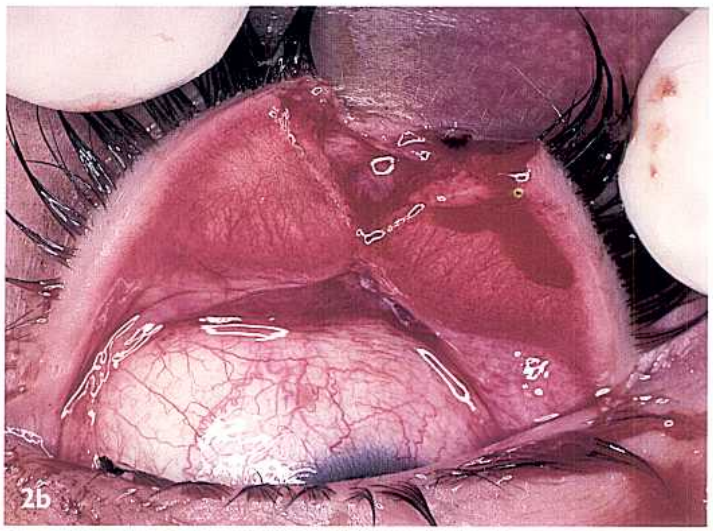


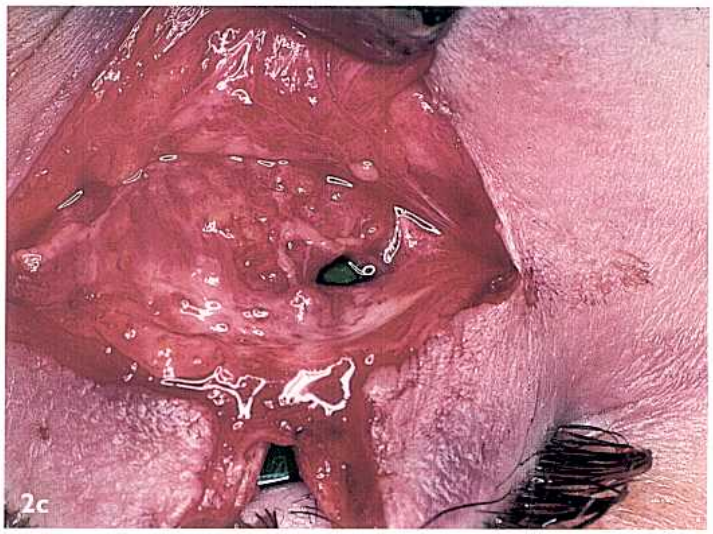


Figure 2. Upper eyelid laceration. 2a: Injury appears limited, but as patient looks up, it is evident that levator function is compromised. 2b: Lid eversion reveals complete vertical tarsal laceration and superior fornix conjunctival laceration. 2c: Exposure, achieved through an anterior lid crease incision, reveals laceration of conjunctiva, Müller's muscle, and levator aponeurosis. The conjunctiva was reattached to the tarsal plate, and the aponeurotic defect was repaired following tarsal approximation. Eight months following repair, levator function was normal. (Reprinted with permission from Stewart WB, ed. *Surgery of the Eyelid, Orbit, and Lacrimal System*. Ophthalmology Monograph 8, vol 1. San Francisco: American Academy of Ophthalmology, 1993:173.)

reason for this priority is that edema reduces eyelid pliability and increases horizontal tension; this is further increased by closing the remote laceration. The reduced eyelid elasticity complicates canalicular reconstruction because it hampers nasolacrimal intubation (see more under ***Canalicular Laceration***).

The repair of intraocular injuries precedes eyelid reconstruction because the eyelid repair might cause further damage to the globe. Further, full-thickness lacerations may enhance exposure of the globe. Eyelid repairs may be delayed for several days without compromising the aesthetic or functional result in cases of excessive eyelid or orbital edema that may pose a risk to ocular or optic nerve circulation. If this approach is elected, antibiotic coverage may be considered, along with measures to control edema such as continuous ice compresses, head elevation, corticosteroids, and protection of the eye.

