

Chapter 11

Ophthalmology

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The visual sensory system of a child less than 8–10 years old is developing and can be irreversibly damaged by a variety of conditions if they are not detected and treated early. In the US military, general ophthalmologists on active duty provide most pediatric eye care in many locations. At some facilities, optometrists may also provide nonsurgical refractive care and evaluate the eye health of pediatric patients, subsequently referring cases with more serious conditions to an ophthalmologist. Both general ophthalmologists and optometrists refer more complicated pediatric eye patients to subspecialty trained pediatric ophthalmologists, who, in the US Army, Air Force, and Navy, are generally located at larger facilities, such as regional medical centers and facilities with ophthalmology teaching programs. All facilities that have ophthalmology residency programs in the military have one or more pediatric ophthalmologists on staff.

- The pediatric eye examination
 - History
 - ▶ Obtain a history of the present condition
 - ▶ Gather information about birth history
 - ▷ Prematurity may be associated with retinopathy of prematurity (ROP), intraventricular hemorrhage with secondary hydrocephalus, and ventriculoperitoneal shunts; a failing shunt may be responsible for abducens palsy ("sun-setting eyes") or papilledema
 - ▷ Forceps delivery is associated with corneal clouding (edema of the cornea from Descemet's membrane tears)

- ▶ Shoulder dystocia, difficult delivery, and neck traction may be associated with Horner's syndrome (ptosis, miosis, anhidrosis). Anisocoria is worse in the dark and there is mild ipsilateral ptosis
- ▶ General medical history should include family history (especially of strabismus and heritable eye and systemic conditions) and surgical history (ie, prior eye surgery)
- Examination
 - ▶ Observe general appearance
 - ▶ Note head position
 - ▶ Observe for head tilts, face turns, and chin-up or chin-down posture
 - ▶ A goniometer is useful for quantifying abnormal head positions
 - ▶ Check facial symmetry (look for gross abnormalities and size or shape disparities)
 - ▶ Determine visual acuity (one of the vital signs of eye health); visual acuity evaluation and documentation is age dependent (Table 11-1)

Table 11-1. Normal Visual Acuity by Age

Age (years)	Vision
3-4	20/30
5	20/25
6-12	20/20
12-18	20/15

- ▶ Premature infants and neonates (up to 2 mo old) should blink in response to a bright penlight
- ▶ Infants (2-6 mo old) should fixate on and follow a target
- ▶ In infants and toddlers (6 mo-2½ y old), vision should be central (eye appears properly aligned with target), steady (no nystagmus or searching movements), and maintained (eye can hold fixation for at least a few seconds when the other eye is covered and then uncovered; this is especially useful in the presence of strabismus)

- ▷ Preschool (2½–5 y old) should be able to see pictograms at 20/20 (feet) or 6/6 (meters)
- ▷ Children of school age and older should be able to see an alphabet at 20/20 (feet) or 6/6 (meters)
- ▶ Intraocular pressure (IOP; the other vital sign of eye health) is always measured indirectly (through the cornea or through the lids and cornea). IOP checks may be obtained while a child is sedated or at the onset of general anesthesia
 - ▷ Digital (finger) method: eyes are palpated through the closed lids; annotated as normal finger tension; this method is acceptable for the majority of patients
 - ▷ Instrument method: measured through the cornea. This method is more accurate, but more frightening to the patient; reserved for older children or for those in whom increased IOP is suspected
- ▶ Binocularity is a special vital sign of pediatric eye health. Binocular vision occurs in the cerebral cortex and involves integrating the sensory input from each eye to produce a single three-dimensional image
 - ▷ Stereo vision testing (often called “depth perception” testing) is commonly used to check binocularity
 - ▷ The Titmus (Titmus Optical Inc, Chester, VA) and Randot (Stereo Optical Company, Inc, Chicago, IL) stereoacuity tests use polarized glasses and slightly horizontally dissimilar photographs to create a three-dimensional illusion to detect the highest level of binocularity; these can be used on children as young as 2 years old
 - ▷ With the Worth 4 Dot Test (Richmond Products, Inc, Albuquerque, NM), glasses with red and green lenses are used to view red and green lights in an otherwise dark room; this test detects a lesser level of binocularity and is used on children around 5 years old and older
 - ▷ A base-out prism test calls for a low-power, clear prism (4–8 prism diopter power) to be brought over one eye, oriented apex toward the nose. The presence or absence of a corresponding fusional convergence

