

# Ocular Blocks and Anesthesia for Ophthalmologic Surgery

Ocular blocks are indicated for provision of surgical anesthesia for ophthalmologic procedures. Anesthetic goals include provision of anesthesia and analgesia as well as akinesia in the surgical field. Benefits of regional techniques over GA for ophthalmologic procedures includes decreased incidence of N+V, rapid return to ambulatory status and hospital discharge, and provision of postoperative analgesia.

## INDICATIONS

- Anesthesia for most general ophthalmologic procedures
- Retrobulbar and Peribulbar blocks provide anesthesia for surgical procedures on the cornea, anterior chamber and lens procedures when combined with blocks of the orbicularis oculi muscle

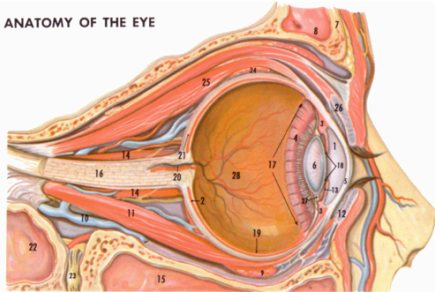
## CONTRAINDICATIONS

- **ABSOLUTE**
  - Patient refusal
  - Allergy to LA solution
  - Increased IOP
- **RELATIVE**
  - Coagulopathy
  - Overlying infection
  - Enucleation of eye
  - Inability for patient to lie still or maintain cardiorespiratory stability intraoperatively (i.e. severe pulmonary disease, cough, etc.)

## ANATOMY

- General Anatomy:
  - Sphere ~ 24 mm in diameter.
  - sits in the pyramidal bony orbit
  - The wall of the globe has three layers—the sclera, the uveal tract, and the retina.
    - The **sclera** is the outermost layer. It is the tough, fibrous “white of the eye.”
    - The transparent cornea is the most anterior part of the sclera. (Most of the focus power of the eye is from the curvature of the cornea)
    - The middle layer, the **uveal tract**, has three structures—the choroid, the iris, and the ciliary body.
      - The choroid is a layer of blood vessels located posteriorly. Bleeding in this layer is one cause of intraoperative expulsive hemorrhage.
      - The pigmented iris controls light entry with muscle fibers that change the size of the pupil. Sympathetic stimulation dilates the pupil by causing iris dilator muscles to contract, whereas parasympathetic stimulation causes miosis, or pupillary constriction, by causing the iris sphincter muscles to contract.
      - The ciliary body lies just behind the iris; it produces aqueous humor. Ciliary muscle fibers adjust the focus by releasing tension on the suspensory fibers, or zonules, of the lens. Opacification of the lens causes a cataract. Uveitis is an inflammatory condition of these structures (iris, choroid, and ciliary body).
    - The innermost eye layer is the **retina**.
      - Light stimulates retinal photoreceptors to produce neural signals that the optic nerve carries to the brain.
      - There are no capillaries in the retina; the choroid layer provides the retina with oxygen.
      - Retinal detachment from the choroid layer compromises the retinal blood supply and is a major cause of vision loss.
      - The retinal layer ends about 4 mm behind the iris.
      - The area between the limbus of the cornea and the retina is called the pars plana. Because there is no retinal layer there, it is a safe entrance site for vitrectomy procedures.
- The center of the eye is filled with vitreous gel. This thick fluid has attachments to blood vessels and the optic nerve. Traction of the vitreous on the retina is a cause of retinal detachment. Scarring, bleeding, or opacification of the vitreous is treated by vitrectomy.
- Extraocular Muscles:
  - The extraocular muscles move the globe within the orbit. They arise from a fibrous ring near the apex of the orbit and insert on the sclera. The six extraocular muscles lie within a cone behind the eye surrounding the optic nerve, ophthalmic artery and vein, and ciliary ganglion.
- The eyelids have an outer layer of skin, a muscle layer, a tarsal plate of cartilage, and a layer of conjunctiva. The conjunctiva is a mucous membrane that lines the inner eyelids and covers the globe up to the corneal-scleral junction.
- The lacrimal gland sits in the superior temporal orbit. It releases tears across the surface of the globe. Tears drain via the puncta near the medial canthus of the eyelids. Tears flow through the canaliculi to the lacrimal sac and duct, to drain into the nasopharynx.

