, polymyxin B sulfate/trimethoprim solution, and tobramycin solution are generally on this list. Topical NSAIDs often cost \$50 or more, as do cycloplegics, aminocaproic acid, and topical fluoroquinolones.
- Bedside ocular ultrasound is a skill that all emergency clinicians should strive to learn. It is not a difficult procedure to perform, and it can have a profound impact on the patient’s management. It may obviate the need for a formal CT, saving time, money, and radiation exposure. While ultrasound should be attempted, and it may increase the speed with which it is diagnosed, a negative ultrasound may be encountered and does not rule out retrobulbar hemorrhage. As such, a lateral canthotomy is still recommended if the clinical scenario indicates a retrobulbar hemorrhage.
- Ophthalmology should be consulted early in the patient’s clinical course once a vision-threatening injury is suspected or diagnosed. In many of these cases, the patient’s treatment and disposition will hinge on the ophthalmologist’s recommendation.

admission of hyphemas > 50% in size, and consultation of ophthalmology in all cases.²²

Given the controversial nature of the disposition of the patient with traumatic hyphema, ophthalmology should be consulted in the ED for management of these patients. Special attention should be paid to patients who may be noncompliant or will have difficulty following up with an ophthalmologist. However, if the patient is reliable and able to follow up, the emergency clinician should be aware that the patient may be potentially discharged home.

Other Injuries

The disposition of other injuries is more straightforward. Patients with open-globe injuries require ophthalmology consultation in the ED to prevent posttraumatic endophthalmitis and for treatment of their injury.^{56,85} A patient with a retrobulbar hemorrhage needs admission to monitor for any change in vision. A reasonable approach for the patient with proptosis without visual changes is hospital admission with visual acuity checks every 1 to 2 hours.⁶⁶ At the other end of the spectrum, patients with traumatic iritis or subconjunctival hemorrhage can generally be safely discharged home with ophthalmology follow-up. Patients with corneal foreign bodies can be discharged home if the foreign body was successfully removed. If the patient has a rust ring, they should follow-up with ophthalmology within 24 hours. If removal of the corneal foreign body results in a corneal abrasion, then the patient should be treated for the corneal abrasion.

Retinal detachment, vitreous hemorrhage, posterior vitreous detachment, and lens dislocation all require evaluation by the ophthalmologist and will very likely require hospital admission as they may require repair in the operating room.^{69,70}

Summary

Ocular trauma is a serious cause of morbidity and a leading cause of blindness in all populations. Although the majority of these injuries are preventable, many people do not wear proper eye protection and present to the ED with a traumatized eye. The absolute first priority is immediate irrigation if the patient has an ocular burn. Otherwise, a thorough history should be performed, with special attention paid to the patient’s ocular history, as well as any history of acquired or congenital coagulopathy or sickle cell disease or trait. The patient’s orbit and surrounding structures should be examined both grossly as well as with the assistance of fluorescein staining, a slit-lamp, and fundoscopy. Visual acuity must be measured. Special care must be taken in multiply injured patients, as they may not be able to provide any information regarding ocular pain or vision changes; clinical examination, ultrasound,

and CT are particularly helpful in these patients. If a vision-threatening injury is suspected, ophthalmology should be consulted and the patient will likely require advanced imaging and possible hospital admission. Patients with more benign entities such as corneal abrasion, traumatic iritis, corneal foreign bodies, and subconjunctival hemorrhage will very likely be discharged home, generally with instructions to follow up with ophthalmology. Although ocular trauma is not encountered frequently, having a step-wise approach to the evaluation and management will ensure adequate care of these patients, and will provide them with the best chance of a favorable final visual outcome.

Case Conclusions

After some quick research, you realized that your first patient, the woman with the corneal abrasion, should be discharged home with a topical antibiotic and a topical NSAID, and that it was safest not to let her take home the bottle of topical anesthetic. She did not wear contact lenses, so you decided to use topical erythromycin 0.5% ointment. She followed up with her primary care doctor 2 days later and had complete resolution of her symptoms and complete healing of her abrasion.

Your motor vehicle crash patient was unable to leave the ED, so you decided to perform a bedside ocular ultrasound, which revealed a retrobulbar hemorrhage. Ophthalmology consultation in the ED was unavailable, so you immediately performed a lateral canthotomy and inferior cantholysis, with resolution of the proptosis. Visual acuity in his right eye was 20/30 at the time of discharge, 1 week later.

For the patient with the chemical splash, you initiated immediate irrigation with lactated Ringer's. After 30 minutes of irrigation, the pH in his left eye was 7.5. Upon examination, you were concerned that the patient may have sustained a Roper-Hall grade III burn, so ophthalmology was consulted. They agreed with your assessment and admitted the patient for intensive treatment with topical steroids and topical antibiotics, as well as ascorbate and citrate.

References

Evidence-based medicine requires a critical appraisal of the literature based upon study methodology and number of subjects. Not all references are equally robust. The findings of a large, prospective, randomized, and blinded trial should carry more weight than a case report.

To help the reader judge the strength of each reference, pertinent information about the study will be included in bold type following the reference, where available. In addition, the most informative references cited in this paper, as determined by the authors, will be noted by an asterisk (*) next to the number of the reference.