movement is noted. This test can be used on children as young as 6 months old

- ▶ Extraocular motility
 - ▷ Follow movement in lateral, medial, upward, downward, and diagonal directions of gaze. The examiner will need an assortment of fixation targets (eg, toys) to maintain the child's interest
 - ▷ Observe for over- or under-muscle action, baseline or induced nystagmus, or strabismus
- ▶ Examine pupils. Check size, shape, and location of the pupils, as well as direct and consensual response to light
 - ▷ Results are more reliable if the child's attention is diverted toward a distant target and away from the examiner's light source
 - ▷ A finding of afferent pupillary defect requires further evaluation, especially of the optic nerve. Magnetic resonance imaging (preferred) or a computed tomography (CT) scan may be indicated
- ▶ The examination for muscle balance is performed in primary position (face straight) at a distance and then near (14–16 inches), followed by other gaze positions as indicated (right, left, up, down, right tilt, and left tilt)
 - ▷ Cover–uncover test: one eye is covered by an occluder while the examiner observes the other eye; if movement is detected, strabismus is manifest
 - ▷ Alternate cover test: an occluder is moved back and forth from one eye to the other; movement represents latent or manifest strabismus
 - ▷ Simultaneous prism cover test: an occluder is placed over the fixing (“straight”) eye while a correcting prism is placed over the nonfixing eye
 - ▷ Deviations in magnitude are measured with calibrated prisms. The endpoint is no movement on the alternate cover test or simultaneous prism cover test
- ▶ External examination
 - ▷ Check lid position (observe for unilateral or bilateral ptosis)
 - ▷ Epicanthal folds are frequently associated with pseudoesotropia

- ▷ Increased tear lake, mucoid discharge, and epiphora may be signs of nasolacrimal duct obstruction
- ▷ Look for lid masses and lesions (eg, dermoids, molluscum lesions)
- ▷ Note telecanthus (increased distance between medial canthi)
- ▷ Check for hypertelorism (increased distance between orbits; associated with midface abnormalities)
- ▷ Examine the anterior segment (cornea, conjunctiva, anterior chamber, and iris)
- ▶ Cycloplegic refraction is the most accurate method of determining a refractive state of the eye
 - ▷ Autorefractometry is often unreliable in children; use only in adolescents
 - ▷ Manifest refraction (using phoropter) is unreliable in young children; it is easy to overestimate the power required (“over minus”); however, manual cycloplegic refraction with free-held lenses or devices (skioscopy bars) is helpful
- ▶ Perform a retinoscopy (if the retinoscopic reflex is obscured, the visual axis is likely affected enough to produce amblyopia)
- ▶ A dilated fundus examination is best performed with an indirect ophthalmoscope set on the dim light setting
 - ▷ A posterior central fundus view is usually all that is required
 - ▷ The standard eight views of the periphery per eye is rarely indicated or tolerated by most younger children; evaluation under anesthesia or sedation may be required for periphery views
- Pediatric ophthalmic disease diagnosis and treatment
 - Nonstrabismic conditions
 - ▶ Orbital dermoid cyst
 - ▷ Most commonly located along the superior–temporal orbital rim; occasionally attached by a narrow transosseous isthmus to an intraorbital component
 - ▷ Slowly enlarges; may internally rupture and produce intense regional inflammation after minor local trauma

- ▶ Surgical removal is indicated after CT scan to rule out intraorbital portion
- ▶ Ptosis
 - ▶ Eyelid droop (usually unilateral). Urgent treatment is needed if the visual axis is obscured. Less urgent correction is indicated for chin-up head position (when children maintain a chin-up position, they are attempting to use the ptotic eye; when the lid droop is such that the child is not even trying to use the ptotic eye, the visual axis is usually blocked in that eye by the lid)
 - ▶ The most common form of ptosis includes poor levator muscle function (upper lid movement is limited), manifested by reversal of ptosis on down-gaze. Treat with a frontalis sling
 - ▶ If levator function is adequate (ie, upper lid has good movement), treat with levator resection
- ▶ Prominent epicanthal folds (skin fold over medial canthus gives the illusion of small-angle esotropia or crossed eyes); this is a normal variant and no treatment is needed
- ▶ Blepharitis (erythema of the lid margin)
 - ▶ Patient may have lash loss and scaling skin debris
 - ▶ Common in those with trisomy 21
 - ▶ May be a sign of immunologic deficiency in severe or chronic cases
 - ▶ Can be treated with proper lid hygiene and a mild topical antibiotic ointment before sleep
- ▶ Nasolacrimal duct obstruction
 - ▶ Common in neonates and infants
 - ▶ Usually unilateral, manifests as chronic mucopurulent discharge with excess tearing (epiphora)
 - ▶ May be mistaken for chronic or recurrent conjunctivitis; symptoms often improve while on antibiotic drops or ointment, only to recur when the medication is discontinued
 - ▶ Most cases resolve by 1 year of age
 - ▶ Massaging the nasolacrimal sac may assist resolution

- ▷ Nasolacrimal duct probing and irrigation is indicated for those cases persisting at 1 year old; if probing fails to resolve symptoms, temporary silicone-tube stenting may be required (see Figure 11-1)
- ▶ Conjunctivitis
 - ▷ Usually viral and self-limited
 - Acute purulent conjunctivitis is characterized by hyperemia, edema, mucopurulent exudates and ocular discomfort. The most frequent organisms are staphylococci, pneumococci, *Haemophilus influenzae*, and streptococci. Gram stain and culture are used to identify the specific organism, and infections usually respond to warm compresses and frequent instillation of topical antibiotic drops
 - Viral conjunctivitis is usually associated with adenovirus and manifested by a watery (as opposed to purulent) discharge. Usually self-limited, Gram stain and bacterial cultures are negative, and treatment with topical sulfonamides is sufficient
 - Chemical conjunctivitis may occur after prophylactic instillation of silver nitrate (1%), erythromycin ophthalmic ointment (0.5%), or azithromycin ophthalmic solution (1%) 12–24 hours after birth. No pathogens are identified and no treatment is necessary
 - ▷ Most cases are treated by the patient's primary physician, but severe, chronic, recurrent, or unusual cases are often referred to an ophthalmologist
 - ▷ Treat raised umbilicated lid lesions (molluscum contagiosum) by scraping
 - ▷ Recurrent and associated with epiphora; if it always occurs on the same side, suspect nasolacrimal duct obstruction and arrange for probing and irrigation. If probing fails to give long-term symptom relief, patient may need a stent
 - ▷ Epidemic keratoconjunctivitis: small, scattered, superficial corneal infiltrates that are self-limited