Types of Lacerations

The Superficial Laceration (RSTL and Anti-RSTL)

When parallel to the relaxed skin tension lines (RSTLs), the edges of partial-thickness lacerations can often be stabilized with Steri-strip supplemented by a skin adhesive. If, however, approximation and skin-edge eversion cannot be maintained by this method, simple interrupted sutures of either 6-0 or 7-0 nylon are required. The edges of vertical eyelid lacerations (anti-RSTL) typically retract, and suture closure of the skin in addition to muscle is required. Skin sutures are removed in about 5 days, followed by the application of Steri-strip, to minimize epithelialization of the suture track.

The Multilayer Laceration

Lacerations that extend through the orbital septum may be associated with occult foreign body and internal disarrangement of crucial eyelid structures, especially the levator aponeurosis. Eyelid excursion is evaluated in every patient with eyelid trauma. Compromised elevation is an indication of possible aponeurotic injury (see Figure 2). The wound is explored layer by layer to assess the integrity of the orbital septum, the levator aponeurosis, conjunctiva, and globe. Injured internal structures are carefully reapproximated, followed by closure of the superficial portion of the wound. It is imperative that the orbital septum not be attached to the levator, orbicularis muscle, or skin during closure; otherwise postoperative lid lag will develop. Complete excision of the septum may be considered in extensive upper eyelid lacerations.

Laceration of the Eyelid Margin

Proper wound preparation, especially the elimination of tarsal irregularities at the edges of the wound, is critical to a good aesthetic outcome in marginal laceration repair. The objective of debridement is a "square" edge in the sagittal plane of the eyelid. Partial vertical debridement of the tarsal plate results in inversion of the wound edges and notching at the margin. The debridement of the tarsal irregularities is, therefore, extended over the entire vertical tarsal span, even if the primary laceration only involves the tarsal segment at the margin. Slightly increasing the width of the debridement at the antimarginal tarsal border favors margin eversion when the incision is closed.

Beginning tarsal repair by placement of 6-0 silk marginal traction sutures simplifies subsequent suture placement by correctly aligning and stabilizing the tarsal segments (see Figure 3). The traction suture is positioned in the plane of the meibomian glands, about 1.5 mm–2.0 mm from the wound edge, and penetrates to a depth of about 1.5 mm–2.0 mm before exiting the tarsus. The suture is then directed into the edge of the opposite tarsal segment, emerging 1.5 mm–2.0 mm from the cut edge, again in the plane of the meibomian orifice. As tension is applied to the traction suture, the tarsal edges are brought into apposition. The tarsal plates are joined with 7-0 silk, and knots are tied on the anterior surface to prevent corneal irritation.

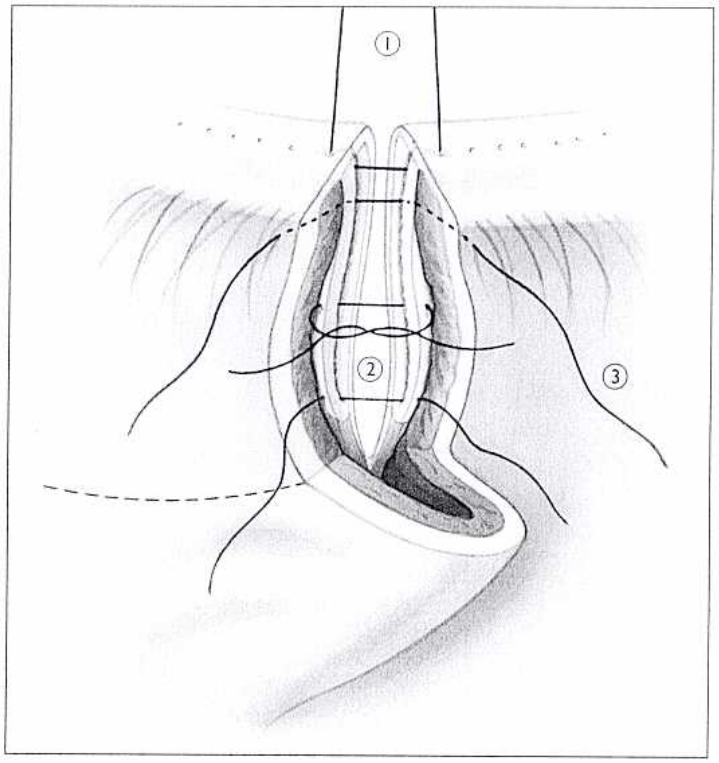


Figure 3. The tarsal segments are apposed by traction on a 6-0 silk marginal suture (1) and approximated with interrupted 7-0 silk (2). An additional 6-0 silk suture is placed to align the lashes (3), followed by skin closure during which the dog-ear is resected parallel to the relaxed skin tension lines (dotted line). *(Illustration by Christine Gralapp, San Francisco.)*

Absorbable sutures of similar size may also be employed in closure of tarsal lacerations, but, if tensile strength is prematurely lost, the eyelid contour may be unsatisfactory; this is especially likely if there is significant tension at the suture points.

