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Introduction

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CATARACT EXTRACTION WITH INTRAOCULAR LENS INSERTION

SURGICAL CONSIDERATIONS

Description

Cataract—the leading cause of treatable blindness in the world—is defined as opacification of the crystalline lens. **Cataract surgery** is the most common surgical procedure, with more than 3 million performed in the United States each year. Several approaches to cataract removal have evolved as a result of advances in both instrumentation and artificial intraocular lenses (IOL). Most modern cataract surgery is performed using a variation of the **extracapsular technique,** which involves removal of the crystalline lens through an opening made in the anterior lens capsule (known as a **capsulotomy**). Removal of the lens nucleus can then be accomplished intact, which requires an 8-10-mm corneal incision, or more commonly by **phacoemulsification** wherein ultrasound energy is used to fragment the lens, allowing aspiration of the lens material. The advantages of phacoemulsification are that the entire procedure can be performed through a much smaller, clear corneal incision (usually 2.8 mm in length) and is associated with fewer adverse events. With both approaches, the softer, more peripheral cortical lens material is then removed by aspiration, leaving the posterior capsular bag intact to support an IOL implant (Fig. 2.1). If the lens capsule is torn or is for any reason unable to support an IOL, the lens can be fixated with sutures in the posterior chamber (behind the iris), or an anterior chamber IOL can be placed in front of the iris. Presently, the most popular materials for IOL implants are polymethyl methacrylate, silicon, and acrylic. Only silicon and acrylic are foldable, which allows their insertion through a small corneal incision and, therefore, are the most commonly used. The wound is typically sealed by hydrating the adjacent corneal stroma to induce mild edema; however, it may be further closed with a nylon suture (9-0 or 10-0) to achieve a watertight seal.

Variant procedure or approaches

Intracapsular cataract extraction involves removal of the crystalline lens with its surrounding capsular bag intact. To accomplish this, the zonules that normally stabilize and center the lens must be broken, and a cryoprobe often is used to remove the lens from the eye through a large incision. This procedure is performed infrequently, given the superior visual outcomes of extracapsular techniques. It may be indicated in situations where capsular bag support has been compromised by trauma, malignancy, or inherited disorders.

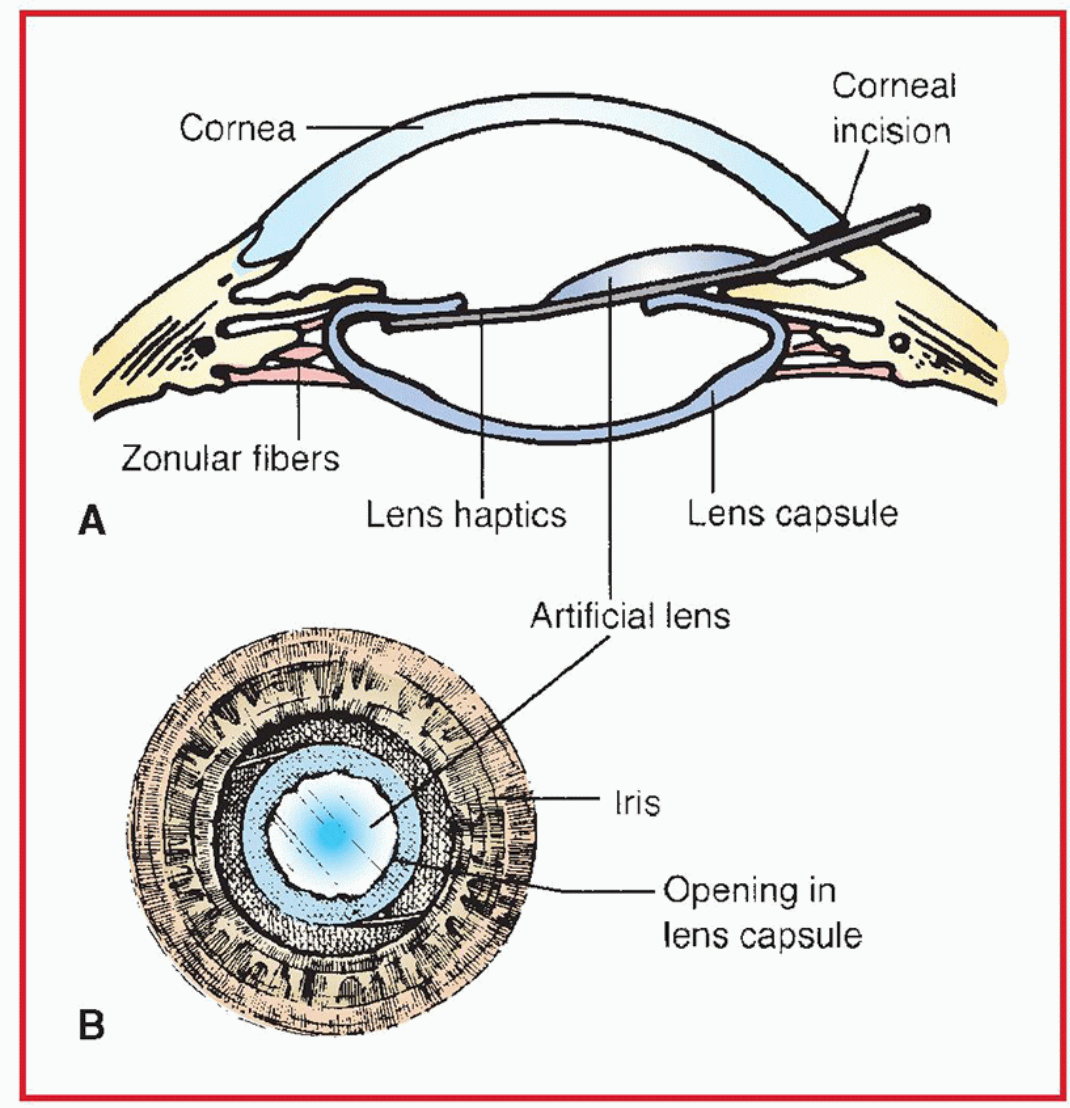

Figure 2.1 A: Placement of intraocular lens into remaining capsular bag. **B:** "In-the-bag" insertion.

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Usual preop diagnosis

Cataract

ERAS: Preop counseling by the surgeon/anesthesiologist should include limiting NPO duration, alcohol and smoking cessation, carb loading, and postop pain management. *See* *Appendix K: Enhanced Recovery After Surgery, p. K-1*.

▪ SUMMARY OF PROCEDURE

Position	Supine, table rotated 90-180°
Incision	2.8-mm peripheral cornea (phacoemulsification) or 8-10 mm (corneoscleral junction)
Special instrumentation	Surgical microscope; phacoemulsification machine
Antibiotics	Subconjunctival cefazolin (50-100 mg) or gentamicin (20-40 mg) or a topical fluoroquinolone
Surgical time	10-60 min
EBL	None
Postop care	Possible eye patch/shield for 24 h, topical medications

Mortality	Rare
Morbidity	Posterior capsule opacification: ˜25% (may require Nd:YAG laser treatment) Posterior capsule rupture: 3.1% Corneal edema: <2% Macular edema: 1-2% Retinal detachment: <1% Choroidal hemorrhage: 0.3% Endophthalmitis: <0.2%
Pain score	1-2

▪ **PATIENT POPULATION CHARACTERISTICS**

Age range	3 mo to 80+ yr (depends on type of cataract)
Male:Female	1:1
Incidence	>1,000,000/yr in the United States. Prevalence: 50% @ 65-74 yo, 70% @ 75+ yo
Etiology	90% age-related; congenital (1/250 newborns); metabolic; traumatic; medication-induced (steroids); previous vitrectomy
Associated conditions	Systemic diseases of elderly patients—common; cardiovascular disease; diabetes; HTN Genetic: Marfan disease; metabolic disorders Patients may be on antiplatelet or anticoagulant therapy. It is generally accepted that these drugs do not need to be discontinued before cataract surgery (especially if INR ≤ 1.5).

ANESTHETIC CONSIDERATIONS

At the present time in the United States, cataract surgery is most commonly performed using only topical anesthetic agents (e.g., preservative-free tetracaine 0.5%, lidocaine 2-4%) to block trigeminal nerve endings in the cornea and conjunctiva. Iris and ciliary body anesthesia depend on local anesthetic penetration into the anterior chamber. Thus, in a few patients, there may be a need for supplemental anesthetic administration (e.g., intracameral, 1% lidocaine) and less commonly systemic analgesic and sedative drugs. Inadvertent eye and lid movement should be expected. Adverse reactions to topical anesthetics are extremely rare and typically allergic in nature. High concentrations or prolonged exposure to local anesthetics can be toxic to the corneal epithelium (delayed wound healing; corneal erosion) and to the retina. A prospective randomized double-blind series demonstrated that combining topical anesthesia with intracameral lidocaine anesthesia was safe and effective in phacoemulsification with intraocular lens implantation. This technique avoided potential sequelae of retrobulbar or peribulbar anesthesia for cataract surgery. However, one study of patients undergoing cataract surgery using topical anesthesia reported greater intraop *(Print pagebreak 160)* and postop discomfort than those given a sub-Tenon block. Use of intravenous sedation increased the incidence of adverse events as compared with topical anesthesia without sedation. All local anesthetic techniques should be avoided in patients with uncontrolled movement disorders or an inability to cooperate. Retrobulbar or peribulbar anesthesia combined with sedation may be indicated for patients who are otherwise suitable for surgery under monitored anesthesia care (MAC) but have limited ability to cooperate with maintaining akinesia of the eye during surgery.

Anesthesia-trained personnel monitored most patients during cataract surgery, and the most commonly used local anesthetic was lidocaine. The anesthetic method associated with the lowest degree of pain, dissatisfaction, drowsiness, or nausea and vomiting was a regional block technique with administration of sedatives and diphenhydramine.

See Anesthetic Considerations for Ophthalmic Surgical Procedures Under MAC (adult).

Suggested Readings

1. Borazan M, Karalezli A, Akova YA, et al: Comparative clinical trial of topical anaesthetic agents for cataract surgery with phacoemulsification: lidocaine 2% drops, levobupivacaine 0.75% drops, and ropivacaine 1% drops. *Eye* 2008; 22(3):425-9.

2. Chuang LH, Yeung L, Ku WC, et al: Safety and efficacy of topical anesthesia combined with a lower concentration of intracameral lidocaine in phacoemulsification: paired human eye study. *J Cataract Refract Surg* 2007; 33(2):293-6.

3. Eke T, Thompson JR: Serious complications of local anaesthesia for cataract surgery: a 1 year national survey in the United Kingdom. *Br J Ophthalmol* 2007; 91(4):470-5.

4. Grzybowski A, Ascaso FJ, Kupidura-Majewski K, et al: Continuation of anticoagulant and antiplatelet therapy during phacoemulsification cataract surgery. *Curr Opin Ophthalmol* 2015; 26(1):28-33.

5. Guay J, Sales K: Sub-Tenon's anaesthesia versus topical anaesthesia for cataract surgery. *Cochrane Database Syst Rev* 2015; (8):CD006291.

6. Liu YC, Wilkins M, Kim T, et al: Cataracts. *Lancet* 2017; 390(10094):600-12.

7. Olson RJ: Cataract surgery from 1918 to the present and future-just imagine! *Am J Ophthalmol* 2018; 185:10-3.

8. Rogers GM, Goins KM: Cataract surgery in the patient that cannot lie flat. *Curr Opin Ophthalmol* 2010; 21(1):71-4.

9. Tan CS, Au Eong KG, Kumar CM: Visual experiences during cataract surgery: what anaesthesia providers should know. *Eur J Anaesthesiol* 2005; 22(6):413-9.

10. Vann MA, Ogunnaike BO, Joshi GP: Sedation and anesthesia care for ophthalmologic surgery during local/regional anesthesia. *Anesthesiology* 2007; 107(3):502-8.

11. Zhao L, Zhu H, Zhao P, et al: Topical anesthesia versus regional anesthesia for cataract surgery: a meta-analysis of randomized controlled trials. *Ophthalmology* 2012; 119(4):659-67.

CORNEAL TRANSPLANTATION

SURGICAL CONSIDERATIONS

Description

Patients with corneal pathology who have failed stem-cell techniques may require **corneal transplantation (penetrating keratoplasty [PKP] or lamellar keratoplasty).** Corneal transplantation involves replacing a portion of the host cornea with tissue from a donor eye (allograft). The primary goals of this procedure are to both restore the integrity of the cornea and establish a clear visual axis. The ideal death-to-preservation time of the donor cornea is <18 h, and the donor cornea can be stored for up to 2 wk before transplantation. The procedure often begins with the placement of a scleral fixation ring (Flieringa ring) just beyond the corneoscleral junction, which is secured with 7-0 Vicryl sutures. This provides additional scleral support that is especially helpful in children or patients who have undergone previous cataract surgery. The donor corneal button is removed from the surrounding corneoscleral rim with a trephine and kept in storage medium until the recipient bed is prepared. The host cornea is then trephined in a previously marked central location, using either manual or vacuum-assisted techniques, while the anterior chamber is maintained with viscoelastics. After the eye is opened, it is critical to avoid patient movement, coughing, *(Print pagebreak 161)* bucking, or any Valsalva maneuvers to prevent expulsion of the intraocular contents through the wound. The size of the donor button is generally

cut ˜0.25 mm larger than the host bed. The donor cornea is then sutured in place with the endothelial side down using 10-0 nylon sutures. This can be accomplished using 16 interrupted sutures (generally preferred with corneas that are inflamed, thinned, or vascularized), running sutures, or a combination, depending on a number of factors unique to each patient. Great care is taken during manipulation of the allograft to avoid trauma to the inner surface of the graft, as damage to the endothelial cells in this location can result in primary graft failure.

Variant procedure or approaches

PKP may be combined with **cataract extraction** or exchange of a previously placed IOL. In addition, PKP may be combined with **limbal stem-cell transplantation** (autograft from less injured eye) in cases where the most superficial corneal epithelial layer is unable to regenerate following damage (e.g., chemical burn injuries) to the limbal stem cells. **Partial-thickness transplants**, called **lamellar keratoplasty**, can also be performed in certain clinical situations. PKP may be combined with glaucoma filtration procedures and/or retinal surgeries.

Usual preop diagnosis

Persistent corneal edema; inherited corneal dystrophy; keratoconus; corneal scar; infectious keratitis; chemical injury

ERAS: Preop counseling by the surgeon/anesthesiologist should include limiting NPO duration, alcohol and smoking cessation, carb loading, and postop pain management. *See Appendix K, p. K-1*.

▪ SUMMARY OF PROCEDURE

Position	Supine, table rotated 90-180°
Incision	Corneal
Special instrumentation	Surgical microscope
Unique considerations	Open-globe precautions may be necessary: avoid coughing, bucking, or Valsalva maneuvers to prevent expulsion of intraocular contents.
Antibiotics	Subconjunctival cefazolin (50-100 mg) or gentamicin (20-40 mg)
Surgical time	60-90 min
EBL	Minimal
Postop care	Patch/shield for 24 h, long-term topical immunosuppression to prevent graft rejection
Mortality	Rare
Morbidity	Graft rejection: ˜5% Suprachoroidal hemorrhage: <1% (higher for MAC: ˜4%) Infection: <1%
Pain score	2

▪ PATIENT POPULATION CHARACTERISTICS

Age range	Any age
Male:Female	1:1
Incidence	>40,000 cases/yr in the United States and Canada
Etiology	Corneal opacity or decompensation resulting from endothelial failure; inherited dystrophy; keratoconus; scarring related to trauma/chemical burn/infection
Associated conditions	Congenital malformations; sleep apnea; atopic disease/asthma; Down syndrome

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ANESTHETIC CONSIDERATIONS

Full-thickness corneal transplants commonly require GA or a retrobulbar/peribulbar block to prevent movement of the eyelids or extraocular muscles that could lead to distortion of the globe during the procedure. However, in patients with significant coagulopathy, a history of perforated corneal ulcers, severe systemic disease, or other conditions that make the use of these forms of anesthesia less preferable, corneal transplant can be performed with topical anesthesia in cooperative patients. Partial-thickness transplants are often done under MAC.