a



b



Figure 11-1. (a) “00” Bowman probe introduction into right superior puncta and canaliculus. (b) Medial and superior rotation of probe, then inferior advancement of probe to hard palate. (**Figure 11-1 continues**)

c



d



Figure 11-1 continued. (c) Replacement of probe with a long, 23-gauge, blunt-tip canula, then, irrigation of a very small amount (< 1 cc or mL) of fluorescein-stained normal saline. (d) Recovery of fluorescein from ipsilateral nares with 8 Fr suction catheter confirms open nasolacrimal duct. Avoid airway compromise from excessive irrigation.

(may take 6–10 wk). Treat with supportive care and mild topical antibiotic ointment before sleep to prevent bacterial superinfection

- ▶ Ophthalmia neonatorum (Figure 11-2) is caused by infection due to *Neisseria gonorrhoeae* or *Chlamydia trachomatis* acquired by passage through the infected genital tract. There is profuse discharge, marked eyelid edema, and conjunctival hyperemia. If untreated, GC infection can lead to corneal perforation and blindness. Gram stain demonstrates Gram negative diplococci in GC infections, and intracytoplasmic inclusion bodies in *Chlamydia*. Both types of infections require systemic and topical antibiotics.
- ▶ Periorbital cellulitis refers to inflammation of the lids and periorbital tissues without involvement of the orbit



Figure 11-2. This was a newborn with *gonococcal ophthalmia neonatorum* caused by a maternally transmitted gonococcal infection. Unless preventative measures are taken, it is estimated that gonococcal ophthalmia neonatorum will develop in 28% of infants born to women with gonorrhea. It affects the corneal epithelium causing microbial keratitis, ulceration, and perforation.

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itself and may be associated with trauma, wound, or abscess of the lid or periorbital region. *Staphylococcus* and *Streptococcus* species are the most common organisms, and prompt treatment with systemic antibiotics is indicated to prevent development of an orbital abscess, cavernous sinus thrombosis, or meningitis.

- ▶ Anterior uveitis (iritis)
 - ▷ Uncommon in children; usually follows blunt ocular trauma
 - ▷ Symptoms may be photophobia and conjunctival injection (redness)
 - ▷ Associated with juvenile idiopathic arthritis
 - May be painless in these patients; perform a baseline examination and periodic screening on all patients
 - Treat with topical antiinflammatory steroids; systemic immune suppressive agents may also be required
 - ▷ Associated with sarcoidosis, especially in older children, children of African descent, and those with a positive family history
 - Treat sarcoidosis with intensive topical anti-inflammatory steroids, followed by a tapered dose
 - Patients may require higher doses of oral steroids for a time; severe cases may require long-term topical or oral steroids to prevent rebound inflammation
- ▶ Leukocoria (white pupil)
 - ▷ Retinoblastoma is a life-threatening malignancy that must be ruled out first in all leukocoria cases
 - May be bilateral
 - May be familial
 - CT scan shows intralesional calcification
 - ▷ A cataract is a lens opacity and is visually significant if the visual axis is blocked
 - May be unilateral or bilateral; all bilateral cases require evaluation for infectious, genetic, and metabolic causes
 - Congenital cataracts are present at birth; urgent

removal is indicated. If left untreated by 6–8 weeks of age, irreversible nystagmus and amblyopia may occur. Congenital cataracts are highly associated with subsequent glaucoma

- Infantile cataracts are present within the first year of life; urgent removal is indicated, but there is a lower association with glaucoma
- Acquired cataracts may be associated with trauma, steroid use, or less-common lens defects (posterior lentiglobus or lenticonus; Figure 11-3)
- Amblyopia management is required for many years after cataract removal (until age 8). Unilateral aphakia (absent lens) makes amblyopia more difficult to manage. Patching the better eye for 4–6 hours a day forces vision development in the aphakic eye, and refractive treatment with special aphakic lenses is preferred over unilateral aphakic glasses for better binocularity development. Bilateral aphakia makes amblyopia management less difficult. Aphakic contact lenses or aphakic glasses may be used. Patching is only needed if a disparity in visual acuity is noted



Figure 11-3. Acute traumatic cataract left eye.