Additional marginal and skin sutures are placed as needed, to achieve precise alignment of the tarsal margin and the eyelashes. Suture placement in the gray line is avoided because the tensile strength of the underlying muscle may not be sufficient to maintain apposition of the wound edges. The ends of marginal sutures are left long and anchored by a skin suture to prevent contact with the cornea. Lid margin sutures are left in place for 7–10 days, depending on the degree of wound tension.

Correct needle size and curvature are important technical components of tarsal repair. The Ethicon TG140-8 on 6-0 silk is useful for the marginal traction suture, and the Alcon C-3 on 7-0 silk for deep tarsal approximation. These needles cause minimal tarsal trauma, unlike larger needles such as the P-1, B-1 (Alcon) and P-2 (Ethicon) needles.

Tissue Loss

Full-Thickness Tissue Loss from the Central Eyelid

When direct approximation is not possible due to full-thickness loss of a segment of the eyelid or extensive damage, simple and contiguous tissue mobilization is employed as an adjunctive reconstructive measure.

Generalizations that relate the size of an eyelid defect to a specific technique for repair are of limited practical value in trauma management, since the viscoelastic properties of the eyelid vary considerably from individual to individual. The distensibility of tissues adjacent to the wound, and thus, the degree to which the remaining eyelid tarsal segments can be advanced, is determined empirically. In the selection of adjunctive reconstructive techniques, additional planning considerations include the degree of injury to internal eyelid structures (i.e., retractors, tarsus), prevention of vascular compromise of tissues to be mobilized, assurance of adequate mucous membrane coverage of the eyelid, and preservation or reconstruction of key anatomic landmarks.

The simplest means of increasing lateral eyelid mobility is release of the lateral canthal tendon from the lateral orbital rim. Division of the tendon (anterior and posterior crus), however, usually allows only slight medial advancement of the lateral eyelid. This limitation is due to the fact that the lids are tethered laterally not only by the tendon, but also by the submuscular fascia, septum, and eyelid retractors. These inelastic attachments are identified by placing anterolateral tension on the lid (see Figure 4). Their release is mandatory to achieve full mobilization.

If the complete release of the eyelid from the lateral orbital rim fails to provide the "lengthening" needed to close a central eyelid defect, rotation of tissue from the lateral canthal region is carried out. A Mustarde rotation flap permits transfer of a large area of skin; however, most eyelid injuries require less extensive tissue manipulation. The semicircular flap, described by Tenzel, is a useful hybrid of the Mustarde technique. The primary advantages are that it permits substantial tissue mobilization while confining dissection to the lateral orbital area, and it can be used to close both upper and lower eyelid defects (see Figure 5).

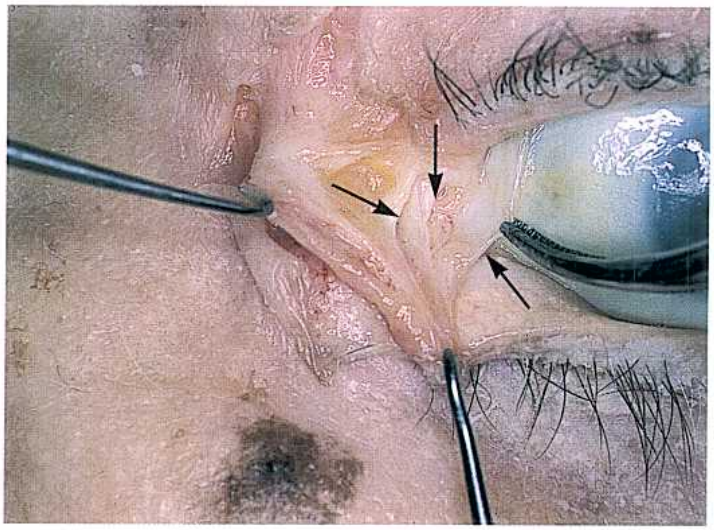


Figure 4. Attachments of the tarsus to the inferolateral orbital rim periosteum include the lateral canthal tendon, orbital septum, and capsulopalpebral fascia. Anterior traction on the lateral tarsus reveals these attachments as distinct bands (see arrows) that are divided by scissors or electrocautery to increase mobility of the lateral eyelid.