ANATOMY OF THE EYE



- |                      |                            |                             |                              |
|----------------------|----------------------------|-----------------------------|------------------------------|
| 1. Aqueous chamber   | 8. Frontal sinus           | 15. Maxillary sinus         | 22. Sphenoid sinus           |
| 2. Choroid           | 9. Inferior oblique muscle | 16. Optic nerve             | 23. Pterygopalatine ganglion |
| 3. Ciliary muscle    | 10. Inferior orbital vein  | 17. Ora serrata             | 24. Superior oblique muscle  |
| 4. Ciliary processes | 11. Inferior rectus muscle | 18. Pupil of the iris       | 25. Superior rectus muscle   |
| 5. Cornea            | 12. Inferior tarsus        | 19. Retina                  | 26. Superior tarsus          |
| 6. Crystalline lens  | 13. Iris                   | 20. Retinal artery and vein | 27. Suspensory ligament      |
| 7. Frontal bone      | 14. Lateral rectus muscle  | 21. Sclera                  | 28. Vitreous chamber         |

## BLOOD SUPPLY:

- The ophthalmic artery provides most of the blood supply to the orbital structures. It is a branch of the internal carotid artery, very close to the circle of Willis. The superior and inferior ophthalmic veins drain directly into the cavernous sinus.
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## **INNERVATION**

- Cranial nerves innervate the ocular structures. The optic nerve (CN II) carries the neural signals from the retina. The oculomotor (CN III), trochlear (CN IV), and abducens (CN VI) control the extraocular muscles. Touch and pain sensation is carried via the trigeminal nerve (CN V). Sensation to the lower lid is via the maxillary nerve. Sensation to the upper lid is via the frontal branch of the ophthalmic nerve. The nasociliary branch of the ophthalmic nerve sends sensory fibers to medial canthus, lacrimal sac, and ciliary ganglion.
- The ciliary ganglion provides sensory innervation to the cornea, iris, and ciliary body. Parasympathetic fibers originate from the oculomotor nerve (CN III) and synapse in the ciliary ganglion before supplying the iris sphincter muscle. Sympathetic fibers originate from the carotid plexus and travel through the ciliary ganglion to innervate the dilator muscle of the iris. Local anesthetic blockade of the ciliary ganglion produces a fixed, mid-dilated pupil.
- The facial nerve (CN VII) exits the base of the skull from the stylomastoid foramen. It supplies motor innervation to the orbicularis muscle via the zygomatic branch. Local anesthetic **block** of the facial nerve can prevent lid squeezing.

## **TECHNIQUE**

N.B. All these blocks assume full sterile precautions and appropriate monitoring

### **RETROBULBAR BLOCK**

Position:

- patient supine
- looking straight ahead (neutral gaze)

Technique:

- A 3-cm, 23- to 25-gauge blunt Atkinson needle is recommended to protect against ocular perforation.
- The needle is placed at the junction of the inferior and lateral walls of the orbit just above the inferior orbital rim.
- The needle is advanced about 15 mm along the wall of the orbit until it is past the equator of the eye.
- The needle is turned superiorly to aim toward the superior orbit.
- The needle is advanced until it enters between the extraocular muscles
- 2 to 3 mL of anesthetic solution is injected.
- Some intorsion on downgaze is expected because the superior oblique muscle is outside the muscle cone and may not be blocked.

Complications:

- Retrobulbar hemorrhage
- Brainstem anesthesia
- Seizures
- Intravascular injection
- Respiratory arrest (optic nerve sheath continuous with subarachnoid space)

### **PERIBULBAR BLOCK**

Position:

- patient supine
- looking straight ahead (neutral gaze)

Technique:

- A blunt 23-gauge 3cm Atkinson needle is placed at the junction of the middle and lateral thirds of the lower lid just above the inferior orbital rim
- 1 mL of local anesthetic is put just below the orbital septum, 3 mL at the equator, and 2 mL posterior outside the muscle cone
- If no bulging is noted at the superior nasal lid area, a second injection of 2 to 3 mL is administered inferonasally. Many patients require a second injection to achieve complete akinesia and anesthesia
  - For the medial injection, the needle is inserted through the conjunctiva on the nasal side and directed straight back 2.5 cm, parallel to the orbital wall.
  - An additional 5 mL of local anesthetic is injected.
- Disadvantages of the technique include a longer onset time (9 to 12 minutes) and lower incidence of complete akinesia.
- Globe perforation from peribulbar injection has been reported.