- Following cataract removal, up to a third of all eyes may develop glaucoma by adulthood
- Pediatric cataracts are best managed by those experienced in their evaluation and treatment
- ▷ Toxocara granuloma (from dog hookworm larvae) is an ocular form of visceral larva migrans characterized by severe local granulomatous inflammation to dead worm larvae
- ▶ Retinal disorders
 - ▷ ROP: abnormal blood vessel growth with a risk of tractional retinal detachment
 - Associated with prematurity (24–28 wk) and birth weight less than 1,300 g
 - These patients are screened while in the neonatal intensive care unit, and screening is continued until the ROP resolves or the treatment threshold is met
 - Treatment consists of laser photocoagulation of the peripheral avascular retina. Evaluation and treatment of ROP during the acute phases should be performed by ophthalmologists experienced in dealing with this condition
 - Long-term periodic follow-up is required to screen for early onset myopia
 - ▷ Nonaccidental trauma or shaken baby syndrome may cause multiple intraretinal and preretinal hemorrhages in the macula, extending to the mid periphery
 - When intraretinal hemorrhages are present, there is often also neurological depression, which may be life threatening
 - Screening examinations are usually requested by the pediatrics service associated with infants or toddlers presenting with injuries inconsistent with their history or with multiple injuries of various chronology
 - Social services and law enforcement officials are required to be notified in all suspected nonaccidental trauma cases. Photo documentation of the retinal findings is becoming the medical–

- legal standard for prosecuting the responsible individuals (though this is not usually available in a deployed environment)
- ▶ Optic nerve abnormalities
 - ▷ A large cup-to-disc ratio is an indicator of possible glaucoma in adults, but the majority of pediatric patients with large cup-to-disc ratios do not have glaucoma. Check the patient's IOP and central corneal thickness (pachymetry), then follow with baseline photos and ocular coherence tomography
 - ▷ Papilledema is a sign of increased intracranial pressure characterized by a blurred disc margin, elevated disc, obscuration of vessels, and hemorrhages. It may indicate an intracranial tumor. An immediate CT scan of the brain is indicated, and neurological or neurosurgical evaluation is required
 - ▷ Optic nerve coloboma (incomplete closure of embryologic fetal fissure) presents an increased lifetime risk of retinal detachment. Patients with this disorder may also have chorioretinal coloboma at the inferior nasal location. It may be associated with systemic abnormalities or syndromes and requires periodic observation and surgery for retinal detachment (as needed)
 - ▶ Refractive error
 - ▷ Treat a high refractive error (like one of the following) with eyeglasses to prevent or treat amblyopia
 - Symmetric astigmatism > 3 diopters
 - Myopia > 7 diopters
 - Hyperopia > 6 diopters
 - ▷ Anisometropia > 1.50 diopters difference requires refractive treatment
 - ▷ Mild to moderate levels of myopia do not need treatment; however, school-aged children with this level of myopia will need to wear eyeglasses for good distance vision. Encourage children to remove their glasses for prolonged near tasks
 - ▷ Mild to moderate levels of hyperopia do not require

- treatment unless there is intermittent esotropia (see strabismus section below); however, school-aged children with mild to moderate hyperopia may need glasses for prolonged near work
- Strabismus is defined as an eye misalignment of any type and is the most common reason for pediatric eye surgery
 - ▶ Comitant strabismus is an ocular misalignment in which there is a similar quantitative deviation in all directions of gaze
 - ▶ Congenital esotropia is the most common strabismus. There is usually a large angle of deviation, but not amblyopia because of cross-fixation (spontaneous alternation of eyes). Treat with strabismus surgery (bilateral medial rectus recessions) around 5–7 months of age, if possible
 - ▶ Accommodative esotropia is associated with hyperopia
 - ▷ Onset is around 1½–4 years of age and is usually initially intermittent
 - ▷ Child may have greater esodeviation on near sight and a high ratio of accommodative convergence to accommodation
 - ▷ Patient may develop amblyopia quickly in the nondominant (esodeviating) eye
 - ▷ Treat with “plus power” eyeglasses; initially give less than full cycloplegic refraction, but if esodeviation is not corrected, full cycloplegic refraction may need to be prescribed
 - ▷ Patients with a high ratio of accommodative convergence to accommodation require bifocals; the bifocal segment must be 1 mm below the visual axis. Surgery is reserved for patients with residual esodeviations while in full cycloplegic refraction. Use bilateral medial rectus recessions (preferred) or unilateral medial rectus recession and lateral rectus resection (recess-resect procedure)
 - ▶ Intermittent exotropia often manifests when an individual is inattentive, fatigued, or has taken substances that decrease state of alertness

- ▷ Highly variable age of onset
- ▷ Individuals typically have excellent control of ocular alignment at near distances, only exhibiting exophoria
- ▷ Vision is usually normal in each eye
- ▷ Stereopsis is usually normal
- ▷ Up to a third of patients may improve with accommodative exercises, and daily alternate-eye patching may improve some cases
- ▷ Patients not responding to the above measures may be treated with strabismus surgery (bilateral lateral rectus recessions)
- ▶ Consecutive strabismus is a deviation that occurs months to years after strabismus surgery, usually in the opposite direction of the initial surgery (typically exotropia after surgery for esotropia). Treat with bilateral recessions of the lateral rectus muscles (for exotropia) or medial rectus muscles (for esotropia)
- ▶ Noncomitant strabismus is a condition in which ocular misalignment varies according to the direction of the patient's gaze
- ▶ Superior oblique, or trochlear, palsy (cranial nerve 6 palsy) usually presents with a head tilt away from the affected side. Longstanding cases often present with intermittent diplopia (rare in children). The patient may have facial asymmetry with contralateral facial hypoplasia. Treat with strabismus surgery. The most common procedure is to weaken the ipsilateral inferior oblique muscle either by recession or myectomy; the next most common is a tuck (shortening) of the affected superior oblique tendon
- Other conditions associated with strabismus
 - ▶ Duane syndrome
 - ▶ Brown's syndrome
 - ▶ Monocular elevation deficiency
- Ocular manifestations of systemic disease
 - ▶ Aniridia: Wilms tumor
 - ▶ Blue sclera: osteogenesis imperfecta
 - ▶ Kayser-Fleischer corneal ring: Wilson disease