The skin incision in the Tenzel procedure is begun at the lateral canthal angle, then curved upward (downward when mobilizing the upper eyelid), followed by moving downward to create a semicircle whose diameter is roughly 2.5 cm–3.0 cm. About 7 mm of medial eyelid advancement is achieved when this diameter is chosen, and a small back-cut adds another 1 mm–2 mm of medial eyelid rotation. The orbicularis is next incised with needle-tip cautery and dissected from the fascia that covers the underlying periosteum. Damage to facial nerve branches lying on the posterior surface of the orbicularis can be avoided by elevating the muscle with a blunt instrument, such as a Tessier elevator. Complete release of the eyelid from the orbital rim occurs when the attachments between the rim and the lateral tarsus and the orbicularis oculi are divided, as previously mentioned. The lateral tarsal segment is then advanced to the medial tarsal segment and approximated. The posterior surface of the advanced tissue is covered by conjunctiva advanced from the fornix, which is joined to the skin edge with fine suture such as 7-0 silk.

Correct positioning of the lateral canthal angle is assured by suturing the skin-muscle flap to the periosteum of the medial aspect of the lateral orbital rim with an absorbable suture such as polyglactin or polydioxanone. This suture prevents distraction of the eyelid from the globe. In upper lid reconstruction, this attachment is re-created at the usual anatomic position, the level of Whitnall's tubercle,

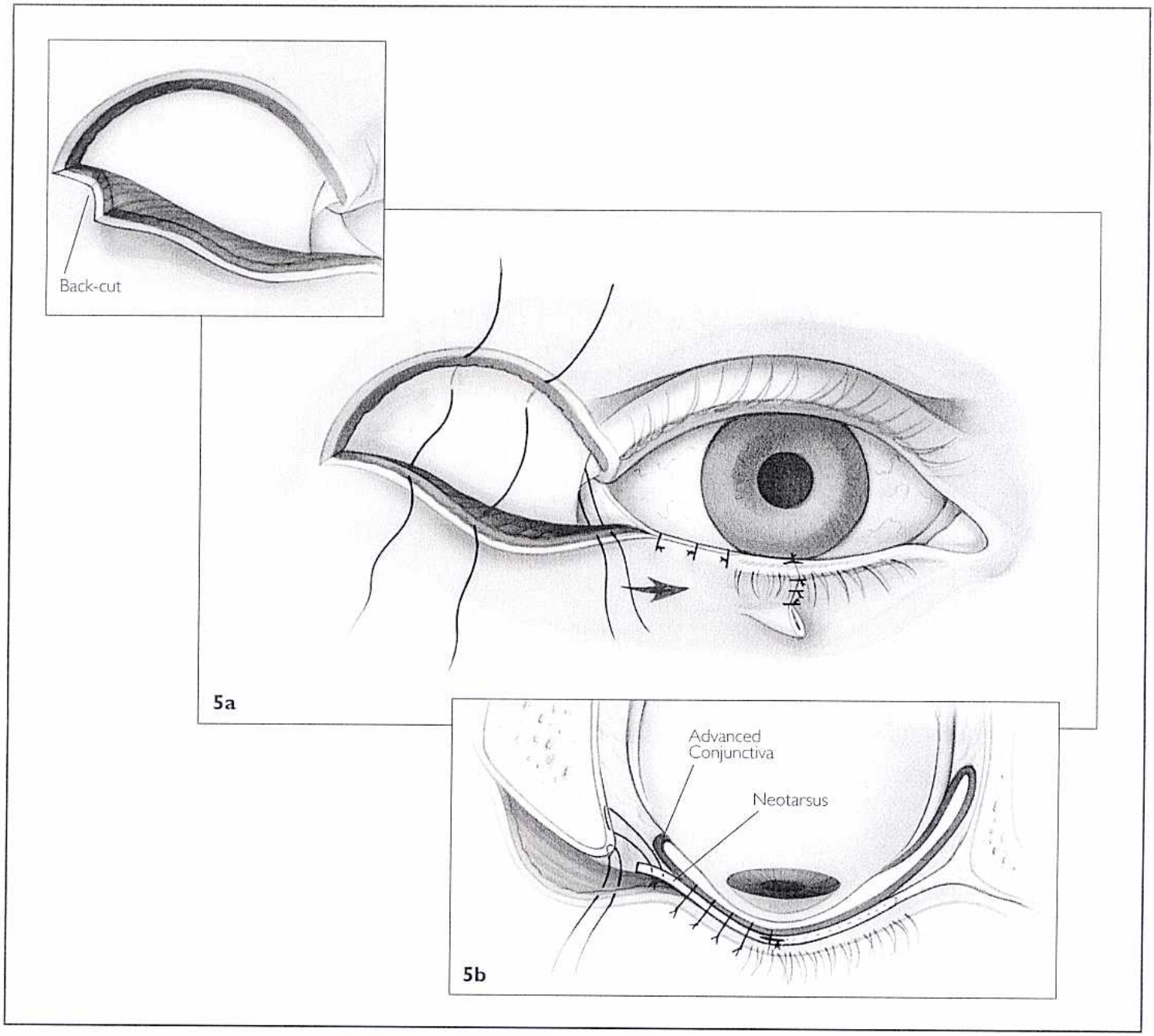
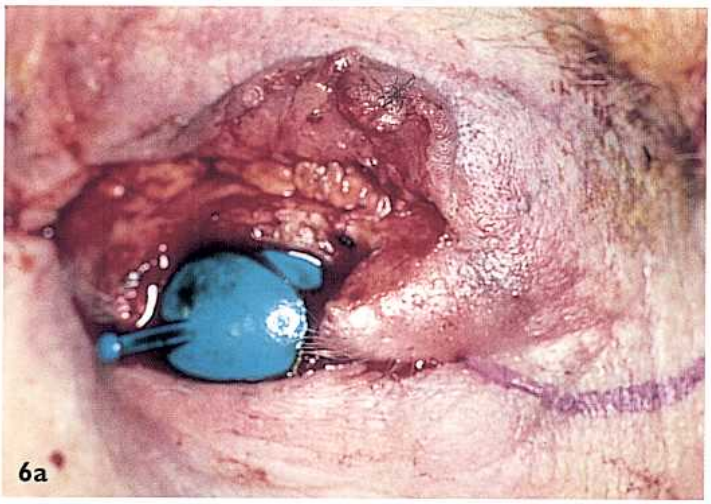