**NB:** With both techniques, blockade of the facial nerve fibers that innervate the orbicularis oculi muscle is also performed to complete the anesthesia. Because these blocks may be uncomfortable for the patient, a small dose of a short-acting sedative, such as propofol, just before the injection prevents pain and patient movement.

### **SUBTENON (EPISCLERAL) BLOCK**

- The technique uses a blunt cannula inserted to contact the conjunctiva between the eyeball and the semilunar fold.
- Direct Technique:
  - Under topical anesthesia with sedation, a speculum is placed to retract the lids.
  - A 2- to 3-mm spot of cautery is made 5 mm from the limbus in the inferonasal or inferolateral quadrant.
  - A 2-mm snip is made in the conjunctiva with blunt dissection through Tenon's fascia.
  - A blunt cannula is directed under Tenon's fascia posteriorly, but not beyond the equator of the globe, with injection of 1 to 3 mL of local anesthetic. Some degree of conjunctival edema is often seen. Analgesia is usually excellent.
- Percutaneous Technique:
  - The needle is advanced in an anteroposterior direction, with the globe directed slightly medially by the needle until a "pop" is perceived, typically at a mean depth of 15 to 20 mm.
  - This pop confirms the episcleral location of the needle tip. After an aspiration test, the local anesthetic is injected slowly.

## **SIDE EFFECTS AND COMPLICATIONS**

Retrobulbar and peribulbar blocks are associated with several possible complications

- globe perforation
- brainstem anesthesia
- retrobulbar hemorrhage
- optic nerve injury
- local anesthetic toxicity from intravascular injection
- development of the oculocardiac reflex
- spinal anesthesia via the optic nerve sheath.

## **EQUIPMENT**

- Sterile procedure tray
- 3 and 5 ml syringes

- LA solution without epinephrine (Lidocaine, Bupivacaine, Tetracaine)
- Prep solution
- 30G, 25G and 22G needles of appropriate length
- Sterile gauze, gloves, etc.

#### **PATHOPHYSIOLOGY:**

##### **INTRAOCULAR PRESSURE AND OCULAR PERFUSION:**

- blood supply to the retina and optic nerve depends on the intraocular perfusion pressure:  $OPP = MAP - IOP$ 
  - High IOP impairs the blood supply, leading to a loss of optic nerve function.
  - After an incision in the globe is made, factors that would increase IOP can cause prolapse and loss of intraocular contents; this can cause permanent vision loss.
- The globe is a relatively noncompliant compartment.
- The volume of the internal structures is fixed *except* for **aqueous fluid and choroidal blood volume**.
  - Two thirds of the aqueous fluid is actively secreted by the ciliary body by a sodium-pump mechanism.
  - One third comes from passive filtration through vessels on the iris. Aqueous fluid is produced at a rate of 2 uL/min. Aqueous flows over the lens and through the pupil to bathe the inner corneal endothelium. It then enters the angle of the anterior chamber to flow through the trabecular meshwork to the canal of Schlemm. The canal of Schlemm is continuous with channels to the episcleral veins.
  - IOP is primarily regulated by the resistance at the trabecular meshwork.
  - Normal intraocular pressure is 10 to 20 mm Hg.
- Impairment of aqueous drainage at any point can elevate the IOP
- Changes in choroidal blood volume can increase IOP rapidly.
  - Hypercapnia causes choroidal congestion.
  - Coughing, straining, or vomiting can increase IOP to 30 to 40 mm Hg.
  - Endotracheal intubation can cause similar increases.
  - These increases are transient and are relatively innocuous in a closed eye.
  - In an open eye, such as after traumatic injury or during cataract surgery, these increases can lead to loss of intraocular contents, hemorrhage, and permanent vision loss.
- Extrinsic compression of the eye also increases the IOP.
  - A normal blink increases the IOP by 10 mm Hg
  - A forceful lid squeeze can increase IOP to more than 50 mm Hg.
  - A poorly placed anesthesia mask can put enough pressure on the eye to reduce blood flow to zero.
- Deep inhaled or thiopental anesthesia causes a dose-related reduction in IOP by 30% to 40%.
- Opioids have little effect.
- Atropine in the usual doses does not cause a significant increase in IOP, even in patients with open-angle glaucoma.
- Ketamine may cause a modest increase in IOP.
- Intravenous succinylcholine causes IOP to increase by 6 to 12 mm Hg. ( This lasts for 5 to 10 minutes. The use of succinylcholine for induction in cases of open-globe injury with full stomach has been controversial. Loss of vitreous in patients from succinylcholine has not been reported.)