- ▶ Congenital cataracts: intrauterine infection
- ▶ Leukocoria (white reflex in the pupil): retinoblastoma
- ▶ Retinal hemorrhages with white centers (Roth spots): subacute bacterial endocarditis
- ▶ Chorioretinitis: toxoplasmosis, histoplasmosis, cytomegalovirus, tuberculosis, syphilis

Eye Injuries

- General guidance for pediatric eye injuries
 - The examiner must have high index of suspicion; patients may not self-report because they are too young or fear reprisal for having participated in unapproved behavior that resulted in the injury. These injuries are not frequently witnessed by adults and may only be suspected after a delay
 - Physical symptoms
 - ▶ Reluctance to open an eye
 - ▶ Reported or observed redness of an eye
 - ▶ Photophobia
 - ▶ Excessive tear production
 - ▶ Pain
 - Vision examination
 - ▶ Carefully measure vision (patient's reaction to light, distance at which patient can count fingers, etc)
 - ▶ Use any printed material (books, medication labels, etc) if a vision-screening card is not available
 - ▶ Compare sight in the injured eye to that in the uninjured eye
 - ▶ Severe vision loss is a strong indicator of serious injury
 - ▶ If there is a lid laceration, suspect and carefully check for signs of possible underlying globe laceration; examine the eyes prior to lid repair
- Ruptures and lacerations (open globe)
 - These may result from penetrating or blunt eye trauma and may cause vision loss from either disruption of ocular structures or secondary infection (endophthalmitis)
 - Signs
 - ▶ Hemorrhagic chemosis (elevation of the conjunctiva from the sclera by dense bleeding)

- ▶ Hyphema (blood in the anterior chamber); if complete, an “eight ball” hyphema is present (may also be present in severe blunt trauma)
- ▶ Disrupted anterior chamber architecture
 - ▷ Irregular or teardrop pupil shape (peaked pupil)
 - ▷ Dark iris or uveal tissue protruding through cornea
- ▶ If there are signs of fragmentation injury (by either primary or secondary missiles) to the head, neck, or face, intraocular foreign bodies may be present
- ▶ Proptosis may indicate a retrobulbar hemorrhage; urgent lateral canthotomy and cantholysis may be indicated
- ▶ Decreased motility of one eye may be a sign of an open globe; other causes of limited motility include muscle injury, orbital fracture, and orbital hemorrhage
- Initial treatment of an open globe injury: in a casualty with severe vision loss, biplanar radiographs or a CT scan of the head may help identify a metallic intraocular fragment, a traumatic hyphema, a large subconjunctival hemorrhage, or other signs of an open globe injury with an intraocular foreign body
- Immediate treatment of an open globe injury
 - ▶ Tape a rigid eye shield (**not** a pressure patch) over the eye
 - ▶ Do not apply pressure to or manipulate the eye
 - ▶ Do not apply any topical medications
 - ▶ Start quinolone antibiotic (oral or intravenous [IV]; dose for patient weight)
 - ▶ Schedule an urgent (within 12–24 h) referral to an ophthalmologist
 - ▶ Administer tetanus toxoid, if indicated
 - ▶ Use antiemetics (dose for patient weight)
 - ▶ Patient can expect surgical exploration and globe repair under general anesthesia by the initial ophthalmologist; further procedures may be required later
- Subconjunctival hemorrhage (SCH)
 - Small SCHs may occur spontaneously or in association with blunt trauma; these lesions require no treatment and resolve in days to weeks

- SCH may also occur in association with a rupture of the underlying sclera
- Warning signs for an open globe include a large SCH with chemosis (conjunctiva bulging away from globe) in the setting of blunt trauma, or any SCH in the setting of penetrating injury. Casualties with blast injury and normal vision do not require special immediate ophthalmologic care, but should get a complete ophthalmic examination at the earliest opportunity. Suspected open globe patients should be treated as described above (see Ruptures and lacerations)
- Chemical injuries of the cornea
 - Initiate immediate copious irrigation (maintain for 30 min) with normal saline, lactated Ringer's, or balanced salt solution (nonsterile water may be used if it is the only liquid available); use topical anesthesia before irrigating, if available
 - Measure tear pH to ensure that irrigation continues until the pH returns to normal (7.35–7.45); **Do not use** alkaline solutions to neutralize acidity (or vice versa)
 - Remove any retained particles
 - Using fluorescein strips or drops, examine for epithelial defects
 - ▶ If none are found, treat mild chemical injuries or foreign bodies with artificial tears
 - ▶ If an epithelial defect is present, use a broad-spectrum antibiotic ophthalmic ointment (bacitracin / polymyxin, erythromycin, or bacitracin) 3–4 times per day (same dosing as for adults)
 - Apply a pressure patch between drops of ointment if a large epithelial defect is present
 - Monitor (via daily topical fluorescein evaluation) for a corneal epithelial defect until epithelial healing is complete (as determined by a negative fluorescein evaluation)
 - Noncaustic chemical injuries usually resolve without sequelae
 - Severe acid or alkali injuries of the eye (recognized by pronounced chemosis, limbal blanching, or corneal opacification) can lead to infection of the cornea,