Figure 5. The semicircular flap technique of Tenzel. 5a: The rotation flap is sutured to the lateral orbital rim and to the medial aspect of the lateral wall in the anatomic position. Bulbar conjunctiva is mobilized from the lower fornix and attached to the skin, covering the posterior surface of the flap. Excess skin is resected from the central eyelid following the relaxed skin tension lines. (Figure shows wound approximation at inferior tarsus as depicted in Figure 3.) A small back-cut (see inset) adds another 1 mm–2 mm when additional medial eyelid rotation is needed. 5b: If tarsal replacement is required, the graft is approximated to the medial eyelid segment and lateral orbital rim and covered by conjunctiva. *(Illustration by Christine Gralapp, San Francisco.)*

which lies on a plane about 1 mm superior to the medial raphe. In lower eyelid repair, the flap is fixed approximately 1 mm above the usual anatomic position of the lateral canthal angle to counteract the effect of gravity and scar contracture, which may cause inferior drift of the canthal angle.

Complex Eyelid Reconstruction: Technical Tips

The semicircular flap yields good aesthetic and functional results in repair of limited tissue loss of the central eyelid (see Figure 6). This method cannot be used as the sole reconstructive maneuver when the lateral eyelid is avulsed or when there is loss of the



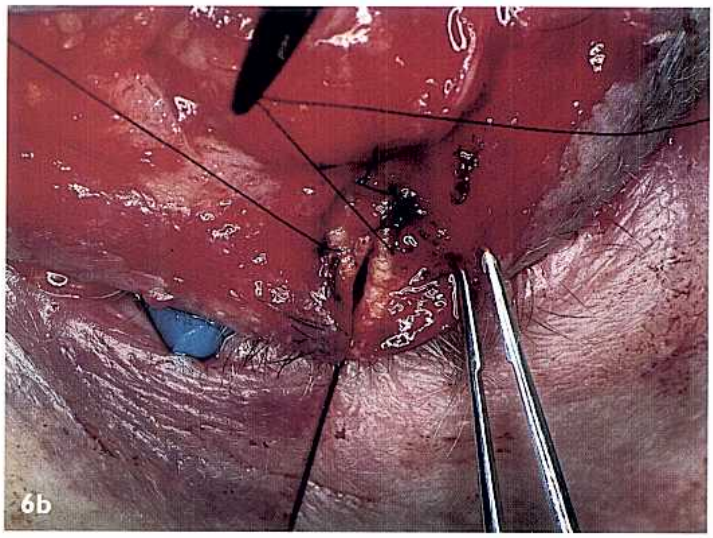


Figure 6. Extensive tarsal injury depicted in Figure 1 is repaired using the Tenzel flap technique. **6a**: Debridement of the central tarsus is done in preparation for reconstruction. **6b**: Following mobilization of the lateral eyelid, the tarsal segments are apposed by tarsal traction suture and repaired, followed by reconstruction of the anterior lamellar injury. **6c**: The patient is shown 5 months following injury.

majority of the lid (see ***Cheek Rotation Flap*** and ***Tarsoconjunctival Flap*** below). In such cases, the posterior lamella of the eyelid and the anterior lamella must be reconstructed using tissue from separate donor sites. The tarsoconjunctival pedicle graft and the cheek rotation flap are two techniques that allow reconstruction of almost all extensive eyelid injuries. The important technical requirements of these procedures and additional points regarding the semicircular flap are presented below.

Semicircular Flap of Tenzel. The following comments regarding the limitations of the semicircular rotation flap are warranted to reduce the risk of complication:

The vertical dimension of the tarsus diminishes as it reaches the canthi and, if the vertical dimension of the lateral tarsus is less than 2 mm, a postoperative notch in the lid margin is likely. A lateral horizontal tarsal remnant shorter than 5 mm will usually have a vertical tarsal dimension insufficient for effective apposition to the medial remnant.

When the distance between the orbital rim and the terminus of the lateral tarsal segment exceeds 1 cm, a noticeable postoperative saddle deformity of this segment may occur. A tarsal replacement may be warranted to minimize this risk of deformity (see Figure 5b). Tarsoconjunctiva is replaced with either a free graft from the ipsilateral or contralateral upper lid or a tarsoconjunctival pedicle flap from the ipsilateral upper lid. Conchal cartilage and nasal septal cartilage are alternative tarsal substitutes. If upper tarsus is lost, a free tarsal graft from the contralateral eyelid is the best option. A pedicle flap is preferred if most of the tarsus must be replaced in the lower eyelid. Free or pedicle tarsoconjunctival grafts from the lower eyelid are not recommended because insufficient tarsus is available for transfer, and a postoperative deformity of the donor site will result.

Cheek Rotation Flap. When the semicircular flap is inadequate, a rotation flap from the lateral periorbit and face provides skin of appropriate color, if not ideal thickness. Popularized by Mustarde, this flap is used as an adjunct in the advancement of the lower lateral eyelid or as a replacement for the anterior lamella.

The incision defines an arc that begins at the lateral canthus and terminates at a pivot point located in the preauricular region. In the original description of the flap, the incision ascended gradually from the lateral canthus. This design does not provide sufficient skin area to prevent lower scleral

show as the flap matures, a drawback that can be corrected by increasing the slope of the incision when it leaves the lateral canthus, as in the Tenzel method. As the flap is rotated medially, a generous area of skin is imparted to the neoeyelid.

Proper lateral canthal positioning and contact of the eyelid with the globe are assured by attaching the flap to the lateral orbit as previously described. Finally, as a random pattern flap, its blood supply is dependent upon an intact dermal-subdermal vascular plexus. This plexus is protected by leaving a small amount of fat attached to the flap as it is undermined.