See Anesthetic Considerations for Ophthalmic Surgical Procedures Under MAC (adult).

Suggested Readings

1. Chua A, Chua MJ, Kam P: Recent advances and anaesthetic considerations in corneal transplantation. *Anaesth Intensive Care* 2018; 46(2):162-70.

2. Di Zazzo A, Kheirkhah A, Abud TB, et al: Management of high-risk corneal transplantation. *Surv Ophthalmol* 2017; 62 (6):816-27.

3. Guerrier G, Boutboul D, Rondet S, et al: Anesthesia: a randomized clinical trial. *Cornea* 2016; 35(1):37-40.

TRABECULECTOMY

SURGICAL CONSIDERATIONS

Description

Glaucoma is a chronic disorder characterized by progressive and irreversible optic neuropathy with visual field defect. Glaucoma can develop at any intraocular pressure (IOP), but most current treatments are targeted at lowering IOP. It is the second most common cause of blindness in the United States and accounts for more than 5.1 million cases of blindness throughout the world. **Trabeculectomy** (glaucoma filtration procedure) is the most common surgical procedure used to reduce IOP and is often undertaken only after maximal medical therapy has failed. In trabeculectomy, a drainage fistula (ostium) is created from the anterior chamber to the subconjunctival space, allowing aqueous humor to drain from the eye. (Normal anatomy relevant for aqueous fluid production is shown in Fig. 2.2.) *(Print pagebreak 163)* First, a limbus-based or fornix-based incision is created in the conjunctiva and Tenon layer, exposing the underlying bare sclera. A partial-thickness (4-5 mm) scleral flap, hinged at the limbus, is then created. Because scarring (secondary to inflammation) is the most common cause of surgical failure, antimetabolites, such as mitomycin-C or 5-fluorouracil, are often applied to the surgical site to slow or prevent fibroblast proliferation. Next, an incision into the anterior chamber is created at the base of the scleral flap and converted to a sclerotomy by removing an ˜1 × 4 mm piece of corneoscleral tissue. To prevent the iris from entering the ostium as well as to protect against future angle closure, an **iridectomy** is performed, followed by closure of the overlying scleral flap with 10-0 nylon sutures. Before closure, it is important to avoid coughing, bucking, or Valsalva maneuvers, which might cause suprachoroidal hemorrhage or expulsion of intraocular content. The conjunctiva is then reapposed, using running 8-0 or 9-0 absorbable or nylon sutures.

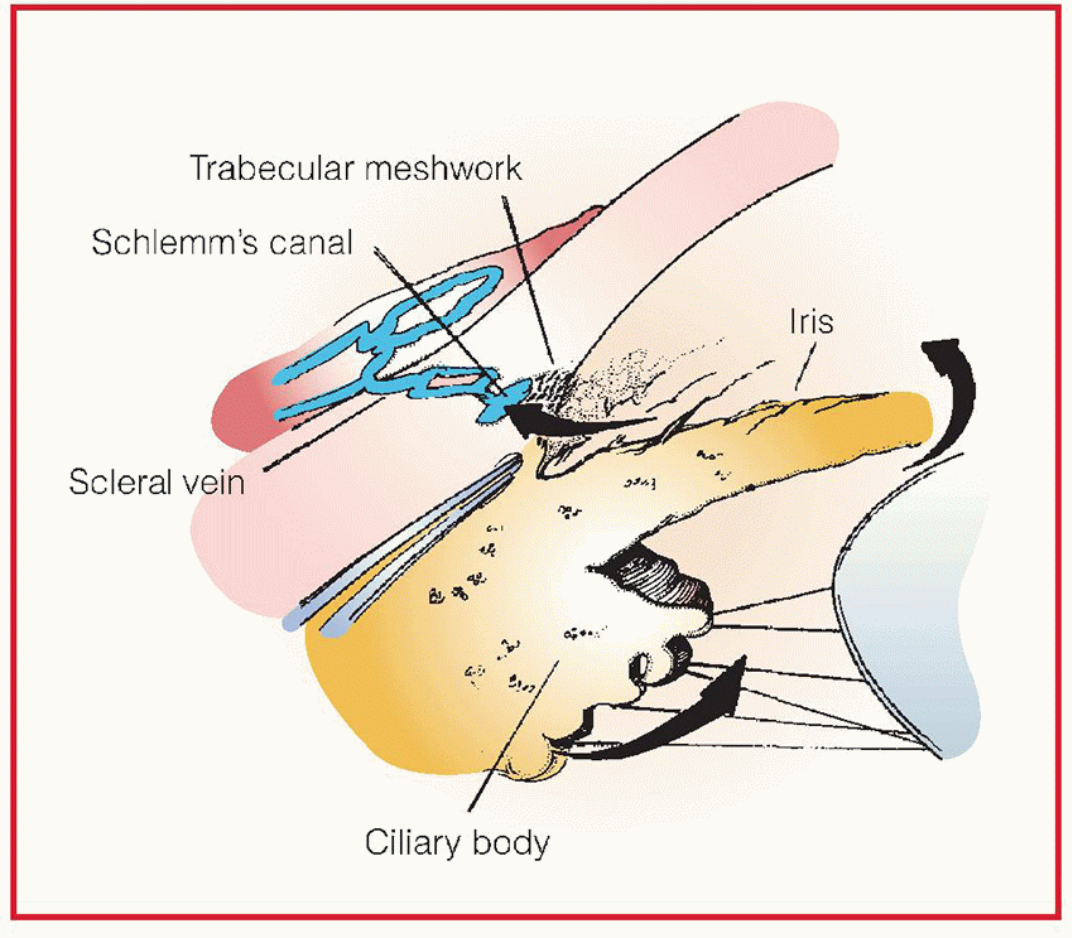

Figure 2.2 Ocular anatomy concerned with control of IOP. (Reproduced with permission from Barash PG, Cullen BF, Stoelting RK, et al., eds: *Clinical Anesthesiology*, 7th edition. Wolter Kluwers Health/Lippincott Williams & Wilkins, Philadelphia: 2013.)

Variant procedure or approaches

In patients for whom trabeculectomy has failed, a variety of drainage implants have been created to maintain the patency of the drainage ostium. These devices (e.g., **Ahmed, Molteno, Krupin, Baerveldt**) consist of plastic reservoirs that are placed in the sub-Tenon space and are connected to a tube that enters the anterior chamber (Fig . 2.3). These devices differ in implant size and whether or not there is an internal valve to prevent excessive drainage. Longterm IOP reduction with drainage implants is not as successful as trabeculectomy.

In infants and children with congenital glaucoma, the anterior chamber angle, which normally allows outflow of aqueous, develops abnormally and often requires surgical intervention. **Goniotomy** (opening Schlemm canal) is usually the initial procedure of choice. An alternative procedure is a **trabeculotomy** performed by exposing Schlemm canal (the drainage system) in a corneoscleral cutdown. A trabeculotome is then threaded into this canal and is rotated, creating a tear in the trabecular meshwork and allowing direct communication between the anterior chamber and Schlemm canal.

Usual preop diagnosis

Glaucoma

ERAS: Preop counseling by the surgeon/anesthesiologist should include limiting NPO duration, alcohol and smoking cessation, carb loading, and postop pain management. *See* *Appendix K, p. K-1*.

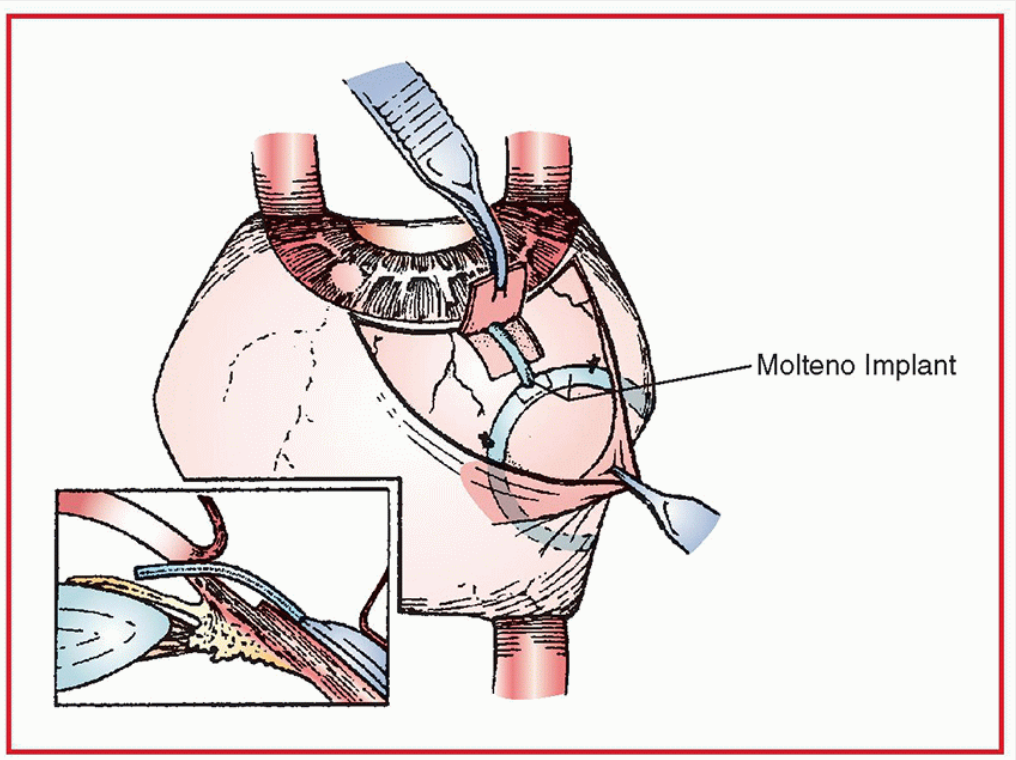

Figure 2.3 Basic technique of inserting Molteno implant. Silicone tube is inserted into anterior chamber via needle track and is connected to a subconjunctival acrylic plate that is attached to the sclera near the equator. (Reproduced with permission from Allingham RR, ed: *Shield's Textbook of Glaucoma*, 6th edition. Wolter Kluwers Health/Lippincott Williams & Wilkins, Philadelphia: 2010.)

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▪ SUMMARY OF PROCEDURE

Position	Supine, table rotated 90-180°
Incision	Superior portion of eye
Special instrumentation	Surgical microscope
Unique considerations	Prevent coughing, bucking, and Valsalva maneuvers while globe is open, to prevent expulsion of intraocular contents.
Antibiotics	Subconjunctival cefazolin (50-100 mg) or gentamicin (20-40 mg)
Surgical time	30-60 min
EBL	Minimal
Postop care	Patch/shield × 24 h; long-term topical corticosteroids to reduce scarring. Topical antibiotics for the fistula. Scleral flap sutures can be cut with a laser postop to increase flow. Patient advised to wear patch at night × 1-2 wk
Mortality	Rare
Morbidity	Overfiltration causing hypotony Leaking bleb Fistula scarring Infection Anterior chamber bleeding/hyphema Serous choroidal detachment/effusion

	Persistent corneal edema Suprachoroidal hemorrhage
Pain score	1-2

▪ **PATIENT POPULATION CHARACTERISTICS**

Age range	Any age; more common in the elderly
Male:Female	1:1
Incidence	1.7% Caucasians; 5.6% African Americans
Etiology	Impaired aqueous outflow. Cause of primary open-angle glaucoma unknown, but elevated IOP is the strongest risk factor. Many secondary causes, including angle closure, trauma, inflammation, neovascularization, and congenital abnormalities
Associated conditions	Diseases of the elderly, including cardiovascular disease, HTN, and diabetes. Children may have multiple congenital anomalies.

ANESTHETIC CONSIDERATIONS

Trabeculectomy is typically accomplished using sub-Tenon anesthesia, which allows monitoring of conjunctival mobility when selecting the surgical site. Alternatively, it can be done using topical anesthetics. GA is usually reserved for pediatric patients and patients unlikely or unable to cooperate during the procedure or if low IOP from anesthesia is desirable.

Subconjunctival anesthesia at the bleb site may be associated with a poorer outcome, because it may stimulate fibroblasts to cause scarring due to hemorrhage and tissue damage. Peribulbar and retrobulbar injections in patients with advanced glaucoma may be associated with increased IOP, which can be prevented by decreasing anesthetic volumes and avoiding the use of orbital Honan balloons.

Topical and intracameral anesthesias are being increasingly employed for trabeculectomy to avoid injection pain and potential complications, such as conjunctival button holes and hemorrhage. However, topical agents have the *(Print pagebreak 165)* following limitations: inferior duration and intensity of anesthetic effect and lack of ocular akinesia, which is necessary to prevent globe compression in patients with prominent eyelid squeezing. Intracameral lidocaine as a supplement to topical anesthesia has the theoretical advantage of increasing depth of anterior chamber, but it poses the risk of damaging the phakic lens and excessive iridectomy enlargement. To avoid these possible complications, intracameral acetylcholine or topical pilocarpine can be used in conjunction with intracameral lidocaine.

See Anesthetic Considerations for Ophthalmic Surgical Procedures Under MAC (adult).

Suggested Readings

1. Kumar CM, Eid H, Dodds C: Sub-Tenon's anaesthesia: complications and their prevention. *Eye (Lond)* 2011; 25(6):694-703.

2. Sauder G, Jonas JB: Topical anesthesia for penetrating trabeculectomy. *Graefes Arch Clin Exp Ophthalmol* 2002; 240:739-42.

3. Theventhiran A, Shabsigh M, Moraes CG, et al: A comparison of retrobulbar versus topical anesthesia in trabeculectomy and aqueous shunt surgery. *J Glaucoma* 2018; 27(1):28-32.

4. Yook E, Vinod K, Panarelli JF: Complications of micro-invasive glaucoma surgery. *Curr Opin Ophthalmol* 2018; 29(2):147-54.

ECTROPION REPAIR

SURGICAL CONSIDERATIONS

Description

Ectropion is a malposition of the eyelid often due to laxity in the tarsoligamentous sling, in which the lid margin is everted away from the globe. The surgical approach depends on the underlying anatomic abnormality, which can be congenital, involutional, or cicatricial (scarring) or due to mechanical traction from masses or facial nerve palsy. A lateral **tarsal strip procedure** is often used, with the lateral canthal tendon first released by performing a **lateral canthotomy and cantholysis** of the crus (Fig. 2.4). A lateral portion of tarsus is then dissected free of overlying skin, *(Print pagebreak 166)* muscle, and conjunctiva. This strip of tarsus is trimmed to the appropriate length and is secured to the periosteum of the lateral orbital rim with suture. Excess skin is removed and the defect is closed. If punctal malposition is present, the tarsal strip procedure may be combined with a **medial conjunctival spindle procedure**.