glaucoma, and possible loss of the eye. Refer patient to an ophthalmologist within 24–48 hours. These more severe chemical injuries may also require treatment with prednisolone 1% drops 4–9 times per day, and scopolamine 0.25% drops 2–4 times per day (these should only be started on the direction of an ophthalmologist)

- Corneal abrasions
 - Be alert for the possibility of an associated open globe injury
 - The eye is usually symptomatic with pain, tearing, and photophobia; vision may be diminished from the abrasion itself or from the profuse tearing
 - Diagnose with topical fluorescein and cobalt blue light or Wood's lamp (if available)
 - A topical anesthetic may be used for diagnosis, but should **not** be used as an ongoing analgesic agent (this delays healing and may cause other severe complications)
 - Apply broad-spectrum antibiotic ointment (polymixin B, erythromycin, or bacitracin) 4 times a day
 - Pain relief options include:
 - ▶ Pressure patch (usually sufficient for most abrasions)
 - ▶ Diclofenac 0.1% drops 4 times a day
 - ▶ Larger abrasions may require a short-acting cycloplegic agent (1% tropicamide or 1% cyclopentolate) and a pressure patch
 - ▶ More severe discomfort can be treated with 0.25% scopolamine (1 drop bid), but this will result in pupil dilation and blurred vision for 5–6 days
 - Small abrasions usually heal well in 1–4 days without patching; if the eye is not patched, antibiotic drops (fluoroquinolone or aminoglycoside) may be used 4 times a day in lieu of ointment. Sunglasses are helpful in reducing photophobia
 - All corneal abrasions need to be checked once a day until healing is complete to ensure the abrasion has not been complicated by secondary infection (eg, corneal ulcer, bacterial keratitis)
- Thermal burns of the cornea are initially treated in the same manner as corneal abrasions

- Laser-induced injuries usually involve the retina, which is the tissue most vulnerable. Degree of injury will depend on the duration of exposure and amount of energy delivered. A reduction in visual acuity, tearing and pain are the main symptoms of laser injury. Nonpenetrating corneal injuries (anterior segment) should be treated as for corneal abrasions. Injury involving the posterior segment should be referred to an ophthalmologist as soon as possible
- Corneal ulcer and bacterial keratitis
 - Corneal ulcer and bacteria keratitis are serious conditions that may cause vision or eye loss
 - These conditions are associated with soft-contact lens wear, especially if contacts are not taken out prior to sleep
 - Symptoms include increasing pain and redness, decreasing vision, persistent or increasing epithelial defect (positive fluorescein test), and a white or gray spot on the cornea (seen on examination with penlight or direct ophthalmoscope)
 - Treatment includes quinolone drops (1 drop every 5 min for 5 doses initially, then 1 drop every 30 min for 6 h, then 1 drop hourly thereafter)
 - ▶ Scopolamine 0.25% (1 drop bid) may help relieve discomfort caused by pupillary spasm; patching and use of topical anesthetics for pain control are contraindicated
 - ▶ Expedite referral to an ophthalmologist (within 1–2 days)
- Conjunctival and corneal foreign bodies
 - These present with abrupt onset of discomfort or history of suspected foreign body
 - If an open globe injury is suspected, treat as discussed above
 - Definitive diagnosis requires visualization of the offending object, which may be difficult; a hand-held magnifying lens or pair of reading glasses will help
 - ▶ Stain the eye with fluorescein to check for a corneal abrasion
 - ▶ The patient may be able to indicate the perceived location of the foreign body prior to instillation of topical anesthesia