##### **OCULOCARDIAC REFLEX:**

- Traction on the extraocular muscles or pressure on the globe causes bradycardia, atrioventricular block, ventricular ectopy, or asystole.
  - It is especially seen with traction on the medial rectus muscle, but can occur with stimulation of any of the orbital contents, including the periosteum.
- The reflex is trigeminovagal.
  - The afferent limb is from orbital contents to ciliary ganglion to ophthalmic division of the trigeminal nerve to the sensory nucleus of the trigeminal near the fourth ventricle.
  - The efferent limb is via the vagus nerve to the heart.
- The reflex may be seen more often with procedures under topical anesthesia.
- Retrobulbar block is not uniformly effective at preventing the reflex.
- Orbital injections can trigger the response.
- The response is exacerbated by hypercapnia or hypoxemia.
- In the event of arrhythmia, the anesthesiologist first should ask the surgeon to stop manipulations. The ventilatory status is assessed. If significant bradycardia persists or recurs, intravenous atropine is administered in 7 ug/kg increments.
  - Rarely, severe bradycardia or asystole occurs.
  - Although chest compressions might be required to allow the atropine to circulate, usually the heart rhythm returns to normal with cessation of manipulation alone.
  - The response fatigues with repeated stimulation.
- Pretreatment with intravenous atropine or glycopyrrolate can be effective. Pretreatment may be indicated in patients with a history of conduction block, vasovagal responses, or  $\beta$ -blocker therapy.

##### **REFERENCES**

- Miller 7<sup>th</sup> Edition Chapters 52 and 75

##### **ANESTHESIA FOR OPHTHALMOLOGIC SURGERY**

- Eye surgery is the most common surgery in the elderly.
- quick outpatient procedures that do not involve blood loss or much postoperative pain
- Eye surgery patients are a high-risk group – elderly, with multiple medical comorbidities
- Surgical Risk:
  - Ophthalmic surgery is low risk
  - Mortality after eye procedures is much lower than for the general surgical population
  - eye surgery does not pose the risk of myocardial reinfarction seen with general surgical procedures.
  - chronic diseases have less effect on outcome with these procedures.
    - In a study of **unanticipated hospital admissions** after outpatient **ophthalmic surgery**, *age and American Society of Anesthesiologists physical status were not significant factors*
- Preop Assessment:
  - Publication of a large, multicenter trial showed no effect of preoperative blood tests and electrocardiogram on postoperative outcome.
  - Another opinion is that every patient must receive a full evaluation to include every possible test, to detect every possible finding, to institute every possible therapy, and to delay as long as possible, so that the patient can be in the best possible condition and have the lowest possible risk.
  - Appropriate preoperative medical consultation is important.
    - A study of malpractice litigation in cataract surgery found that medical consultation accounted for 16% of the liability; this compared

with 17% attributed to either local or general anesthesia.<sup>[112]</sup>

## HISTORY

- Routine anesthetic history
- Medications:
  - Anticoagulation
    - Many patients undergoing ophthalmic surgery take anticoagulants. Perioperative management of anticoagulants involves weighing the relative risks of thrombotic against possible hemorrhagic complications. Either of these results can be devastating to the patient. In a study of more than 19,000 cataract procedures, the incidence of hemorrhagic and thrombotic complications was very low.<sup>[114]</sup>
  - The risk of thrombotic complications depends on the following:
    - Indication for anticoagulation
    - RF for thromboembolism\
- Risk of hemorrhagic complications
  - Degree of anticoagulation
  - Hemorrhagic potential of surgical procedure ( orbital and oculoplastic surgery > vitreoretinal/glaucoma/corneal transplant > cataract
- A consensus is developing that cataract surgery may be safely performed while maintaining patients on warfarin. For intermediate-risk procedures, such as some glaucoma surgeries, stopping warfarin for 4 days preoperatively is indicated. For high-risk cases for hemorrhage or thrombosis, conversion from warfarin to heparin may be required.