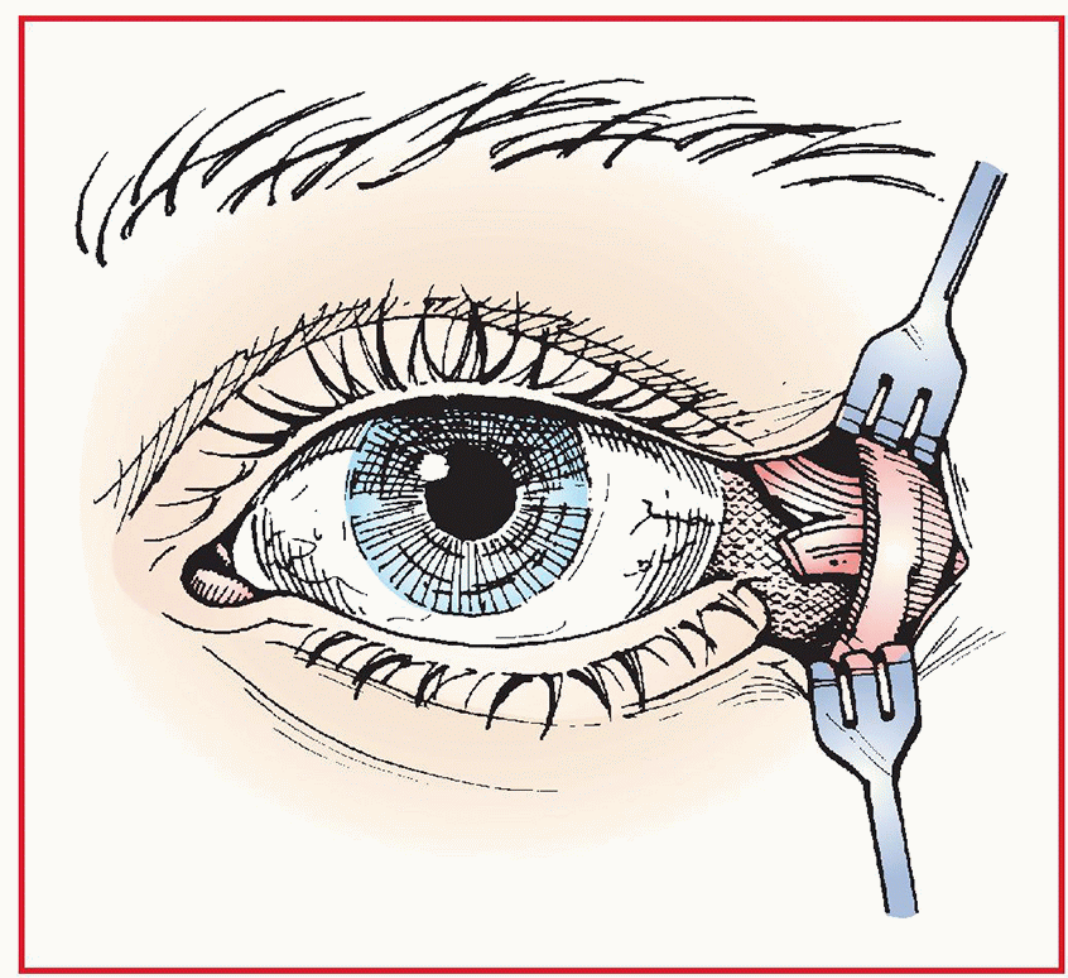

Figure 2.4 In the tarsal strip procedure, the lower eyelid is incised laterally. The entire lower crus of the canthal tendon must be severed. (Redrawn with permission from Tasman W, Jaeger EA, eds: *Duane's Ophthalmology*, Wolter Kluwers Health/Lippincott Williams & Wilkins, Philadelphia: 2013.)

Variant procedure or approaches

Cicatricial ectropion from a contracting scar can sometimes be released with a Z-plasty incision that releases vertical skin tension. Alternatively, a full-thickness skin graft may be required and can be harvested from the upper lid or the postauricular or supraclavicular regions.

Usual preop diagnosis

Ectropion of the eyelid

ERAS: Preop counseling by the surgeon/anesthesiologist should include limiting NPO duration, alcohol and smoking cessation, carb loading, and postop pain management. *See* *Appendix K, p. K-1*.

▪ SUMMARY OF PROCEDURE

Position	Supine, table rotated 90-180°
Incision	Lateral canthal region or area of scarring
Special instrumentation	Surgical loupes
Antibiotics	None intraop
Surgical time	0.5-1 h
EBL	Minimal
Postop care	Topical antibiotic ointment
Mortality	Rare
Morbidity	Lid malposition Infection: Very rare Corneal injury Local postop bleeding
Pain score	1-2

▪ PATIENT POPULATION CHARACTERISTICS

Age range	Any age, but most common in older adults
Male:Female	1:1
Incidence	Common in elderly patients
Etiology	Congenital; aging; malignancy; facial nerve palsy
Associated conditions	Systemic diseases of elderly patients are common, such as cardiovascular disease, diabetes, HTN, and neurologic disease

ANESTHETIC CONSIDERATIONS

See Anesthetic Considerations for Ophthalmic Surgical Procedures Under MAC (adult).

Suggested Reading

1. See Suggested Readings following Ophthalmic Surgery section.

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ENTROPION REPAIR

SURGICAL CONSIDERATIONS

Description

Entropion is a condition characterized by an inward rotation of the eyelid margin. The surgical approach depends on the underlying anatomic abnormality, which can be congenital, spastic, involutional, or cicatricial (scarring). For the more common involutional or

age-related cases, the primary defect involves horizontal lid laxity, disinsertion of the lower lid retractors, and/or an overriding orbicularis muscle. Correction often involves use of the **lateral tarsal strip procedure** (see description under Ectropion Repair) to achieve tightening of the lower lid. Reattachment of the eyelid retractor muscles/aponeurosis may also be used in certain cases, either alone or in addition to a tarsal strip procedure.

Variant procedure or approaches

Cicatricial entropion results from a contracting scar of the tarsus and/or conjunctiva pulling the lid margin inward. Correction requires release of this tension and a **lid-splitting procedure** with tarsal advancement, rotational grafts, or free mucosal grafts harvested from the hard palate. In the latter case, nasal intubation will be required to allow access to the graft site. **Quickert procedure** involves the placement of 2-3 sutures under local anesthesia to evert the eyelid. Entropion frequently recurs after this procedure.

Usual preop diagnosis

Entropion of eyelid

ERAS: Preop counseling by the surgeon/anesthesiologist should include limiting NPO duration, alcohol and smoking cessation, carb loading, and postop pain management. *See* *Appendix K, p. K-1*.

▪ SUMMARY OF PROCEDURE

Position	Supine, table rotated 90-180°
Incision	Lateral canthal region or area of conjunctival scarring. Mucosal graft may be harvested from the hard palate.
Special instrumentation	Surgical loupes
Antibiotics	None intraop
Surgical time	0.5-1 h
EBL	Minimal
Postop care	Topical antibiotic ointment
Mortality	Rare
Morbidity	Infection: Very rare Lid malposition Local bleeding Corneal injury
Pain score	1-2

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▪ PATIENT POPULATION CHARACTERISTICS

Age range	Any age
Male:Female	1:1
Incidence	Common
Etiology	Congenital; aging; inflammation
Associated conditions	Cicatricial entropion can be associated with pemphigoid; Stevens-Johnson syndrome (a sometimes fatal form of erythema multiforme); chemical burns; trachoma.

ANESTHETIC CONSIDERATIONS

Entropion repair can usually be accomplished as an outpatient procedure using local anesthesia and MAC.

See Anesthetic Considerations for Ophthalmic Surgical Procedures Under MAC (adult).

Suggested Reading

1. See Suggested Readings following Ophthalmic Surgery section.

PTOSIS REPAIR

SURGICAL CONSIDERATIONS

Description

Ptosis (drooping of the upper eyelid margin) can be severe enough to obstruct the visual axis. Causes include congenital maldevelopment, mechanical traction, myogenic conditions (e.g., dystrophies, myasthenia gravis), neurogenic conditions (e.g., Horner syndrome, cranial nerve III palsy), actinic skin changes, and aponeurotic dehiscence. The surgical approach depends primarily on the presence or absence of adequate levator muscle function that is responsible for elevating the upper eyelid. The most common etiology is age-related dehiscence or disinsertion of the levator aponeurosis from its normal attachment to the tarsus. Because levator muscle function is usually satisfactory in these patients, surgical correction involves reinserting the aponeurosis to the anterior tarsus alone or in combination with shortening of the aponeurosis by advancement or resection. Access is obtained by an incision in the upper eyelid crease. Removal of excess skin and orbicularis muscle (**blepharoplasty**) may be performed simultaneously. Although several formulas have been devised to determine the amount of aponeurotic shortening, intraop measurement usually is performed to ensure that the appropriate lid position and contour are achieved. This requires that the procedure be performed under local anesthesia and that the patient be positioned and draped in a way that allows him/her to sit upright during surgery. Incisions are closed, and crease reformation can be performed if desired.

Variant procedure or approaches

In patients with levator muscle function that is not adequate to achieve eyelid elevation, a **frontalis sling procedure** is performed to elevate the upper eyelid (Fig. 2.5). More commonly required in children with congenital ptosis, this allows the patient to open the eye by elevating the brow. A variety of materials can be used to accomplish this suspension, including silicone rods or fascia. In children <3 yr, autologous fascia lata can be harvested from the outer thigh from hip to knee. The material is tunneled beneath the skin and muscle from the brow incisions to the anterior tarsal region of the eyelid using Wright needles. After appropriate contour and height are achieved, the sling is secured and incisions are closed. Frontalis suspension usually is performed under GA in both adults and children.

Usual preop diagnosis

Ptosis

ERAS: Preop counseling by the surgeon/anesthesiologist should include limiting NPO duration, alcohol and smoking cessation, carb loading, and postop pain management. *See Appendix K, p. K-1*.

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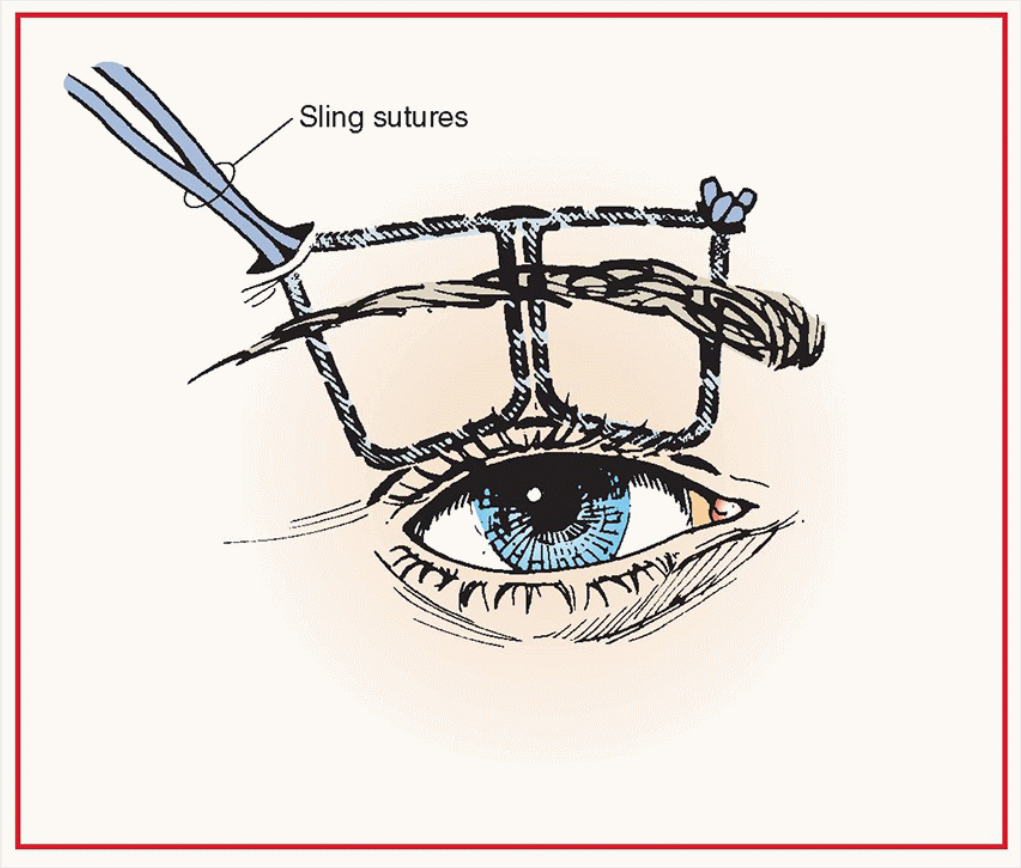

Figure 2.5 Frontalis sling (modified Crawford technique). Note location of brow and lid incisions and double rhomboid fascial slings. (Redrawn with permission from Tasman W, Jaeger EA, eds: *Duane's Ophthalmology*, Wolter Kluwers Health/Lippincott Williams & Wilkins, Philadelphia: 2013.)

▪ SUMMARY OF PROCEDURE

Position	Supine, table rotated 90-180°
Incision	Upper eyelid crease; brow; and lateral thigh (frontalis sling)
Special instrumentation	Surgical loupes
Antibiotics	Cefazolin 2 g iv
Surgical time	0.5-1 h
EBL	Minimal
Postop care	Topical antibiotic ointment; cool compresses
Mortality	Rare
Morbidity	Lid malposition (overcorrection, undercorrection, asymmetry) Corneal exposure (lagophthalmos) Infection: More common with silicone rods Numbness below incision
Pain score	1-2

▪ PATIENT POPULATION CHARACTERISTICS

Age range	Any age
Male:Female	1:1
Incidence	Common
Etiology	Congenital; aponeurotic; neurogenic; myogenic; mechanical; aging

Associated conditions	Neurogenic causes associated with myasthenia gravis; myogenic causes include chronic external ophthalmoplegia (can have dysrhythmias and Sz disorders); oculopharyngeal dystrophy

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ANESTHETIC CONSIDERATIONS

Ptosis repair typically requires GA for infants and children and can be accomplished with local anesthesia (± subcutaneous epinephrine) and MAC as an outpatient procedure in adults. The need for patient cooperation during the surgery should be discussed with the surgeon and patient in advance.

See Anesthetic Considerations for Ophthalmic Surgical Procedures Under MAC.

Suggested Reading

1. Parikh M, Kwon YH: Vision loss after inadvertent corneal perforation during lid anesthesia. *Ophthalmic Plast Reconstr Surg* 2011; 27(5):e141-2.

EYELID RECONSTRUCTION

SURGICAL CONSIDERATIONS

Description

Given the relatively small tissue area of the eyelids and their importance in both ocular health and cosmesis, excision of lid tumors often requires some form of reconstructive surgery. For lesions suspected of being malignant, **frozen sections** are often performed prior to closing the defect. In addition, **Mohs technique** (microscopically controlled serial excision) may be performed (usually by a dermatologist) to achieve clear margins, with reconstruction undertaken during a separate operation. During closure of full-thickness defects that involve the eyelid margin, attention is focused on aligning the lid in all dimensions (Fig. 2.6), while avoiding exposed sutures on the conjunctival surface that might damage the cornea. For small lid defects involving <¼ of the lid length, direct closure often can be accomplished with release of the lateral canthal tendon (**canthotomy and cantholysis**) to reduce wound tension, if necessary.

Variant procedure or approaches

Larger excisions often require grafting techniques that are designed to replace both the anterior (skin/orbicularis) and posterior (tarsus/conjunctiva) lamellae of the eyelid. This can be accomplished with rotational grafts, a *(Print pagebreak 171)* tarsoconjunctival advancement flap or free grafts of cartilage, hard palate, and cadaver sclera; or composite grafts as posterior lamellar replacement materials.

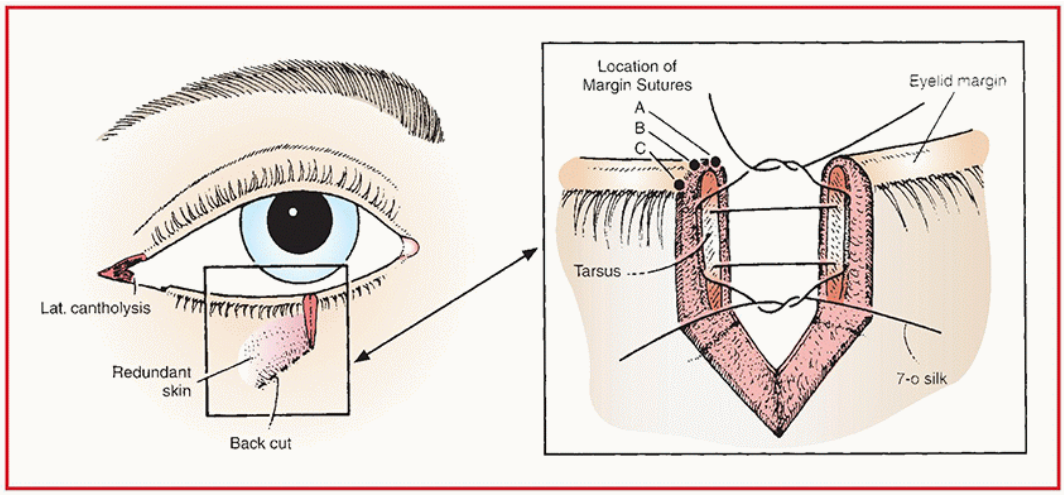

Figure 2.6 Closure of full-thickness defect in the lower lid. The tarsal sutures and half-thickness tarsus are placed first, with the secondary closures at points *A*, *B*, and *C* and the eyelid margin. (Reproduced with permission from McCord CD, Tanenbaum M, eds: *Oculoplastic Surgery*, 2nd edition. Raven Press, New York: 1987.)