- ▶ Eyelid eversion with a cotton-tipped applicator helps the examiner identify foreign bodies located on the upper tarsal plate
- Treatment
 - ▶ Superficial conjunctival or corneal foreign bodies may be irrigated away or removed with a moistened sterile swab under topical anesthesia
 - ▶ Objects adhering to the cornea may be removed with a spud or the edge of a sterile 22-gauge hypodermic needle mounted on a tuberculin syringe (hold the needle tangential to the eye)
 - ▶ If no foreign body is visualized but the index of suspicion is high, the foreign body may be removed by vigorous irrigation with artificial tears or sweeps of the conjunctival fornices with a moistened, cotton-tipped applicator (after applying topical anesthesia)
 - ▶ If an epithelial defect is present after the foreign body is removed, treat as a corneal abrasion (see page 112)
- Hyphema (blood in the anterior chamber)
 - Treat to prevent vision loss from increased intraocular pressure or corneal blood-staining
 - Suspect a possible open globe and treat appropriately
 - A major goal of management is to avoid rebleeding
 - ▶ Avoid aspirin and nonsteroidal antiinflammatory drugs
 - ▶ Limit activity (require bed rest, with the patient only getting up to use the bathroom) for 7–10 days
 - Administer prednisolone 1% drops 4 times a day, and scopolamine 0.25% drops twice daily
 - Cover the eye with a protective shield
 - Elevate the head of the bed to promote settling of red blood cells in the anterior chamber (Figure 11-4)
 - Patient should be seen by an ophthalmologist within 24–48 hours to monitor for increased intraocular pressure (which may cause permanent injury to the optic nerve or corneal blood-staining and secondary deprivation amblyopia) and to evaluate for associated eye injuries. If evaluation by an ophthalmologist is delayed (> 24 h), treat with a topical β -blocker (timolol or levobunolol) twice a day

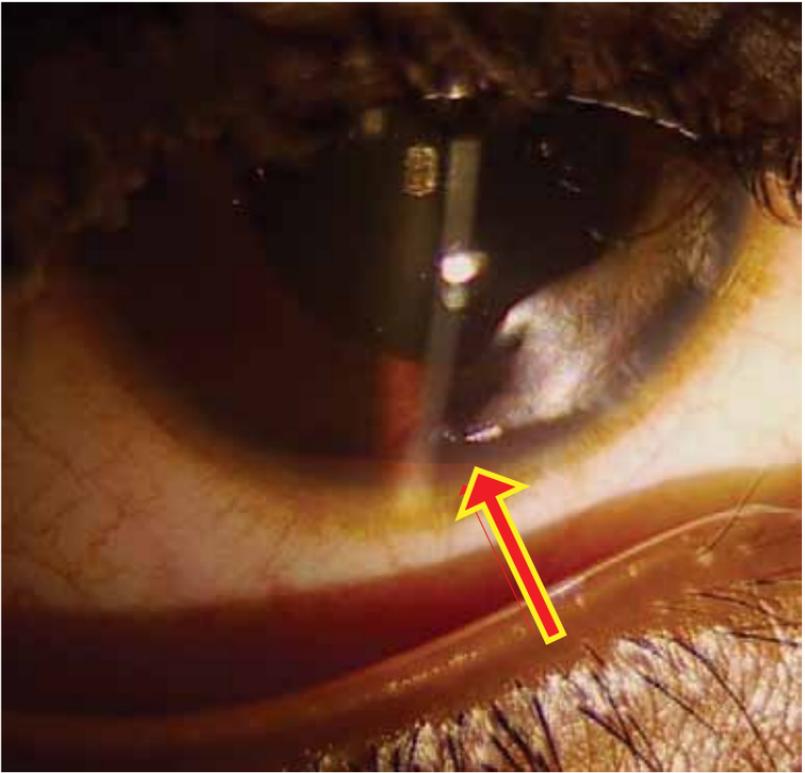


Figure 11-4. Blood aqueous level (arrow) indicates 5% hyphema.

- to help prevent intraocular pressure elevation
- If intraocular pressure is found to be markedly elevated (above 30 mmHg) with a portable tonometry device, other options for lowering intraocular pressure include administering acetazolamide (oral or IV) or mannitol (IV), dosed for the patient's weight
- Retrobulbar (orbital) hemorrhage
 - Symptoms include severe eye pain, proptosis, vision loss, and decreased eye movement
 - Marked lid edema may make the proptosis difficult to recognize
 - Failure to recognize may result in blindness from increased ocular pressure
 - Treatment

- ▶ Perform an immediate lateral canthotomy and inferior cantholysis
- ▶ Provide an urgent referral to an ophthalmologist (within 6–12 h)
 - ▷ If evaluation by an ophthalmologist is delayed (> 24 h), treat with a topical β -blocker (timolol) twice a day to help lower intraocular pressure elevation
 - ▷ If intraocular pressure is found to be elevated (> 30 mmHg), follow first two steps under Treatment (see page 114)
- ▶ Lateral canthotomy and cantholysis
 - ▷ Do not perform these procedures if the eyeball structure has been violated; if the globe is open, apply a Fox shield for protection and seek immediate ophthalmic surgical support
 - ▷ Inject 2% lidocaine with 1:100,000 epinephrine into the lateral canthus
 - ▷ Crush the lateral canthus with a straight hemostat, advancing the jaws to the lateral fornix
 - ▷ Using straight scissors make a 1-cm long horizontal incision of the lateral canthal tendon, in the middle of the crush mark
 - ▷ Grasp the lower eyelid with large, toothed forceps, pulling the eyelid away from the face; this pulls the inferior crus (band of the lateral canthal tendon) tight so it can be easily cut loose from the orbital rim
 - ▷ Use blunt-tipped scissors to cut the inferior crus; keep the scissors parallel (flat) to the face with the tips pointing toward the chin
 - ▷ Place the inner blade just anterior to the conjunctiva, and the outer blade just deep to the skin; the eyelid should pull freely away from the face, releasing pressure on the globe
 - ▷ Cut residual lateral attachments of the lower eyelid if it does not move freely (cutting $\frac{1}{2}$ cm of conjunctiva or skin is not cause for alarm)
 - ▷ Once the lower eyelid is cut, relieving orbital pressure, if the intact cornea is exposed, apply copious erythromycin ophthalmic ointment or ophthalmic lubricant ointment hourly to prevent devastating

corneal desiccation and infection. Orbital pressure relief must be followed by lubricating protection of the cornea and urgent ophthalmic surgical support.