Tarsoconjunctival Flap. The transfer of tarsus with an attached broad pedicle of conjunctiva and Müller's muscle is a reliable means of restoring the posterior lamella of the lower lid. The complications of this technique can usually be avoided by attention to critical technical details. One of these complications, eyelid ectropion, occurs if the horizontal dimension of the transferred tarsus is excessive. The length of the donor tarsus is determined by measuring the length of the deficit to be corrected as the margins of the wound are drawn firmly toward one another with forceps. The other major complication, upper lid retraction, is caused by incomplete release of adhesions between Müller's muscle and the upper tarsus at the second stage of the procedure. Normal upper eyelid motility is restored by thoroughly releasing all attachments between the muscle and the tarsus. Complete release is confirmed if the levator aponeurosis is freely mobile when the dissection is complete. Recession of the conjunctiva and Müller's muscle composite to the correct position by suture fixation at the level of the eyelid crease further reduces the risk of lid retraction. Irregularity of the lid margin at the donor site is avoided by preserving 3 mm–4 mm of marginal tarsus. This is a modification of the original technique described by Hughes.

Canthal Injuries

From a functional viewpoint, the anterior components of the canthal tendons may be regarded as check ligaments of the orbicularis oculi and tarsus, while the posterior components maintain apposition between the eyelids and the globe. The medial canthal tendon's anterior component, about 6 mm–8 mm in length and 3 mm in width, attaches the tarsi to the frontal process of the maxilla. The tarsi attach to the posterior lacrimal crest via the lacrimal portion of the orbicularis oculi muscle complex, sometimes referred to as Horner's muscle. This attachment is essential to maintain the puncta in the lacrimal lake.

The anterior component of the lateral canthal tendon is about 6 mm long and 2 mm wide and lies immediately posterior to the orbicularis oculi muscle. It attaches the orbicularis and the tarsi to the fascia that lies anterior to the lateral periosteum. The posterior crus inserts on Whitnall's tubercle about 3.0 mm posterior to the orbital rim. Failure to restore this posterior relationship leads to lid-globe distraction at the lateral canthus.

Lateral Canthal Disruptions

Lacerations of the anterior crus are repaired by simple direct approximation with absorbable sutures prior to skin repair. Deeper lacerations and avulsion may also be closed directly *if the ends of the tendon can be identified,* a task that is usually difficult (even with loupe magnification). Accordingly, it is often necessary, and easier, to create a direct tarsoperiosteal attachment at the usual anatomic position of the tendon insertion. A nonabsorbable suture (e.g., 4-0 Polydek, 5-0 nylon) attached to a half-circle cutting needle (e.g., ME-2, S-22) is ideal for this purpose. The needle is passed through the lateral tarsus and next purchases the periosteum at Whitnall's tubercle. If both tarsi are detached from the orbital rim, they are both incorporated in the suture.

When the periosteum is also damaged, direct tarso-osseus fixation is required. The tarsus is attached to the bone as follows: Two 1.5-mm diameter holes are drilled in the lateral orbital rim, entering the orbit at the level of Whitnall's tubercle (about 2 mm–3 mm inferior to the frontozygomatic suture). The holes are placed 2 mm–3 mm apart and tapered to a common opening at the medial orbit. Their individual identity is preserved on the lateral orbital surface to provide a bridge over which the tarsal sutures are tied. The sutures are retrieved from the orbit by use of a 30-gauge wire, folded in half to form a loop, and passed through the drilled holes. One arm of the suture at a time is passed through the loop and the wire is withdrawn.

Medial Canthal Disruptions

Superficial or partial-thickness lacerations of the anterior limb of the medial canthal tendon are

repaired by a simple interrupted absorbable suture. Complete disruption of the medial canthal tendon complex necessitates reattachment of the tarsi to the posterior lacrimal crest. Injury to the lacrimal system usually results when the posterior component of the complex is injured. Posterior tendon repair precedes definitive lacrimal repair. However, bicanalicular intubation is performed before tendon repair is initiated, as tube placement is difficult after the posterior tendon is reconstructed.

Canalicular Laceration

Knowledge of canalicular anatomy and proper examination technique is critical for efficient and successful repair of canalicular lacerations (see Table 1).

The punctum marks the beginning of the distal lacrimal collecting system. Its superficial vertical tubular structure expands to a fundus, which empties into the transverse canaliculus. The canaliculi are covered posteriorly by conjunctiva and surrounded anteriorly by orbicularis oculi muscle and skin. In the coronal plane, the canaliculi remain in and then *anterior* to the plane of the caruncle as they move toward the lacrimal sac. Medial to the caruncle, the canaliculi are protected by the anterior limb of the medial canthal tendon (see Figure 7, cover). They usually enter the lacrimal sac in common, although rarely each canaliculus may join the sac separately.