Usual preop diagnosis

Basal-cell carcinoma; squamous cell carcinoma; melanoma; sebaceous carcinoma; or trauma

ERAS: Preop counseling by the surgeon/anesthesiologist should include limiting NPO duration, alcohol and smoking cessation, carb loading, and postop pain management. *See* *Appendix K, p. K-1*.

▪ SUMMARY OF PROCEDURE

Position	Supine, table rotated 90-180°
Incision	Upper and/or lower eyelid. Postauricular, supraclavicular, or hard palate if graft harvesting required
Special instrumentation	Surgical loupes
Antibiotics	Cefazolin 2 g iv
Surgical time	0.5-2 h
EBL	Minimal
Postop care	Topical antibiotic ointment; cool compresses; pressure dressing
Mortality	Rare
Morbidity	Graft failure Lid deformity Corneal exposure Infection: <1%
Pain score	2-3

▪ PATIENT POPULATION CHARACTERISTICS

Age range	Usually elderly
Male:Female	1:1
Incidence	Common
Etiology	Sun exposure-related malignancy Diseases of the elderly, including cardiovascular disease, HTN

Associated conditions	, and diabetes

ANESTHETIC CONSIDERATIONS

Eyelid reconstruction can often be accomplished with local anesthesia and MAC. For patients presenting for eyelid reconstruction immediately following Mohs surgery, ensure that their NPO status has been maintained.

See Anesthetic Considerations for Ophthalmic Surgical Procedures Under MAC.

Suggested Readings

1. Codner MA, Weinfeld AB: Comprehensive eyelid reconstruction. *ANZ J Surg* 2007; 77(Suppl 1):A71.

2. See Suggested Readings following Ophthalmic Surgery section.

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PTERYGIUM EXCISION

SURGICAL CONSIDERATIONS

Description

Pterygia are fibrovascular growths that originate in the limbal conjunctiva within the palpebral fissure and grow into the superficial layer of the cornea. They often produce refractive changes and/or obstruct the central visual axis and, thus, require removal. Although this procedure is often performed in the clinic or minorprocedure room, larger lesions may require an OR. In both settings, local anesthesia is applied both topically (tetracaine 0.5%) and subconjunctivally (lidocaine 2%). The lesion is dissected from the cornea and from the surrounding healthy conjunctiva, leaving a bed of bare sclera that may or may not be closed primarily (Fig. 2.7).

Variant procedure or approaches

For larger excisions and to decrease the rate of recurrence, **conjunctival transposition** or **free-graft techniques** can be used to cover the area of bare sclera. Topical antimetabolites, such as mitomycin-C, also may be applied to prevent recurrence. Recently, a method known as PERFECT (pterygium extended removal followed by extended conjunctival transplant) has been employed to reduce the long-term recurrence rate.

Preop diagnosis or indications

Pterygium

ERAS: Preop counseling by the surgeon/anesthesiologist should include limiting NPO duration, alcohol and smoking cessation, carb loading, and postop pain management. *See Appendix K, p. K-1*.

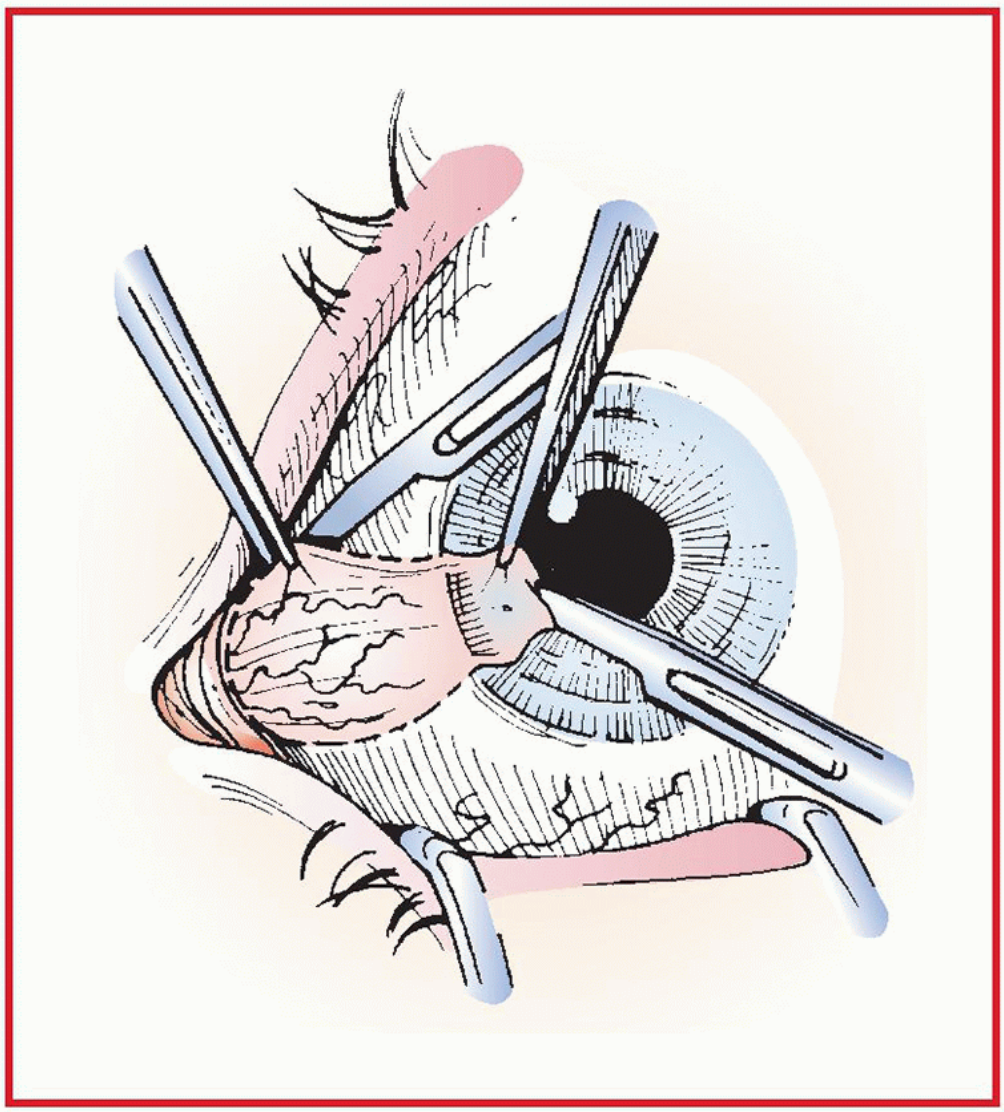

Figure 2.7 Bare sclera excision can be started from the corneal apex or by incising around the conjunctival body of the pterygium. (Redrawn with permission from Tasman W, Jaeger EA, eds: *Duane's Clinical Ophthalmology*, Vol 6. Lippincott Williams & Wilkins, Philadelphia: 2000.)

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▪ SUMMARY OF PROCEDURE

Position	Supine, table rotated 90-180°
Incision	Interpalpebral area adjacent to involved limbus
Special instrumentation	Operating microscope
Antibiotics	Topical postop
Surgical time	15-45 min
EBL	Minimal
Postop care	Topical antibiotic ointment
Mortality	Rare
Morbidity	Recurrence: 37% without adjunctive therapy or grafting, <1% with PERFECT (**p**terygium **e**xtended **r**emoval **f**ollowed by **e** xtended **c**onjunctival **t**ransplant) method Extraocular muscle injury (higher risk in reop eyes) Cyst

	Local bleeding Infection
Pain score	1-2

▪ **PATIENT POPULATION CHARACTERISTICS**

Age range	Usually young to middle age
Male:Female	1:1
Incidence	Common
Etiology	Related to sun exposure with higher rate in latitudes near the equator

Suggested Readings

1. Hirst LW: Recurrent pterygium surgery using pterygium extended removal followed by extended conjunctival transplant: recurrence rate and cosmesis. *Ophthalmology* 2009; 116(7):1278-86.

2. Hovanesian JA, Starr CE, Vroman DT, et al; ASCRS Cornea Clinical Committee: Surgical techniques and adjuvants for the management of primary and recurrent pterygia. *J Cataract Refract Surg* 2017; 43(3):405-19.

ANESTHETIC CONSIDERATIONS FOR OPHTHALMIC SURGICAL PROCEDURES UNDER MAC

(Procedures covered: cataract extraction and other procedures; corneal transplant; trabeculectomy; ectropionentropion repair; ptosis surgery; eyelid reconstruction; pterygium excision)

PREOPERATIVE

Ophthalmic procedures that are of relatively short duration and those that result in minimal blood loss are being performed increasingly more often on an outpatient basis, usually with topical or regional anesthesia (e.g., retrobulbar or peribulbar blocks) under MAC. **Retrobulbar and peribulbar injections** achieve excellent anesthesia and provide equal degrees of akinesia. Given the associated risk of inadvertent intrathecal injection of anesthetic, orbital hemorrhage, need for heavy sedation during injection, and delayed return of visual function postop, most cataract surgeries are performed using **topical anesthesia**. An additional benefit is that the bleeding risk is lower and the procedure can be performed safely in most patients taking anticoagulants or with bleeding disorders. Although satisfactory pain relief usually is achieved with this method, the lack of akinesia requires a highly cooperative patient to prevent sudden eye movements during surgery. Some surgeons will supplement topical anesthesia with **intracameral** *(Print pagebreak 174)* lidocaine (injections into the anterior chamber), although any further reduction in pain perception will be quite modest. **Sub-Tenon injection** is another anesthetic technique used by many surgeons as a compromise between topical application and orbital injections. After preop application of topical anesthetics, a small incision is made in the bulbar conjunctiva, exposing the episcleral (sub-Tenon) space. A blunt cannula is inserted under direct visualization and local anesthetic injected into the episcleral space. The main benefit is that no sharp needle is used, thereby reducing the risk of intrathecal injection and orbital hemorrhage from vessel injury. The onset of akinesia, however, is often delayed, and this technique still has the disadvantage of delayed return of postop visual function.

The pain on injection is slightly less with peribulbar blocks or sub-Tenon blocks as compared with retrobulbar techniques. For many patients, placement of the intravenous cannula was the most painful event during eye surgery, suggesting that some eye blocks are well tolerated. Intraoperative pain is significantly less with retrobulbar or peribulbar blocks than with topical anesthesia. Rates of ocular perforation following injection blocks are low (1 in 1000-10,000).

Because the majority of ocular procedures are performed on elderly patients, multiple coexisting medical illnesses are often present. A thorough preop H&P along with appropriate ancillary studies are mandatory even though local anesthesia/MAC is planned.

Contraindications to regional anesthesia/MAC for ocular surgery may include uncontrolled movement disorder, bleeding diathesis, open-eye injuries, claustrophobia, chronic cough (or other Valsalvaproducing conditions), symptomatic gastric reflux, inability to lie flat, inability to communicate or cooperate, or patient refusal.

Respiratory	Elderly patients have increased incidence of hiatal hernia and, therefore, are at increased risk for pulmonary aspiration. Assess the patient's ability to lie flat for the duration of the procedure. Patients with chronic cough may require GA. **Tests:** As indicated from H&P
Cardiovascular	Hx of HTN, CAD, CHF, or poor exercise tolerance should prompt a thorough investigation into the patient's cardiac status, including efficacy of current medications and recent ECG (compared with previous ECGs). Consultation with a cardiologist may be appropriate to optimize the patient's condition before surgery. Patients on antithrombotic drugs may be at higher risk for bleeding complications. The decision to stop these drugs and institute heparin bridge therapy should be made in consultation with both the surgeon and the prescribing physician. **Tests:**ECG; others (e.g., ECHO) as indicated from H&P
Diabetes	Diabetic patients are at increased risk for silent myocardial ischemia. Pulmonary aspiration 2° diabetic gastroparesis is also a risk in this population. Patients taking sc insulin should take two-thirds of their usual dose the evening before surgery and one-half of their usual NPH dose on the morning of surgery. Any morning dose of regular insulin should be held. Fasting blood sugar is checked; consider an iv infusion of D5 LR if glucose <90 mg/dL or regular sc insulin if glucose >200 mg/dL. Blood glucose is often checked intraop and postop. Patients on insulin pumps should reduce their overnight infusion rate by 30% and eliminate preprandial boluses. The insulin pump may be removed before surgery for safety reasons. The anesthesiologist should ask the patient about their insulin sensitivity (the amount of insulin necessary to ↓ blood glucose by 50 mg/dL). Blood glucose should be monitored hourly.
Musculoskeletal	Arthritic changes make lying flat difficult for some patients. Careful positioning and padding are essential. A low-level remifentanil infusion (0.025-0.05 mcg/kg/min) may be helpful in some cases.
Neurologic	Patients with tremor, agitation, severe anxiety, cognitive impairment, or inability to cooperate are not appropriate candidates for regional anesthesia/MAC.
Hematologic	for antiplatelet or anticoagulant drug use, particularly in patients undergoing lid or orbital procedures where both the risks and consequences of hemorrhage may be significant **Tests:** As indicated from H&P (e.g., PT if patient is on anticoagulant)
Laboratory	As indicated from H&P
	Patients will benefit from a detailed explanation of events prior to surgery (including iv placement, application of monitors, performance of local block, ocular compression, prepping eye, draping of the whole face, and provision of supplemental air/O_2) and the assurance that the anesthesiologist will always be present, monitoring them. Midazolam (0.5-1 mg iv) is often beneficial.

Premedication	For patients with increased risk of aspiration (e.g., with hiatal hernia or diabetic gastroparesis) and for obese and/or very anxious patients, metoclopramide 10 mg iv may enhance gastric emptying. Many patients will receive topical ocular medications during the immediate preop period to produce, for example, mydriasis or to ↓ IOP (see Table 2.1). Some of these medications may have significant cardiovascular effects and should be avoided in poorly controlled hypertensive patients.
ERAS	Check compliance with presurgical ERAS recommendations (see above) including NPO status. Consider preop acetaminophen 1000 mg po with sip of water. Topical anesthesia will often be started in the preop holding area.

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INTRAOPERATIVE

Anesthetic technique

MAC: Topical anesthesia typically is accomplished by the ophthalmologist, often using long-lasting LA, supplemented with 2% lidocaine with epinephrine, injected subconjunctivally. Placement of retrobulbar or peribulbar blocks may be painful, and very-short-acting agents (e.g., remifentanil 0.25-1 mcg/kg, alfentanil 5-7 mcg/kg, or propofol 30-50 mg) should be administered to minimize patient discomfort. Dose requirements vary significantly among patients, and the anesthesiologist should be prepared to treat sudden ↓ BP and apnea. Usually, further sedation is unnecessary and may result in snoring with head movement or otherwise interfere with patient cooperation during the surgery. Coughing, or other Valsalva maneuvers, should be avoided during the procedure, and the anesthesiologist must always be prepared to administer GA if necessary. If it is possible that cautery may be used during the surgery, then the delivered FiO_2 should be <0.3 to minimize fire hazard when using open oxygen delivery methods (e.g., nasal prongs, mask, etc.).