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CME Questions



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- In which of the following cases should treatment for the injury begin prior to evaluation of the injury?**
 - Corneal abrasion
 - Ocular burn
 - Traumatic iritis
 - Subconjunctival hematoma
- What physical examination maneuver should be performed in a patient with multiple linear corneal abrasions seen on fluorescein examination?**
 - Slit-lamp examination to look for cells and flare
 - Orbital CT to look for an intraocular foreign body
 - Tonometry to evaluate for elevated intraocular pressure
 - Eversion of the eyelid to search for a foreign body
- Proptosis can be caused by which of the following?**
 - Bony displacement into the orbit (blow-in fracture)
 - Retrobulbar edema
 - Retrobulbar hemorrhage
 - All of the above

4. A 2-year old black patient presents to the ED with a traumatic hyphema. He was recently adopted and his medical history is unknown. Which of the following laboratory tests would be the most beneficial to obtain in this patient?
 - a. Complete blood count
 - b. Basic metabolic panel
 - c. Sickle cell screening test
 - d. Blood cultures

5. A patient was cutting wood when he felt something fly into his eye. He had immediate pain. Orbital CT was within normal limits. Which of the following is the next best imaging study to obtain on this patient to evaluate for an intra-ocular foreign body?
 - a. CT with intravenous contrast
 - b. X-ray
 - c. Magnetic resonance imaging
 - d. No further imaging is necessary since the CT was within normal limits

6. Which of the following would be the most useful in evaluating an unstable trauma patient with significant periorbital swelling?
 - a. Bedside ocular sonography
 - b. Computerized tomography
 - c. Magnetic resonance imaging
 - d. Slit-lamp examination

7. Current recommendations most support treating corneal abrasions with which of the following?
 - a. Topical cycloplegics
 - b. Oral antibiotics
 - c. Eye patching
 - d. Topical NSAIDs

8. Which of the following should be performed in addition to a lateral canthotomy in the treatment of retrobulbar hemorrhage?
 - a. Superior cantholysis
 - b. Medial canthotomy
 - c. Inferior cantholysis
 - d. Dissection of Whitnall tubercle

9. A patient presents to the ED with a corneal abrasion of her right eye. She normally has 20/20 vision in both eyes, but vision in her right eye is now 20/100. What is the best disposition for this patient?
 - a. Discharge home with instruction to follow up with ophthalmology in 3 to 7 days
 - b. Discharge home with instructions to follow up with ophthalmology in 24 hours
 - c. Consult ophthalmology in the ED
 - d. Obtain an orbital CT then admit the patient for further management

10. Which of the following injuries is the least likely to necessitate hospital admission?
 - a. Traumatic lens dislocation
 - b. Traumatic iritis
 - c. Traumatic vitreous hemorrhage
 - d. Traumatic retinal detachment

Coming Soon In *Emergency Medicine Practice*

An Evidence-Based Approach To Intracerebral Hemorrhage In Anticoagulated Patients (Stroke CME)

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Intracerebral hemorrhage (ICH) is a devastating disease that must be recognized immediately in the emergency department. Unlike ischemic stroke, which has a large body of evidence supporting intravenous tPA and endovascular treatment, there are no targeted modalities for treatment of ICH. Anticoagulated patients with ICH require rapid reversal of coagulopathy to cease hemorrhage

progression; however, the optimal approach has been debated. Because there are no targeted therapies in the treatment of ICH, current strategies to improve outcome rest largely on reducing the risk of hematoma expansion early in treatment, as each milliliter of expansion decreases the patient's chances of living independently.

This issue reviews the history and physical elements that are important to obtain in the ED, including airway control, blood pressure management, frequent reassessment, reversal strategies, and the need for rapid consultation, ICU admission, and possible transfer. Data are quite limited at this point regarding optimal coagulopathy reversal in the setting of the novel oral anticoagulants, but these patients will inevitably present, and the emergency clinician must be aware of new developments and become involved in developing local protocols to manage these patients.

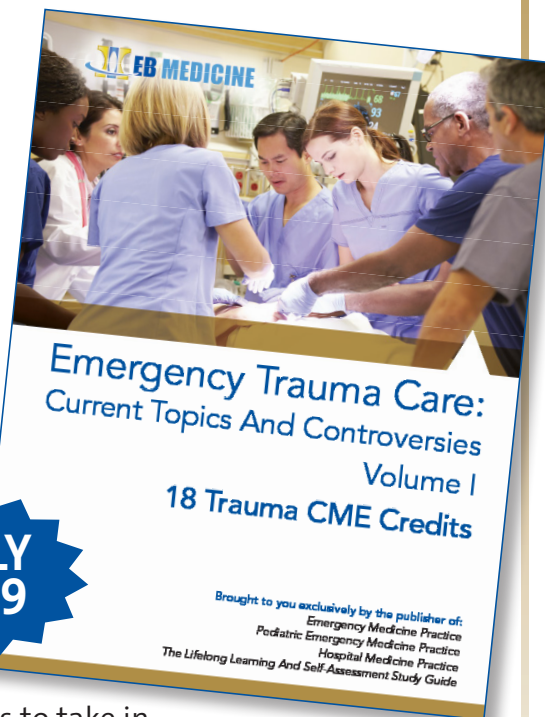
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Date of Original Release: November 1, 2015. Date of most recent review: October 10, 2015. Termination date: November 1, 2018.

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