## PHYSICAL EXAMINATION

- Routine anesthetic preoperative physical assessment
- Airway Exam
- Ocular Exam
  - document visual impairment – note severe impairment in visual acuity in either eye
  - Severe myopia or amblyopia
  - Ultrasound for globe length (axial) – high risk of globe perforation if >25mm
  - Increased IOP
  - glaucoma
- Cardiovascular Evaluation
  - Low risk surgery
  - Proceed as per ACC/AHA 2007 guidelines
  - Document any unstable cardiac conditions that may require further investigation preop
  - Stage 3 of severe hypertension is defined as a systolic blood pressure of 180 mm Hg or more or a diastolic blood pressure of 110 mm Hg or more.
    - (Miller) It would be prudent to reschedule elective procedures in patients with sustained stage 3 hypertension until after 2 weeks of antihypertensive therapy.
- Respiratory Exam
  - Ophthalmic procedures generally require that the patient lie flat comfortably and quietly
  - Cough
  - sleep apnea
  - orthopnea

## INVESTIGATIONS:

Not routinely indicated. If clinical condition dictates:

- Laboratory Studies
- ECG

## OPTIMIZATION

- NPO status
- anticoagulation
- medication management
- anxiolysis

## INDUCTION

- avoid increased IOP with laryngoscopy and induction
- avoid ketamine and succinylcholine if possible
- consider LMA – less coughing and airway irritation

## MAINTENANCE

- avoid nitrous
- avoid hypercapnia and hypoxemia
- avoid coughing

## EMERGENCY

- avoid PONV
- avoid coughing and consider extubating deep or remi wakeup

## POSTOPERATIVE CONSIDERATIONS

### OPHTHALMOLOGIC PROCEDURES

#### GENERAL PROCEDURES

Most general ophthalmologic procedures are done with topical or local anesthetic injection techniques. Enucleation can be done under block, but usually is done under general anesthesia.

#### INCISION AND DRAINAGE OF CHALAZION

A chalazion is an eyelid mass that results from chronic inflammation of the meibomian gland. Surgical treatment is indicated when there is inadequate response to conservative methods.

#### TARSORRHAPHY

The partial or total suturing together of the eyelids is performed to protect the eye and to allow healing of ulcers or exposure problems.

#### TEMPORAL ARTERY BIOPSY

A biopsy of the temporal artery is performed to diagnose temporal arteritis.

#### ANTERIOR CHAMBER PARACENTESIS

A tap of the anterior chamber fluid is done for diagnostic testing or to reduce IOP quickly.

#### ENUCLEATION

Enucleation refers to the removal of the entire eyeball after the muscles and optic nerve have been cut. Indications for surgery are a blind painful eye and intraocular tumors.

#### CATARACT EXTRACTION

Cataracts are opacities of the crystalline lens of the eye. Cataract extraction is performed under topical or regional block. General anesthesia is rarely used.

#### INTRACAPSULAR CATARACT EXTRACTION.

Intracapsular cataract extraction is the total removal of the opaque lens with the lens capsule. It may be done with a cryoprobe. Intracapsular cataract extraction is done in selected cases of lens subluxation, dislocation, or a lens containing a foreign body.

#### EXTRACAPSULAR CATARACT EXTRACTION.

Extracapsular cataract extraction refers to the removal of the lens, while leaving the posterior lens capsule and zonules intact. A rim of the anterior capsule also is preserved. This provides an excellent location for an intraocular lens implant.

#### PHACOEMULSIFICATION

Phacoemulsification refers to the use of ultrasonic vibration of fragments of the lens with simultaneous irrigation and aspiration. This technique allows for very small incisions.

#### GLAUCOMA PROCEDURES

*Glaucoma* is a general term for diseases of the eye characterized by an increase in IOP.

#### FILTRATION PROCEDURES.

Trabeculectomy is a surgical excision of the trabeculum to increase the drainage of aqueous humor. Baerveldt and Ahmed devices are glaucoma drainage implants that shunt aqueous fluid out of the eye to drain under the conjunctiva of the orbit.

#### PROCEDURES FOR THE CORNEA

##### PENETRATING KERATOPLASTY.

A corneal transplant is done to replace an optically poor, infected, or traumatized cornea. Control of IOP and avoidance of patient movement are especially important in these open-globe procedures.

##### RADIAL KERATOTOMY.

A series of incisions is made in the cornea in a spikelike manner to change the shape of the cornea to correct myopia.