Retrobulbar block

Using a 25- or 27-ga needle (1.5 inches), the retrobulbar space is approached from the infratemporal quadrant of the orbit. The eye should be in a neutral position. Once the needle is positioned and there is no return of blood or cerebrospinal fluid (CSF) on aspiration, 3-5 mL of anesthetic solution is injected slowly. A facial nerve block is necessary *(Print pagebreak 176)* to prevent eyelid movement. This can be accomplished by injecting 4-8 mL of anesthetic solution above and below the lateral aspect of the orbit. Typically, the anesthetic solution consists of a 50:50 mixture of 0.5-0.75% bupivacaine and 2% lidocaine ± hyaluronidase, ± epinephrine 1:400,000.

Table 2.1 Commonly Used Ophthalmic Drugs and Their Systemic Effects

Phenylephrine	An α-adrenergic agonist that causes mydriasis (pupillary dilation) and vasoconstriction to aid ocular surgery; however, it also can precipitate significant HTN and dysrhythmias.
Echothiophate	An irreversible cholinesterase inhibitor used in glaucoma treatment to cause miosis and ↓ IOP. Its systemic absorption can reduce plasma cholinesterase activity and thereby prolong paralysis 2° to succinylcholine (usually not more than 20-30 min).
Timolol	A nonselective β-blocker that decreases production of aqueous humor → ↓ IOP. Rarely, it may be associated with atropine-resistant bradycardia, asthma, CHF, and ↓ BP.
Acetazolamide	A carbonic anhydrase inhibitor used to ↓ IOP. It also can cause diuresis and a hypokalemic metabolic acidosis.
Betaxolol	A relatively oculospecific β-blocker used to ↓ IOP. Effects may be additive to systemic β-blockers.
	A commonly used mydriatic with the potential for CNS toxicity,

Cyclopentolate	including Sz, psychotic reactions, and dysarthria.
Atropine	An anticholinergic that produces mydriasis to aid with ocular examination and surgery. It also can precipitate central anticholinergic syndrome. (Sx range from dry mouth, tachycardia, agitation, delirium, and hallucinations to unconsciousness.) Physostigmine 0.01-0.03 mg/kg will increase central acetylcholine and reverse the symptoms. (It may be repeated after 15-30 min.)
Apraclonidine	An α-2 adrenergic agonist used to treat glaucoma (↓ aqueous formation + ↑ outflow). Systemic absorption → sedation and drowsiness. Hypotension is possible.

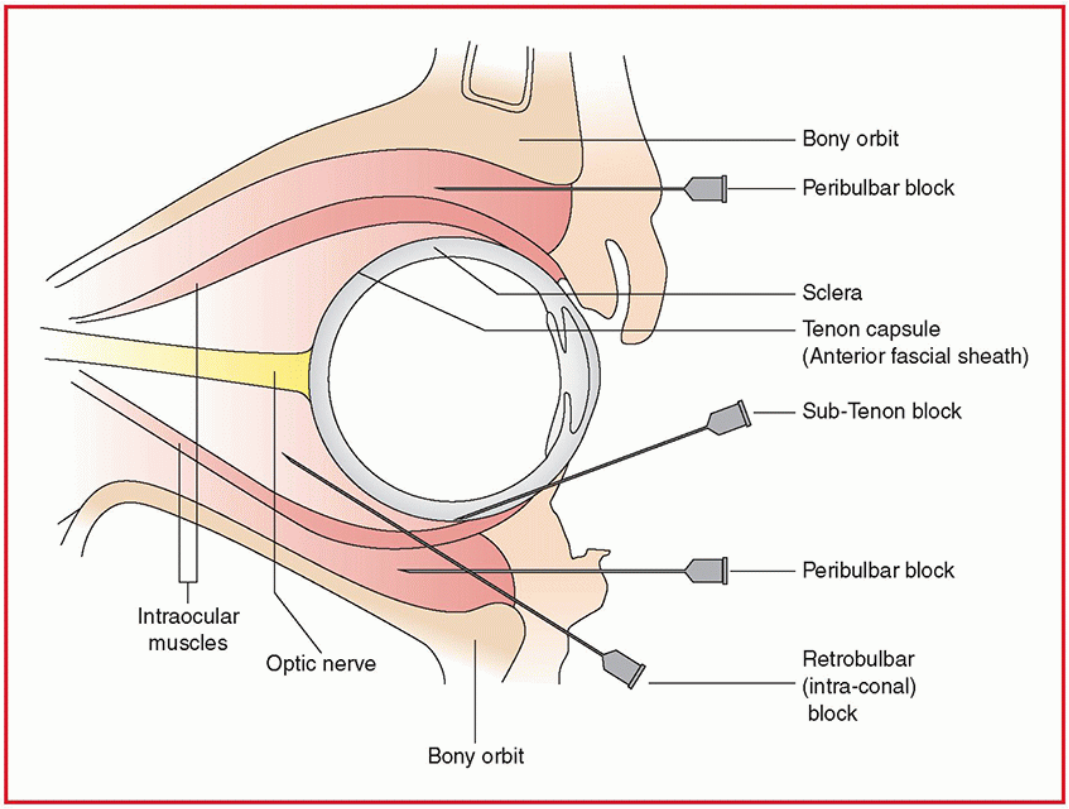

Figure 2.8 Horizontal section of the orbit illustrating regional blocks. There is continuum between the episcleral (sub-Tenon) space and the rectus muscle sheaths.

Peribulbar block

Using a 25- or 27-ga needle (5/8-1 inches), 6-8 mL of anesthetic solution is injected into the peribulbar space, entering just superior to the inferior rim of the orbit at the junction of the lateral and middle thirds of the lower lid. Orbital compression is usually applied to facilitate spread of local anesthetic. Although perforation of the globe and hemorrhage are still possible, direct injury to the optic nerve and subdural injection are not likely due to the length and position of the needle. Peribulbar blocks generally have a slower onset than retrobulbar blocks and are more likely to cause conjunctival swelling, which may interfere with surgery.

Sub-Tenon anesthesia

Injection of LA (often 1% lidocaine ± epi) through a 22-ga cannula into the space below Tenon capsule (episcleral membrane) produces ocular anesthesia in many ways similar to retrobulbar block. However, the onset is slower and akinesia is less reliable. The usual injection volume is 3-5 mL with more necessary if akinesia is required. Unlike retrobulbar block, significant complications with the technique are extremely rare.

Blood and fluid requirements	IV: 18-20 ga × 1 NS/LR @ 1.5-3 mL/kg/h	Excessive fluids → bladder distension → ↑ BP, agitation. See Zero Balance Fluid Management,

		Appendix K, p. K-2 and p. K-4
Monitoring	Standard monitors Verbal response	It is important to remain in communication with the patient throughout the procedure (Take care to avoid evoking head movement.)
Positioning	and pad pressure points nonoperated eye	Place pillows under knees to relieve back strain.
Complications	Dysrhythmias, especially ↓ HR	Usually 2° traction or pressure on ocular/periocular tissues. Rx: stop surgical stimulation
	↑ BP	2° anxiety, pain, and phenylephrine eye drops. Rx: reassurance, local anesthetics, labetalol 5 mg, or hydralazine 2.5-mg increments, as appropriate
	Retrobulbar hemorrhage (1-3%)	Rx: pressure bandage; usually cancel surgery Globe perforation If a needle perforation, usually no repair is necessary
	Convulsions 2° iv local anesthetic	Supportive treatment with IPPV; cancel surgery
	Respiratory/circulatory arrest	2° subarachnoid anesthetic injection. Rx: CPR, IPPV
	Oculocardiac reflex (OCR)	OCR: traction on EOMs → ↓↓ HR, ↓↓ BP, ventricular ectopy, and asystole. Rarely occurs during GA or following adequate retrobulbar block. Rx: stop surgical manipulation, atropine for persistent bradycardia, and CPR

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POSTOPERATIVE

Complications	Myocardial ischemia	Rx: Provide O_2; BP; ECG; cardiology consultation. Rx may include sublingual NTG, aspirin, β-blocker, and MS
	Corneal abrasion Photophobia	
	N/V	Rx: ondansetron 4 mg iv
	Diplopia	
Multimodal pain management	Acetaminophen 325-1000 mg po	Emphasize nonopioid analgesics including acetaminophen and NSAIDs if not contraindicated (see p. K-5).
ERAS	PONV protocol (see p. B-1)	Encourage early enteral nutrition and mobilization. Consider DVT prophylaxis if early mobilization is not possible.

Suggested Readings

1. Assam JH, Bernhisel A, Lin A: Intraoperative and postoperative pain in cataract surgery. *Surv Ophthalmol* 2018; 63(1):75-85.

2. Chronopoulos A, Herbert J, Thumann G, et al: Avoiding complications from patient positioning for intraocular surgery. *Anesth Analg* 2018; 126(4):1206-11.

3. Malik A, Fletcher EC, Chong V, et al: Local anesthesia for cataract surgery. *J Cataract Refract Surg* 2010; 36(1):133-52.

4. Nanji KC, Roberto SA, Morley MG, et al: Preventing adverse events in cataract surgery: recommendations from a Massachusetts expert panel. *Anesth Analg* 2018; 126(5):1537-47.

5. Rogers GM, Goins KM: Cataract surgery in the patient that cannot lie flat. *Curr Opin Opthalmol* 2010; 21(1):71-4.

6. Sanmugasunderam S, Khalfan A: Is fasting required before cataract surgery? A retrospective review. *Can J Ophthalmol* 2009; 44(6):655-6.

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REPAIR OF RUPTURED OR LACERATED GLOBE

SURGICAL CONSIDERATIONS

Description

A ruptured globe involves a tear of either the corneal or scleral layers of the eye and can occur in the setting of blunt, penetrating, or perforating trauma. The primary goal of surgical repair is to replace extruded intraocular contents, close defects, and remove any foreign body. Orbital CT scans are performed preop to aid in the identification of the latter. To reduce the risk of causing further damage, complete examination of the eye is often delayed until the patient is in the controlled setting of the OR under GA. Although anterior injuries are readily identifiable, posterior injuries may require extensive exploration that can require a 360° opening of the conjunctiva and isolation of each extraocular muscle to allow adequate inspection of the entire scleral surface. Corneal lacerations usually are closed with 10-0 nylon sutures, while 8-0 nylon or Vicryl may be used for scleral tissue. Until these wounds are closed, it is crucial that Valsalva maneuvers (which raise IOP) be avoided to prevent further extrusion of intraocular contents.

Variant procedures or approaches

After globe integrity has been established, other associated injuries may be addressed, including repair of conjunctival lacerations, extraocular muscle injuries/detachments, retinal detachments, or removal of a traumatic cataract.

Usual preop diagnosis

Ruptured globe

ERAS: These are usually emergency procedures with little opportunity to benefit from preop ERAS considerations.

▪ SUMMARY OF PROCEDURE

Position	Supine, table rotated 90-180°
Incision	Conjunctival peritomy (360° conjunctival incision) to allow exposure of the posterior sclera
Special instrumentation	Operating microscope
Antibiotics	IV gentamicin (80 mg) and cefazolin (1 g), subconjunctival and topical antibiotics
Closing considerations	Avoid Valsalva-like maneuvers (coughing, bucking, etc.)
Surgical time	1-2 h
EBL	Minimal
Postop care	Hospital admission for iv antibiotics
Mortality	Rare

Morbidity	Wound leak Infection: Rate depends on injury Sympathetic ophthalmia: Rare Retinal detachment Suprachoroidal hemorrhage
Pain score	4

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▪ PATIENT POPULATION CHARACTERISTICS

Age range	Usually <40 yr
Male:Female	8:1 (as a result of recreational and occupational preferences)
Incidence	Common (˜2 million eye injuries in the United States per year with ˜40,000 resulting in vision loss)
Etiology	Work- or sports-related injury; motor vehicle accidents
Associated conditions	Intoxication; orbital/facial trauma; head injury

ANESTHETIC CONSIDERATIONS

PREOPERATIVE

This is a generally healthy patient population; however, patients with penetrating eye injuries present the anesthesiologist with two special challenges: (a) they invariably have full stomachs, resulting in risk of aspiration; (b) they are at risk of blindness 2° ↑ IOP → loss of ocular contents, which may be a result of coughing, crying, and/or struggling during induction. Normal IOP ranges from 10 to 22 mm Hg, depending on the rates of formation and drainage of aqueous humor, choroidal blood volume, scleral rigidity, extraocular muscle tone, as well as extrinsic pressure on the eye (e.g., a poorly fitting mask or retrobulbar hematoma). Patient movement, coughing, straining, vomiting, hypercarbia, hypertension (HTN), and endotracheal (ET) intubation may ↑ IOP to 40 mm Hg or more.

Full-stomach precautions	Consider patient to have a full stomach if the injury occurred within 8 h of the last meal. Pain and anxiety due to trauma will delay gastric emptying. Goal is to minimize the risk of aspiration pneumonitis by decreasing gastric volume and acidity. Consider premedication with metoclopramide (10-20 mg iv), antacids such as Na citrate (15-30 mL po, immediately prior to induction), and H_2-histamine receptor antagonists (ranitidine [50 mg iv, ˜15 min before induction]). H_2-histamine receptor antagonists, however, have no effect on the pH of gastric secretions present in the stomach prior to administration and are, therefore, of limited value in patients presenting for emergency surgery. If patient has Hx of smoking or is an asthmatic, consider preop use of inhalers such as albuterol (2-4 puffs).
Associated injuries	A ruptured globe may be only one of multiple injuries to the head and neck or other structures. Other injuries should be excluded preoperatively.
Laboratory	Tests as indicated from H&P
Premedication	Patients often are very anxious and may benefit from benzodiazepines (e.g., for pediatric population, midazolam 0.5-0.75 mg/kg po in cola or apple juice, 15-30 mL). Avoid

	narcotic premedication, which may ↑ nausea and possibility of emesis.

INTRAOPERATIVE

Anesthetic technique

GETA: Regional anesthesia (e.g., retrobulbar block) is contraindicated in patients with open-eye injury because of ↑ IOP, which may accompany injection of local anesthetic behind the globe. Thus, despite the increased risk of aspiration from a full stomach, general endotracheal anesthesia (GETA) is recommended. In patients where the risk of GA is unacceptably high (e.g., extensive pulmonary or unstable cardiac disease), surgical repair can be accomplished using topical anesthesia (see Auffarth GU, et al.).