Do not apply absorbent gauze dressings to the exposed cornea

- Orbital floor (blowout) fractures
 - These fractures are usually the result of a blunt injury to the globe or orbital rim and may be associated with head and spine injuries
 - Blowout fractures may be suspected on the basis of enophthalmos, diplopia, decreased ocular motility, hypoesthesia of the V2 branch of the trigeminal nerve, associated subconjunctival hemorrhage, or hyphema
 - Immediate treatment includes administering broad-spectrum antibiotics for 7 days, applying ice packs, and instructing the casualty to avoid nose blowing
 - Definitive diagnosis requires a CT scan of the orbits with axial and coronal views
 - Indications for repair include severe enophthalmos and diplopia in the primary or reading-gaze positions. The surgery may be performed 1–2 weeks after the injury, but may have greater success in children if it is performed as soon as possible in trapdoor-style blowout fractures
 - Patients with an orbital floor (blow-out) fracture often have a limited (restricted) up gaze on the affected side and may also have a restricted down gaze on the affected side. Early surgical intervention may be indicated, especially if there is a trapdoor fracture that results in entrapment of the inferior rectus on the affected side. Strabismus surgery is reserved for patients with diplopia in the primary gaze (straight ahead) or in the reading position (moderate down gaze)
- Lid lacerations
 - Treatment for lid lacerations not involving the lid margin
 - ▶ Delayed primary closure is not necessary when there is adequate blood supply
 - ▶ Eyelid function (protecting the globe) is the primary consideration
 - ▶ Begin with irrigation and antisepsis (using any topical solution), and check for retained foreign bodies
 - ▶ Superficial lacerations of the eyelid that do not involve

- ▶ the eyelid margin may be closed with running or interrupted 6-0 silk (preferred) or nylon sutures
- ▶ Horizontal lacerations should include the orbicularis muscle and skin in the repair
- ▶ If skin is missing, an advancement flap may be created to fill in the defect. For vertical or stellate lacerations, use traction sutures in the eyelid margin for 7–10 days
- ▶ Apply antibiotic ointments 4 times a day until sutures are removed
- ▶ Skin sutures may be removed in 5 days
- Treatment guidelines for lid lacerations involving the lid margin
 - ▶ Tissue loss greater than 25% will require a flap or graft
 - ▶ When repairing a marginal lower-eyelid laceration with less than 25% tissue loss, the irregular laceration edges may be freshened by creating a pentagonal wedge. Remove as little tissue as possible
 - ▶ Place a 4-0 silk or nylon suture in the eyelid margin (through the meibomian gland orifices, 2 mm from the wound edges and 2 mm deep) and tie it in a slipknot; symmetric suture placement is critical to obtaining post-operative eyelid margin alignment
 - ▶ Loosen the slipknot and place two or three absorbable 5-0 or 6-0 sutures internally to approximate the tarsal plate; the skin and conjunctiva should not be included in this internal closure
 - ▶ Place anterior and posterior marginal sutures (6-0 silk or nylon) in the eyelid margin just in front and behind the previously placed 4-0 suture
 - ▶ Leave the middle and posterior sutures long and tie them under the anterior suture; ensure that the wound edges are everted
 - ▶ Close the skin with 6-0 silk or nylon sutures and place the lid on traction for at least 5 days
 - ▶ Remove the skin sutures at 3–5 days, and the marginal sutures at 10–14 days
 - ▶ If there is orbital fat in the wound or if ptosis is noted in an upper lid laceration, damage to the orbital septum

- and the levator aponeurosis should be suspected
- ▶ If the eyelid is avulsed, the missing tissue should be retrieved, wrapped in a moistened, nonadherent dressing, and preserved on ice. The tissue should be soaked in a dilute antibiotic solution prior to reattachment. If necrosis is present, minimal debridement should occur to prevent further tissue loss. The avulsed tissue should be secured in the anatomically correct position in the manner described for lid margin repair above
 - ▶ Damage to the canalicular system can occur as a result of injuries to the medial aspect of the lid margins
 - ▷ Suspected canalicular injuries should be repaired by an ophthalmologist to prevent subsequent problems with tear drainage
 - ▷ This repair can be delayed for up to 24 hours
 - Enucleation
 - A general surgeon in a forward unit should not remove a traumatized eye unless the globe is completely disorganized. Enucleation should only be considered if the patient has a very severe injury, exhibits no light perception when the provider uses the brightest light source available, and is not able to be evacuated to a facility with an ophthalmologist. Sympathetic ophthalmia is a condition that may result in loss of vision in the uninjured eye if a severely traumatized, blind eye is not removed, but it rarely develops prior to 14 days after an injury; thus, delaying the enucleation until the patient can see an ophthalmologist is relatively safe and advisable