##### PTERYGIUM EXCISION.

A pterygium is an abnormal fold of membrane in the interpalpebral fissure. An excision is generally performed when the abnormal tissue impinges on the cornea, affecting vision, or for cosmetic improvement.

#### VITREORETINAL SURGERY

##### RETINAL CRYOTHERAPY.

A cryoprobe is used for prophylaxis of certain retinal breaks and tears. It also is used in some patients with retinal tumors and vascular malformations.

##### REPAIR OF RETINAL DETACHMENT.

Retinal reattachment involves localizing all tears and holes, creating chorioretinal adhesions, and scleral buckling with silicone belts around the globe to pull the sclera in to support the retina.

##### VITRECTOMY.

Vitrectomy is the surgical extraction of the contents of the vitreous chamber and their replacement with a physiologic solution. A posterior vitrectomy is indicated for the removal of foreign bodies, to repair retinal detachments, to remove membranes and media opacities, and to alleviate vitreous traction on the retina. These may be prolonged procedures. Many patients have diabetes or severe chronic hypertension and offer difficult challenges to the anesthesiologist.

#### OCULOPLASTIC SURGERY

Most oculoplastic surgery is performed with local infiltration anesthesia. Some longer, more invasive procedures require general anesthesia.

##### ECTROPION REPAIR.

Ectropion usually results from the effects of aging on the eyelid. Other causes include mechanical or congenital lid pathology. The eyelid is turned outward.

##### ENTROPION REPAIR.

Involitional entropion usually results from aging. The eyelid is inverted or turned inward.

##### PTOSIS REPAIR.

Ptosis, or drooping of the upper eyelid, can be congenital (dystrophy of the levator muscle) or acquired from aging or trauma.

##### BLEPHAROPLASTY.

Blepharoplasty is plastic surgery of the eyelids to remove redundant tissue that is obstructing vision, or for improved appearance.

##### DACRYOCYSTORHINOSTOMY

Dacryocystorhinostomy refers to the formation of a communication channel between the lacrimal sac and the nasal cavity. This is performed for congenital or acquired nasolacrimal duct obstruction. It usually requires general anesthesia.

#### ORBITAL SURGERY

Most orbital surgery is performed using general anesthesia. If the surgery is anterior, local anesthesia can be used. Examples of orbital surgery include the following:

- Repair of blow out fracture
- Drainage of orbital abscess
- Decompression of optic nerve
- Exenteration of orbit for malignancy

**OPHTHALMOLOGIC EMERGENCIES (START THERAPY WITHIN MINUTES)**

- chemical burns of the cornea
- central retinal artery occlusion.

**URGENT SITUATIONS (START THERAPY IN 1 TO SEVERAL HOURS)**

- open-globe injuries
- endophthalmitis
- acute narrow-angle glaucoma
- acute retinal detachment
- corneal foreign body
- lid laceration.

**SEMI-URGENT SITUATIONS. (DAYS TO WEEKS)**

- ocular tumors
- blow-out fractures of the orbit
- congenital cataract
- chronic retinal detachment.

**OPEN GLOBE AND FULL STOMACH.**

- Conflict: protect the patient from aspirating stomach contents and to protect the eye from acute changes in IOP, which could cause vitreous loss, retinal detachment, and blindness.
- A rapid-sequence induction provides rapid airway control, but succinylcholine is associated with a modest increase in IOP.
  - Precurarization
  - large-dose vecuronium or pancuronium
  - succinylcholine using the priming principle. Regional anesthetic techniques also have been shown to be applicable
  - Factors to consider include the following:
    - size of perforation (small punctures have higher resistance to vitreous loss with changes in IOP)
    - pulmonary status: patients with decreased FRC may desaturate more quickly warranting a more rapid technique
    - what is the magnitude of aspiration risk

**ANESTHESIA-RELATED EYE INJURIES**

- POVL: central retinal artery occlusion
  - Systemic hypotension
  - anemia
  - prone
  - cpb
- corneal abrasion
  - General anesthesia has been shown to decrease basal tear production
  - Proper eye care with taping of lids with or without an ocular lubricant provides protection
  - If a patient emerges from general anesthesia with eye pain or a foreign body sensation, the patient must be followed up to ensure improvement

If left untreated, corneal abrasions can progress to form corneal ulcers.

**REFERENCES:**

Miller 7<sup>th</sup> Edition Chapter 52 and 74