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Induction	To protect the airway and prevent ↑ IOP, a rapid-sequence induction with cricoid pressure and a smooth intubation are required. Although the choice of induction agent is relatively straightforward—propofol 1-2 mg/kg—the choice of neuromuscular blocking agents for facilitating intubation is controversial. Succinylcholine provides a rapid onset, short duration of action, and excellent intubating conditions, but it also transiently increases IOP (˜9 mm Hg). This minor ↑ IOP is usually attenuated by pretreatment with a nondepolarizing agent (e.g., rocuronium) followed by propofol induction. Rocuronium (1.2 mg/kg) produces muscle relaxation in 1-2 min and may be a satisfactory alternative to succinylcholine; however, a premature attempt at intubation may significantly ↑ IOP as a result of coughing and straining. Of interest, there are no reports in the literature documenting exacerbation of eye injuries with the use of succinylcholine following pretreatment with a NMR. Given that the anesthesiologist's main concern is safe airway management, the following is a suggested induction plan: 1. Preoxygenation, avoiding external pressure on the eye from face mask 2. Pretreatment with a nondepolarizing relaxant (e.g., rocuronium 0.06-0.12 mg/kg or equivalent), followed by iv lidocaine (1 mg/kg) and fentanyl (2-3 mcg/kg) to blunt the cardiovascular response to laryngoscopy and intubation 3. 4 min later, with cricoid pressure, induce with propofol (1-2 mg/kg) and succinylcholine (1.5 mg/kg). Intubate with oral RAE tube. Note: for pediatric patients, it might be appropriate to induce with sevoflurane while maintaining cricoid pressure and intubating when the patient is deeply anesthetized. Trying to start an iv prior to induction may precipitate struggling and crying, leading to further eye injury.
ERAS	Verify preincision antibiotics. Assess volume status (see Appendix K). Maintain normovolemia and normothermia.
Maintenance	Standard maintenance or TIVA. Avoid hypercapnia, which → ↑ IOP. Muscle relaxation is mandatory until the eye is surgically closed. Humidify gases for pediatric patients. Avoid N_2O in patients receiving intraocular gas injection.
Emergence	Decompress the stomach with OG tube. Goal is smooth emergence and extubation with patient awake with intact airway reflexes. IV lidocaine (1.5 mg/kg) 5 min before extubation; posterior pharyngeal suctioning with patient deeply anesthetized, combined with a small amount of narcotic (remifentanil ˜1 mcg/kg), may blunt cough reflex prior to extubation. The common occurrence of PONV requires administration of intraop antiemetics (e.g., dexamethasone 4 mg iv and/or ondansetron 4 mg iv 30 min before the end of surgery).
Blood and fluid requirements	IV: 18-20 ga × 1 (adult) 20 ga × 1 (child) NS/LR @ 5-10 mL/kg/h Warm fluids if large volume will be administered. See Zero Balance Fluid Management, Appendix K, p. K-2 and p. K-4

Monitoring	Standard monitors	Neuromuscular blockade must be monitored closely and additional relaxant given as necessary to prevent patient movement during surgery.
Positioning	and pad pressure points nonoperated eye	
Complications	↑ IOP with extrusion of intraocular contents Aspiration of gastric contents	IOP (normal = ˜10-22 mm Hg) increased by blink = 10-15 mm Hg and forced lid closure = >70 mm Hg

(Print pagebreak 181)

POSTOPERATIVE

Complications	N/V Aspiration pneumonitis Photophobia Diplopia Hemorrhagic retinopathy Corneal abrasion	Rx: metoclopramide 10-20 mg iv, droperidol 0.625 mg iv (with due respect to the black-box warning), ondansetron 4 mg iv Provide O_2 by face mask, if not intubated. Follow O_2 sat. CXR
Multimodal pain management	Acetaminophen	Occasionally, parenteral opiates. Emphasize nonopioid analgesics including acetaminophen and NSAIDs if not contraindicated (see p. K-5).
ERAS	PONV protocol (see p. B-1)	Encourage early enteral nutrition and mobilization. Consider DVT prophylaxis if early mobilization is not possible.

Suggested Readings

1. Auffarth GU, Vargas LG, Klett J, et al: Repair of a ruptured globe using topical anesthesia. *J Cataract Refract Surg* 2004; 30 (3):726-9.

2. Boscia F, La Tegola MG, Columbo G, et al: Combined topical anesthesia and sedation for open-globe injuries in selected patients. *Ophthalmology* 2003; 110(8):1555-9.

3. Chidiac EJ, Raiskin AO: Succinylcholine and the open eye. *Ophthalmol Clin North Am* 2006; 19(2):279-85.

4. Kelly DJ, Farrell SM: Physiology and role of intraocular pressure in contemporary anesthesia. *Anesth Analg* 2018; 126 (5):1551-62.

5. Palte HD: Ophthalmic regional blocks: management, challenges, and solutions. *Local Reg Anesth* 2015; 8:57-70.

DACRYOCYSTORHINOSTOMY

SURGICAL CONSIDERATIONS

Description

Dacryocystorhinostomy (DCR) is performed for patients with symptomatic obstruction of the nasolacrimal duct (NLD) and is commonly associated with chronic dacryocystitis. The procedure is designed to create a fistula from the common canaliculus to the nasopharynx, which bypasses the site of obstruction. This involves removal of bone adjacent to the nasolacrimal sac and incorporating the sac with the lateral nasal mucosa. DCR can be performed under GA or local anesthesia (subcutaneous [equal mixture of 1-2% lidocaine and 0.5% bupivacaine with 1:100k epinephrine] and nasal cavity cocaine 4%) with most patients preferring local anesthesia. Intranasal phenylephrine and/or cocaine pledgets are often placed to decrease mucosal bleeding. A skin incision is made below the medial canthal tendon that is extended to the lacrimal fossa with blunt dissection. Bleeding can be excessive if the angular vessels are injured. The now exposed periosteum is incised, and a 1.5 × 1.5 cm osteotomy is created with a burr and/or Kerrison punch, exiting at the level of the middle meatus. A Crawford lacrimal probe attached to silicone tubing is inserted into the superior punctum and advanced into the lacrimal sac, which is then opened along its medial wall. Following incision of the nasal mucosa through the osteotomy, the posterior flap of the lacrimal sac *(Print pagebreak 182)* is sutured to the posterior nasal mucosa flap. The probe is advanced through the osteotomy and into the middle meatus, where it is retrieved through the nare. The second end of the probe is advanced along the same path but beginning through the inferior punctum. The ends of the silicone tubing are tied together in the nare, and the anterior flaps of the lacrimal sac and nasal mucosa are sutured together. Thrombin and gel foam can be used to control mucosal bleeding, and the skin is reapproximated after ensuring hemostasis. Meticulous hemostasis is essential to a successful outcome.

Variant procedures or approaches

If the lacrimal obstruction is more proximal to the lacrimal sac, a **Jones tube** can be placed (Fig. 2.9), creating an artificial lumen from the conjunctiva to the nasopharynx to bypass the entire nasolacrimal drainage system. An endonasal approach using a rigid endoscopic ± laser offers the advantage of no skin incision, good visualization of intranasal pathology, and less postop discomfort. The endoscopic approach is more common in children and young adults where the absence of skin creases makes scar concealment difficult.

Usual preop diagnosis

NLD obstruction

ERAS: Preop counseling by the surgeon/anesthesiologist should include limiting NPO duration, alcohol and smoking cessation, carb loading, and postop pain management. *See Appendix K, p. K-1*.

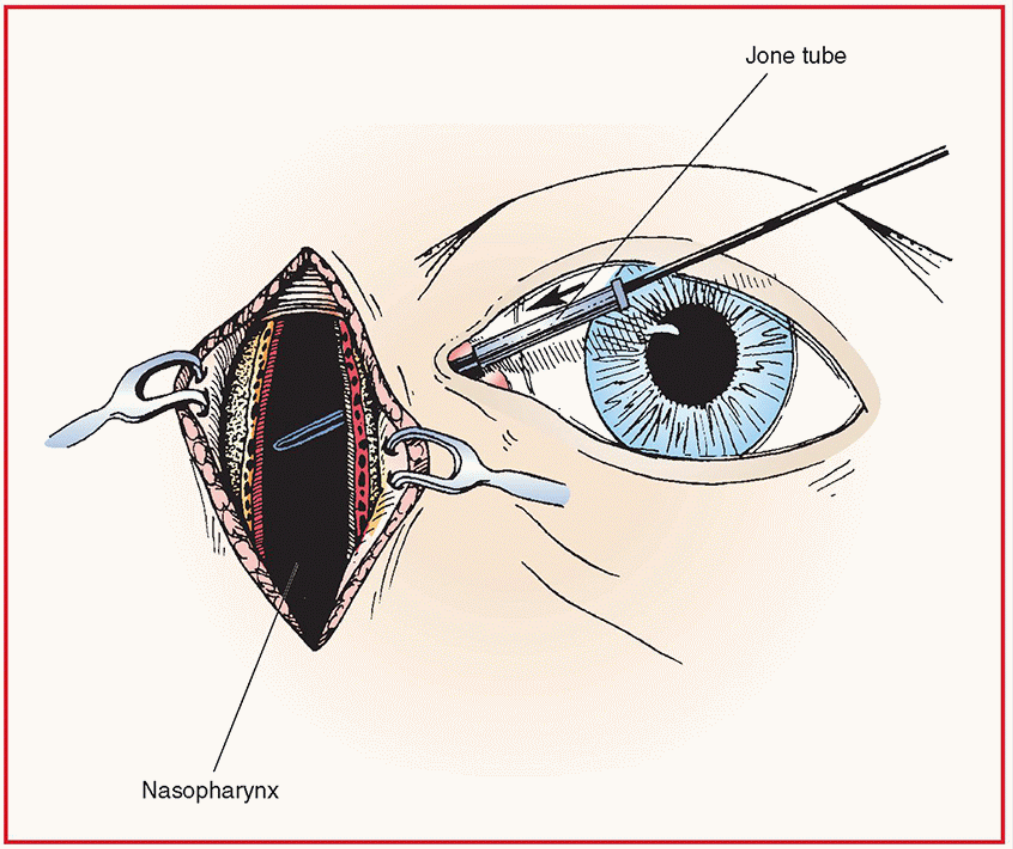

Figure 2.9 Insertion of a Pyrex Jones tube. (Reproduced with permission from McCord CD, Tanenbaum M, Nunery WR, eds: *Oculoplastic Surgery*, 3rd edition. Raven Press, New York: 1995.)

(Print pagebreak 183)

▪ SUMMARY OF PROCEDURE

Position	Supine, table rotated 90-180°
Incision	15 mm, just below medial canthus (Fig. 2.10)
Special instrumentation	Headlight; surgical loupes
Unique considerations	Nasal packing with phenylephrine/4% cocaine/lidocaine. Blood may drain into upper airway during surgery.
Antibiotics	Cefazolin 2 g iv
Surgical time	1-1.5 h
EBL	100-200 mL
Postop care	Outpatient tube removal required
Mortality	Rare
Morbidity	Failure to drain Bleeding: 5% Infection: <1% Cerebrospinal fluid leak
Pain score	3-4 (Pain scores are lower following local anesthesia compared to GA.)

▪ PATIENT POPULATION CHARACTERISTICS

Age range	30-70 yr
Male:Female	1:1

Incidence	Common
Etiology	Adults: Usually scarring from prior infection or trauma Children: Congenital or prior infection
Associated conditions	Deviated septum; nasal polyps, nasopharyngeal masses, congenital anomalies

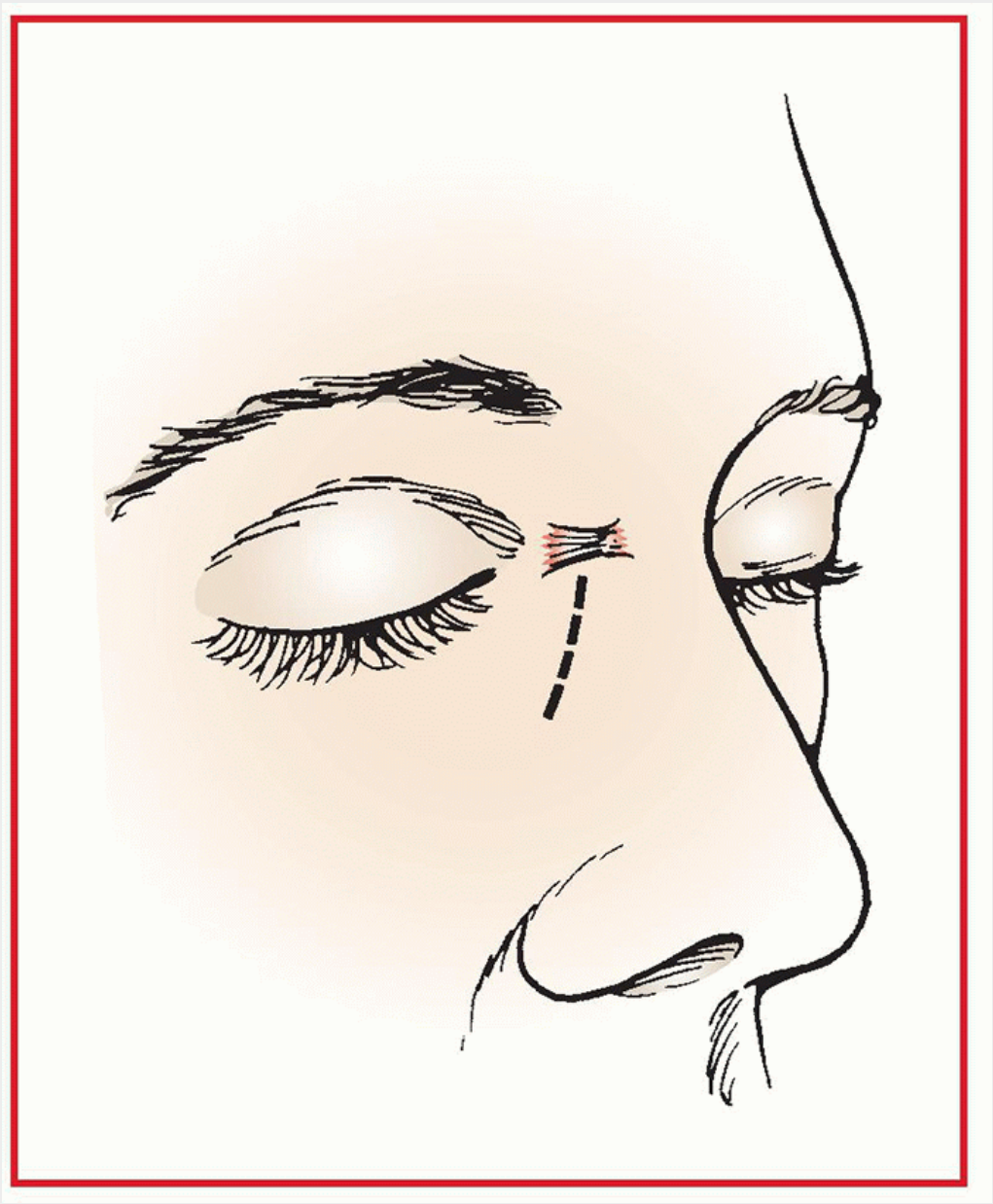

Figure 2.10 Linear skin incision for a standard DCR. (Reproduced with permission from Wright KW: *Textbook of Ophthalmology*, Williams & Wilkins, Baltimore: 1997.)

(Print pagebreak 184)

ANESTHETIC CONSIDERATIONS

DCR can be performed with local anesthetic and MAC or under GA depending on patient and surgeon preferences. *See Anesthetic Considerations for Ophthalmic Surgical Procedures Under MAC or GA*.

Suggested Readings

1. Choi WC, Paik JS, Doh SH: Results of endoscopic dacryocystorhinostomy under local anesthesia with minimal sedation. *J Ophthalmol* 2017; 2017:6712491.

2. Madge SN, Selva D: Intubation in routine dacryocystorhinostomy: why we do what we do. *Clin Experiment Ophthalmol* 2009; 37(6):620-3.

3. Watkins LM, Janfaza P, Rubin PA: The evolution of endonasal dacryocystorhinostomy. *Surg Ophthalmol* 2003; 48(1):73-84.

4. See Suggested Readings following Ophthalmic Surgery section, p. 193.

ENUCLEATION

SURGICAL CONSIDERATIONS

Description

Enucleation involves removal of the entire globe and a portion of the optic nerve. It usually is performed for painful blind eyes or intraocular tumors (e.g., retinoblastoma, melanoma). If possible, the surrounding ocular adnexa, including the conjunctiva, Tenon connective tissue, and extraocular muscles, are left in place to secure an orbital implant. The procedure begins with a 360° conjunctival incision (**peritomy**) at the limbus, allowing exposure of the underlying extraocular muscles and the sclera. Each of the recti muscles is isolated with a muscle hook and secured with fixation sutures before disinsertion from the globe. The oblique muscles are cut and allowed to retract into the orbit (Fig. 2.11). A curved clamp *(Print pagebreak 185)* is closed across the optic nerve ˜3-10 mm posterior to the globe, and the nerve is cut and the globe removed. After hemostasis has been ensured, an orbital implant (polymethylmethacrylate or hydroxyapatite) is placed into the socket. The overlying muscles, connective tissue, and conjunctiva are closed to improve motility and prevent extrusion.

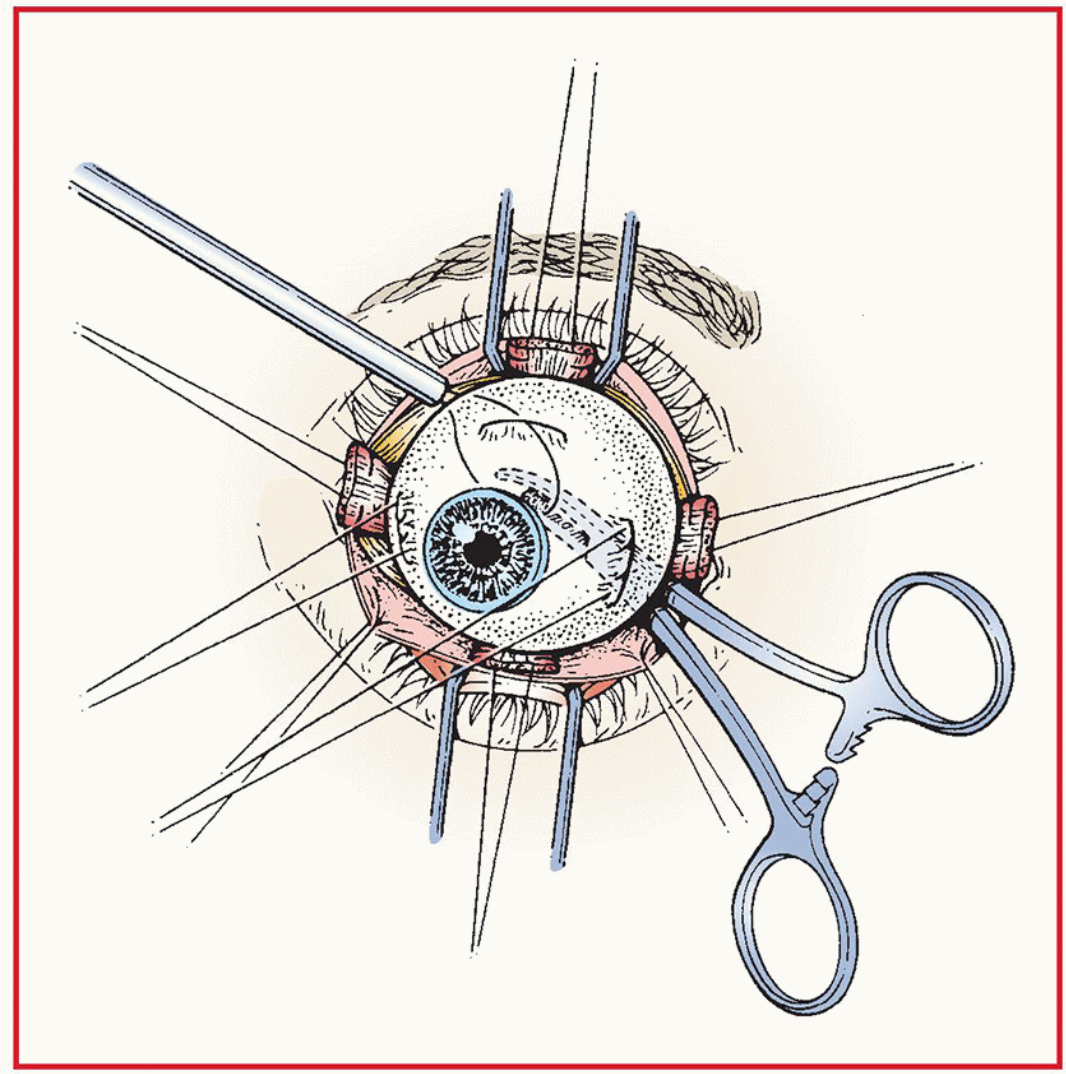

Figure 2.11 Each of the four recti is isolated with 6-0 Dexon suture. The superior oblique tendon is detached. The inferior oblique is sutured to the inferior border of the lateral rectus. 4-0 silk traction sutures are in place over the medial and lateral rectus stump. The globe is rotated laterally, while a curved clamp is introduced from the medial direction. Either curved scissors or an enucleation snare may be used to transect the optic nerve. (Reproduced with permission from McCord CD, Tanenbaum M, Nunery WR, eds: *Oculoplastic Surgery*, 3rd edition. Raven Press, New York: 1995.)

Variant procedure or approaches

Evisceration involves removing all intraocular contents through a corneoscleral incision, leaving the scleral shell with the attached adnexa in place. This usually is performed in cases of endophthalmitis, but never if malignancy is suspected. **Exenteration** is a more extensive procedure for the management of aggressive malignant tumors or infections where all orbital tissue, often including surrounding orbital bone and adjacent sinuses, is removed. If the extent of orbital tumors is unknown, frozen sections from the surgical margins will be used to determine if exenteration is needed.

Usual preop diagnosis

Painful blind eye; intraocular tumors; sympathetic ophthalmia; trauma

ERAS: Preop counseling by the surgeon/anesthesiologist should include limiting NPO duration, alcohol and smoking cessation, carb loading, and postop pain management. *See* *Appendix K, p. K-1*.

▪ SUMMARY OF PROCEDURE

Position	Supine, table rotated 90-180°
Incision	360° conjunctival (peritomy)
Special instrumentation	Surgical loupes
Antibiotics	Irrigate socket with gentamicin postop
Surgical time	1 h
EBL	<100 mL
Postop care	Outpatient
Mortality	Rare
Morbidity	Extrusion of implant Infection: <1%
Pain score	3-4

▪ **PATIENT POPULATION CHARACTERISTICS**

Age range	Any age
Male:Female	Male > female
Incidence	3-5 per 100,000
Etiology	Trauma; infection; glaucoma; tumors (e.g., retinoblastoma, melanoma); inflammation; intractable pain
Associated conditions	Diabetes mellitus

ANESTHETIC CONSIDERATIONS

See Anesthetic Considerations for Ophthalmic Surgical Procedures Under GA.

Suggested Reading

1. See Suggested Readings following Ophthalmic Surgery section.

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ORBITOTOMY—ANTERIOR AND LATERAL

SURGICAL CONSIDERATIONS

Description

Surgical access to the orbit is required for biopsy/excision of masses, drainage of orbital abscesses, removal of a foreign body, or repair of orbital fractures, among other procedures. The orbit may be divided into several compartments, and the surgical approach will vary by the location and size of the lesion. In general, an **anterior orbitotomy** is used for small tumors in the anterior orbit and can be approached from a transconjunctival, transseptal, or transperiosteal incision. By contrast, a **lateral orbitotomy** allows for removal of larger masses located further posteriorly in the orbit, as well as those lesions involving the lacrimal gland. In this procedure, the skin incision can be placed just under the brow (**Stallard-Wright**), in the lid crease with lateral extension, or higher in the eyebrow (**coronal**). The dissection is carried down to the periosteum, which is then incised and reflected. The lateral orbital wall is exposed, and an osteotomy is performed using an oscillating saw, after preplacing suture holes with a power drill. The section of bone is removed with a clamp, and the periorbita is opened, allowing intraorbital dissection. After biopsy or removal of the mass, the periorbita is closed and the bone fragment replaced.

Variant procedures or approaches

A **medial orbitotomy** is often required to access lesions that are located medial to the optic nerve.

Usual preop diagnosis

Orbital mass; fractures; foreign body; abscess

ERAS: Preop counseling by the surgeon/anesthesiologist should include limiting NPO duration, alcohol and smoking cessation, carb loading, and postop pain management. *See* *Appendix K, p. K-1*.

▪ SUMMARY OF PROCEDURE

Position	Supine, table rotated 90-180°
Incision	Variable (see above)
Special instrumentation	Surgical loupes
Antibiotics	Cefazolin 2 g iv
Surgical time	1-3 h
EBL	Usually minimal, unless vascular tumor
Mortality	Rare
Morbidity	Orbital hemorrhage (retrobulbar → proptosis, retinal ischemia) Impaired ocular motility, strabismus Perforation of the globe: <1:1000 needle blocks Loss of vision, optic nerve injury Infection: <1%
Pain score	3-6

▪ PATIENT POPULATION CHARACTERISTICS

Age range	Any age
Male:Female	1:1
Incidence	Fairly common
Etiology	Tumor, such as hemangioma, lymphangioma, and lymphoma; lacrimal gland tumors; infection; fracture; foreign body

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ANESTHETIC CONSIDERATIONS

(Procedures covered: dacryocystorhinostomy [DCR], enucleation, anterior and lateral orbitotomy)

PREOPERATIVE

Patients presenting for DCR, enucleation, and orbitotomy represent a diverse population. These patients are generally healthy, aside from the infection, tumor, or trauma underlying their ocular or periocular pathology. Preop evaluation should focus on possible coexisting disease and the systemic manifestations of previous therapeutic interventions (e.g., chemotherapy and drugs used to treat glaucoma). NB: Always verify that surgery is performed on the correct side.

Laboratory	Tests as indicated from H&P
Premedication	Standard premedication

ERAS	Check compliance with presurgical ERAS recommendations (see above) including NPO status. Consider preop acetaminophen 1000 mg po with sip of water.

INTRAOPERATIVE

Anesthetic technique	GETA ± local anesthetic block	
Induction	Standard induction. An oral RAEETT may be preferred.	
ERAS	Verify preincision antibiotics. Assess volume status (see Appendix K). Maintain normovolemia and normothermia.	
Maintenance	Standard maintenance. Muscle relaxation is not required.	
Emergence	No special considerations. The common occurrence of PONV requires the administration of intraop antiemetics (e.g., dexamethasone 4 mg iv and/or ondansetron 4 mg iv).	
Blood and fluid requirements	Blood loss variable IV: 18-20 ga × 1 NS/LR @ 4-6 mL/kg/h	See Zero Balance Fluid Management, Appendix K, p. K-2 and p. K-4
Monitoring	Standard monitors	
Positioning	Table rotated 90° and pad pressure points nonoperated eye	
Complications	Oculocardiac reflex (OCR)	OCR: tractions on EOMs → ↓↓ HR, ↓↓ BP, ventricular ectopy, and asystole. Rarely occurs during GA or following adequate retrobulbar block. Rx: stop surgical manipulation, atropine for persistent bradycardia, and CPR
	Brainstem anesthesia	Onset <20 min → ↓ HR, ↓ BP, apnea, agitation, and asystole. Rx: may require CPR, intubation, and prolonged ventilation

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POSTOPERATIVE

Complications	PONV	Rx: metoclopramide 10-20 mg iv and/or ondansetron 4 mg iv
Multimodal pain management	Acetaminophen	Occasionally parenteral opiates. Emphasize nonopioid analgesics including acetaminophen and NSAIDs if not contraindicated (see p. K-5).
ERAS	PONV protocol (see p. B-1)	Encourage early enteral nutrition and mobilization. Consider DVT prophylaxis if early mobilization is not possible.

RETINAL SURGERY

SURGICAL CONSIDERATIONS

Description

Retinal surgery is performed for a wide variety of conditions (see Usual preop diagnoses, below). Most **retinal detachments** are due to one or more small tears in the retina. Retinal detachments are classified as traction, exudative (not usually treated with surgery), or rhegmatogenous (rupture, tear). Children, especially those with retinopathy of prematurity (ROP) or trauma, may develop retinal detachments. In adults, retinal detachments are most frequently associated with diabetes, myopia, trauma, and previous cataract surgery. Rhegmatogenous retinal detachments (more common in adults) start off with a small retinal tear, which allows the vitreous to seep in between the retina and pigment epithelium, forcing retinal separation. Sx range from floaters and flashing lights to showers of black specks and, ultimately, to a dark shadow that impinges on the field of vision. Retinal detachments may be complicated by proliferative vitreoretinopathy (PVR), in which scar tissue grows along the surface of the retina, rendering it stiff and difficult to reattach. Less commonly, retinal detachments are induced by other forms of vitreoretinal traction, or by trauma involving an open globe. Care must be taken to avoid any increase in IOP in an eye that may be ruptured. On rare occasion, retinal detachments are due to the formation of a giant retinal tear. Just as rarely, retinal surgery may be done on premature infants in an effort to prevent or repair retinal detachments. The ultimate aim of retinal surgery is the preservation or recovery of vision through the restoration of normal posterior segment anatomy. (Anatomy of the eye is shown in Fig. 2.12.)

Retinal surgery may involve various procedures alone or in combination, including scleral buckling, vitrectomy, gas-fluid exchange, and injection of vitreous substitutes. **Scleral buckles** are silicone rubber appliances sutured to the sclera to indent the eye wall, thereby relieving vitreous traction and functionally closing retinal tears. This is an external procedure in which the eye may either not be entered at all or entered with a small needle puncture through the sclera for drainage of subretinal fluid or injection of gas.

Cryotherapy or lasers are used frequently to establish chorioretinal adhesions around retinal tears. Cryotherapy is applied to the sclera; a laser is applied with a fiber-optic cable introduced into the vitreous cavity during vitrectomy surgery, often in combination with a wide-field viewing system. It also can be administered with an indirect ophthalmoscope delivery system for those eyes not undergoing vitrectomy.

Simple detachments frequently can be repaired by a pneumatic retinopexy, in which retinal tears are treated with cryotherapy and/or laser and an expanding gas is injected into the vitreous cavity. This technique usually is done in phakic eyes (eyes with intact lens) with tears between the 9 o'clock and 4 o'clock positions. Pneumatic retinopexy usually is done as an outpatient office procedure, with local anesthesia or, less commonly, MAC. The other procedures discussed usually are done with MAC, although GA may be used, according to surgeon's preference and the patient's systemic condition. Some surgeons inject retrobulbar or subconjunctival bupivacaine at the end of a procedure done under GA to decrease postop pain.

Vitrectomy (removal of vitreous) is commonly performed to reduce traction on the retina (↓ retinal detachment), clear blood and debris, and remove scar tissue. It is an intraocular procedure in which three 20-25-ga openings are made into the vitreous cavity with a myringotomy blade 3-4 mm posterior to the limbus (junction of the cornea and sclera). One of these openings in the inferotemporal quadrant is used for infusion of balanced salt solution via a sutured or *(Print pagebreak 189)* transconjunctival trocar-based cannula. The remaining openings are at the 9:30 and 2:30 o'clock positions. One is used for a handheld fiber-optic light, and the other for insertion of a variety of manual and automated instruments, including suction cutters, scissors, and forceps, used to remove and section abnormal tissue within the vitreous cavity.

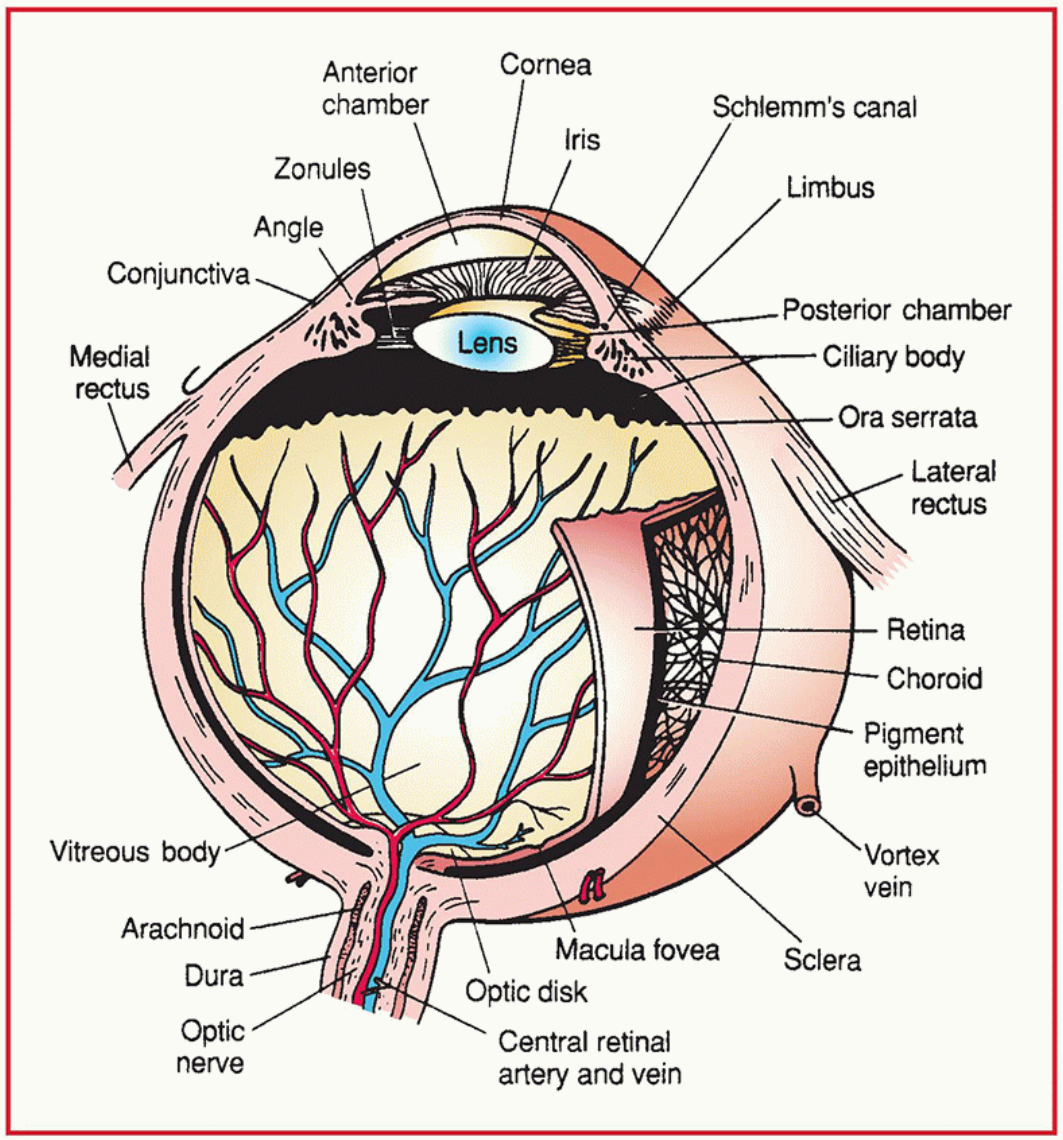

Figure 2.12 Eye anatomy. (Reproduced with permission from Langston D, ed: *Manual of Ocular Diagnosis and Therapy*, 2nd edition. Little, Brown, Boston: 1985.)

Visualization of the retina during vitrectomy is made possible by a contact lens, which is either sutured to the eye or held in position by an assistant. Some of these lenses provide a wide-field, inverted view of the retina, necessitating an image inverter on the microscope. Alternatively, a noncontact, wide-field lens may be positioned just above the cornea, suspended from the microscope. Balanced salt solution gas, silicone oil, or liquid perfluorocarbon replaces the vitreous and other tissues removed during the operation. A bubble of gas (e.g., sulfur hexafluoride or perfluoropropane mixed with air) is sometimes introduced into the vitreous cavity during a scleral buckle or a vitrectomy when the surgeon wants an internal tamponade of retinal tears that cannot be closed adequately by a scleral buckle alone. N_2O must be discontinued before a gas-fluid exchange to avoid an intraop or postop change in gas bubble size, possibly accompanied by abnormal IOP.

In the case of a giant retinal tear, a **gas-fluid exchange** formerly was performed with the patient in the prone position toward the end of the operation. This required that the patient be on a Stryker frame, so that he or she could be moved from the supine to the prone position for the gas-fluid exchange. Perfluorocarbon liquids now obviate the need for a Stryker frame.

Liquid vitreous substitutes, such as perfluorocarbon liquids or silicone oil, are sometimes introduced into the vitreous cavity during a vitrectomy. Perfluorocarbon liquids are heavier than water and are used as an intraoperative tool to unfold the detached retina; they are removed at the end of the procedure. Perfluorocarbon liquids make possible repair of giant retinal tears in the supine position, thus eliminating the need for a Stryker frame. They also facilitate reattaching the retina when PVR is present, by allowing a relaxing retinotomy for those situations where the retina is too stiff and foreshortened to be reattached by less-invasive measures. Silicone oil is used for complex detachments in which a long-term, internal tamponade of retinal tears is deemed necessary to prevent redetachment. It usually is removed a few months postoperatively with a second operation.

(Print pagebreak 190)

Usual preop diagnosis

Simple and complex retinal detachment; diabetic retinopathy; vitreous hemorrhage or opacification; macular epiretinal membranes; other surgically correctable macular conditions, such as macular holes or macular degeneration with subfoveal choroidal neovascularization or hemorrhage; dislocated IOL; endophthalmitis; macular degeneration with posterior segment trauma, including repair of ruptured globes and removal of intraocular foreign bodies; ROP; high myopia; trauma

ERAS: For elective surgery, counseling by the surgeon/anesthesiologist should include limiting NPO duration, alcohol and smoking cessation, carb loading, and postop pain management. *See Appendix K, p. K-1*.

▪ SUMMARY OF PROCEDURE

Position	Supine
Incision	Transconjunctival
Special instrumentation	Vitrectomy machine; cryoprobe; laser; indirect ophthalmoscope; microscope
Unique considerations	Ruptured globe—avoid ↑ IOP. Stop N_2O 5-10 min before a gas-fluid exchange. Retinal detachments often require urgent surgery (<24 h).
Antibiotics	May use iv antibiotics at the start of surgery, in addition to subconjunctival antibiotics at conclusion of surgery
Surgical time	Pneumatic retinopexy: 20 min Scleral buckle: 30 min to 2 h Vitrectomy: 1-4+ h
Closing considerations	Try to avoid postop coughing, bucking, vomiting, or other Valsalva-like events. Specific head positioning may be required following intraocular gas injection.
EBL	None
Postop care	Prone positioning may be necessary if gas was injected. Alternatively, the surgeon may permit recovery in a sitting position with face down.
Mortality	Extremely rare
Morbidity	Hemorrhage: <5% Retinal detachment: <5% Infection: <1% Proliferative retinopathy
Pain score	4-6

▪ PATIENT POPULATION CHARACTERISTICS

Age range	Usually adults; occasionally premature infants (ROP), and children (retinal detachment or trauma)
Male:Female	3:2
Incidence	1/10,000/yr phakic, 1-3% of patients postcataract extraction with placement of intraocular lens
Etiology	Majority idiopathic possibly related to anatomic predisposition; some related to systemic disease or induced by

Associated conditions	trauma or cataract surgery Idiopathic: retinal detachment, epiretinal membrane, macular hole Diabetic retinopathy: vitreous hemorrhage or traction retinal detachment Macular degeneration: subfoveal choroidal neovascularization or hemorrhage Trauma: vitreous hemorrhage, retinal detachment, ruptured globe Intraocular foreign body (IOFB) HTN: vitreous hemorrhage Extreme prematurity: ROP Proliferative sickle-cell retinopathy

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ANESTHETIC CONSIDERATIONS

PREOPERATIVE

In MAC cases, the need for anxiolytics can often be reduced or eliminated by discussing in detail what will happen to the patient during the procedure and by addressing patient concerns (e.g., claustrophobia, positional pain, supine dyspnea). Most vitreous and retinal procedures can be accomplished using regional anesthetic techniques (retrobulbar, peribulbar, or sub-Tenon block) with MAC. Procedures requiring more than 2 h and patients (or surgeons) with special needs (e.g., claustrophobia, uncooperative, immature) may benefit from GA. With MAC, the anesthesiologist's goal should be a comfortable, cooperative patient who can lie completely still without falling asleep (thereby avoiding uncontrolled movement when suddenly awakened) for 1-2 h while avoiding Valsalva-like events (e.g., coughing).

Cardiovascular	Mannitol decreases IOP by increasing plasma oncotic pressure relative to aqueous humor pressure. It may be given just before or during surgery. Total dosage should not exceed 1.5-2 g/kg iv over a 30-60-min period. Rapid infusion of large doses of mannitol may precipitate ↓ BP, CHF, pulmonary edema, electrolyte abnormalities, and, possibly, myocardial ischemia, hence, the importance of a thorough evaluation of the patient's renal and cardiovascular status prior to administering mannitol. Patients on antithrombotic drugs may be at higher risk for bleeding complications. The decision to stop these drugs and institute heparin bridge therapy should be made in consultation with both the surgeon and the prescribing physician. **Tests:** As indicated from H&P
Diabetes	Diabetic patients are at increased risk for silent myocardial ischemia. Pulmonary aspiration 2° diabetic gastroparesis is also a risk in this population. Patients taking sc insulin should take two-thirds of their usual dose the evening before surgery and one-half their usual NPH dose on the morning of surgery. Any morning dose of regular insulin should be held.
	Acetazolamide, a carbonic anhydrase inhibitor, decreases

Renal	secretion of aqueous humor. It also inhibits renal carbonic anhydrase, thereby causing loss of HCO_3, Na^+, K^+, and water. Thus, patients on chronic therapy may be acidotic, hypokalemic, and hyponatremic. **Tests:** Electrolytes; others as indicated from H&P
Hematologic	Sickle-cell disease → retinopathy. Sickle-cell trait is not commonly associated with periop complications. Patients with sickle-cell anemia should be well hydrated and transfused preop, as necessary to increase HbA concentration >40%.
Laboratory	Tests as indicated from H&P
Premedication	Midazolam 0.5 mg/kg po for pediatric patients (˜30 min to peak effect, ˜30-min duration of effect) and midazolam 1-2 mg iv incrementally for adults will help alleviate anxiety. Avoid excessive sedation (respiratory depression) in sickle-cell patients. Surgeons prefer a normal IOP during retinal reattachment surgery, and therefore, patients may be given acetazolamide or mannitol to decrease IOP.
ERAS	Check compliance with presurgical ERAS recommendations (see above) including NPO status. Consider preop acetaminophen 1000 mg po with sip of water. Topical anesthesia will often be started in the preop holding area.

INTRAOPERATIVE

Anesthetic technique

Retinal detachment surgery may be performed under regional anesthesia (e.g., retrobulbar or peribulbar block); however, if the surgery is expected to be >2 h, GETA may be preferable. Increased discomfort may occur during scleral buckle placement. Rx with short-action analgesics. If it is possible that cautery may be used during the surgery, then the delivered FiO_2 should be <0.3 to minimize fire hazard when using open oxygen delivery methods (e.g., nasal prongs, mask, etc.).

(Print pagebreak 192)

Induction	Standard induction is appropriate for these patients with care being taken not to put pressure on the affected eye with the face mask.	
ERAS	Verify preincision antibiotics. Assess volume status (see Appendix K). Maintain normovolemia and normothermia. The ophthalmologist may place nerve blocks.	
Maintenance	Standard maintenance. Ophthalmologists, however, may use expanding gases, such as sulfur hexafluoride (SF_6) or perfluoropropane (C_3F_8), for internal tamponade of the retinal tears, and, if N_2O is used, the injected bubble may expand rapidly, causing a dramatic rise in IOP. This can impair retinal blood flow. N_2O, if used at all, should be D/C'd at least 15 min before gas injection. For any subsequent surgery, N_2O should be avoided for at least 14 d after an air injection, 30 d after a SF_6 injection, and 90 d after C_3F_8. Given the importance of patient immobility, nondepolarizing muscle relaxants may be advantageous, especially if N_2O is D/C'd.	
Emergence	Use narcotics for pain control and consider iv lidocaine 1.0-1.5 mg/kg 5 min prior to extubation to provide smooth emergence. The common occurrence of PONV requires the administration of intraop antiemetics (e.g., metoclopramide 10-20 mg iv and ondansetron 4-8 mg iv 30 min before the end of surgery).	
Blood and fluid requirements	IV: 18-20 ga × 1 (adult) 20 ga × 1 (child) NS/LR @ 4-6 mL/kg/h	See Zero Balance Fluid Management, Appendix K, p. K-2 and p. K-4
		Processed EEG may be useful in

		monitoring level of sedation.
Monitoring	Standard monitors	Care should be taken to avoid CO_2 accumulation under the drapes in MAC cases. The unheated output from a Bair Hugger™ hose or similar air source can be used to improve air circulation under the drapes.
Positioning	and pad pressure points and pad nonsurgical eye	For long MAC cases, short "time-outs" should be taken to allow patients to reposition themselves.
Complications	Oculocardiac reflex (OCR)	OCR: traction on EOMs → ↓↓ HR, ↓↓ BP, ventricular ectopy, and asystole. Rarely occurs during GA or following adequate retrobulbar block. Rx: stop surgical manipulation, atropine for persistent bradycardia, CPR

POSTOPERATIVE

Complications	PONV Corneal abrasion Vitreous hemorrhage Glaucoma Ptosis Diplopia Loss of vision Infection	Rx: ondansetron 4-8 mg iv ± metoclopramide 10-20 mg iv; however, eye pain (e.g., 2° to corneal abrasion) may also cause N/V. If this is the case, treat eye pain (ophthalmology consult). Persistently low BP → retinal ischemia and central retinal artery occlusion
Multimodal pain management	Acetaminophen 1 g po or iv if not given within previous 4-6 h	PO narcotics may be needed, especially when retrobulbar anesthesia was contraindicated. Emphasize nonopioid analgesics including acetaminophen and NSAIDs if not contraindicated (see Appendix K, p. K-5).
ERAS	PONV protocol (see p. B-1)	Encourage early enteral nutrition and mobilization. Consider DVT prophylaxis if early mobilization is not possible.
Tests	None routinely required	

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Suggested Readings

1. Bryant JS, Busbee BG, Reichel E: Overview of ocular anesthesia: past and present. *Curr Opin Ophthalmol* 2011; 22(3):180-4.

2. Charles S, Fanning GL: Anesthesia considerations for vitreoretinal surgery. *Ophthalmol Clin North Am* 2006; 19(2):239-43.

3. Cruz-Iñigo YJ, Acabá LA, Berrocal MH: Surgical management of retinal diseases: proliferative diabetic retinopathy and traction retinal detachment. *Dev Ophthalmol* 2014; 54:196-203.

4. Kumar CM, Eld H, Dodds C: Sub-Tenon's anaesthesia: complications and their prevention. *Eye (Lond.)* 2011; 25(6):694-703.

5. Nouvellon E, Cuvillon P, Ripart J: Regional anesthesia and eye surgery. *Anesthesiology* 2010; 113(5):1236-42.

6. Palte HD. Ophthalmic regional blocks: management, challenges, and solutions. *Local Reg Anesth* 2015; 8:57-70.

General Ophthalmic Surgery Suggested Readings

1. Ahmad S, Ahmad A: Complications of ophthalmologic nerve blocks: a review. *J Clin Anesth* 2003; 15(7):564-9.

2. Barton JG: Enhanced recovery pathways in pancreatic surgery. *Surg Clin North Am* 2016; 96(6):1301-12.

3. Hughes MJ, McNally S, Wigmore SJ: Enhanced recovery following liver surgery: a systematic review and metaanalysis. *HPB (Oxford)* 2014; 16(8):699-706.

4. Kelly DJ, Farrell SM: Physiology and role of intraocular pressure in contemporary anesthesia. *Anesth Analg* 2018; 126 (5):1551-62.

5. Mahajan D, Sain S, Azad S, et al: Comparison of topical anesthesia and peribulbar anesthesia for 23-gauge vitrectomy without sedation. *Retina* 2013; 33(7):1400-6.

6. Mason J, Gupta S, Compton C, et al: Comparison of hemorrhagic complications of warfarin and clopidogrel bisulfate in 25-gauge vitrectomy versus a control group. *Ophthalmology* 2011; 118(3):543-7.

7. Pędziwiatr M, Mavrikis J, Witowski J, et al: Current status of enhanced recovery after surgery (ERAS) protocol in gastrointestinal surgery. *Med Oncol* 2018; 35(6):95.

8. Pokhrel PK, Loftus SA: Ocular emergencies. *Am Fam Physician* 2007; 76(6):829-36.

Suggested Viewing

Links are available online to the following videos:

Scleral Buckle and Vitrectomy for Retinal Detachment: https://www.youtube.com/watch?v=CJy8qjNojAc

Vitrectomy for Vitreous Opacities (Floaters): https://www.youtube.com/watch?v=zryk1Ys7td8

Advanced Cataract Surgery—"In Simple English": https://www.youtube.com/watch?v=aohAHNYpAOs