Assessment

To permit thorough and painless evaluation, the injured area is infiltrated with an epinephrine-containing anesthetic agent to which hyaluronidase is added in a 9:1 ratio. This mixture is administered through a 30-gauge needle. Gentle pressure is applied to disperse the anesthetic and eliminate tissue distortion. Ten to fifteen minutes after injection, delicate forceps without teeth and cotton-tipped applicators are used for initial exploratory dissection. Rough handling of the tissue is avoided, because bleeding from the pericanalicular tissue may obscure the severed canaliculus. As the tissues are gently separated, the circular canalicular ends, lighter in color than the muscular tissue that surrounds them, are readily identified along the posterior-superior lid margin. Good illumination and at least a 3x–4x loupe magnification facilitates tissue identification. The operating microscope may be beneficial in macerated or very proximal wounds.

Table 1. Critical Steps in Canalicular Repair

1. Infiltrate injured region with local anesthetic containing epinephrine and Wydase additives.
2. Inspect wound after onset of vasoconstriction (10–12 minutes).
3. Dissect area atraumatically to identify nature and location of canalicular injury using bright illumination and 4x loupe or microscope.
4. Assess tendinous and other associated soft tissue injuries.
5. Intubate upper and lower canalicular systems with Crawford tubes.
6. Place canalicular anastomosis suture but do not tie.
7. Place tendon (anterior and/or posterior) repair sutures but do not tie.
8. Bring wound margins together using traction on the silicone tubes; tie the canalicular suture and then the tendon suture.
9. Repair remaining soft tissue injuries.
10. Secure silicone tubes to inner aspect of nasal ala to prevent subsequent migration of tubes into palpebral fissure.

A laceration located lateral to the caruncle usually is easily recognized and repaired. Lacerations closer to the sac present a greater challenge because the ends of the canaliculus lie beneath the medial canthal tendon and may also retract due to the contracture of the orbicularis oculi. The laceration may be extended to achieve necessary exposure, or a separate incision parallel to the tendon may be made to expose the injury.

Repair

When the canaliculus has been adequately exposed, its reconstruction is begun with bicanalicular intubation. Silicone intubation sets with flexible probes offer two advantages: The smooth, ball-tipped end of the wire segment of the Crawford tubes is less likely to create false passages than the more rigid devices. Also, these may be withdrawn from the nose atraumatically with the retrieval hook. If the eyelid is edematous, the probe is first passed *completely* through the distal canalicular segment and

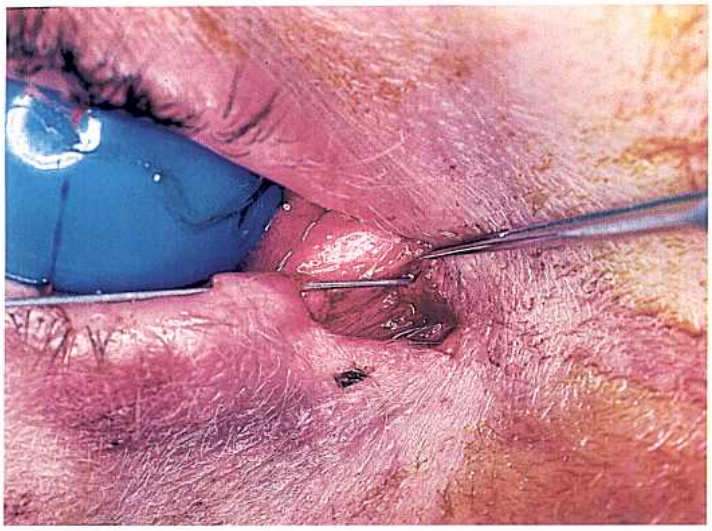


Figure 8. If the eyelid is not swollen, the lacrimal probe may be passed through both canalicular segments in a single maneuver. The proximal canalicular segment is stabilized with forceps, facilitating passage of the probe into the lumen. However, eyelid swelling may prevent subsequent positioning of the probe for nasolacrimal duct passage and, in this case, the probe is first advanced completely through the distal segment before attempting cannulation of the proximal segment. This sequence eliminates eyelid pressure on the probe as it is rotated to alignment with the nasolacrimal duct.

then advanced into the proximal canaliculus. If eyelid swelling is nil, both canalicular segments are cannulated in a single maneuver. Stabilization of the proximal canaliculus with a delicate forceps will aid passage of the probe into its lumen (see Figure 8). It is then rotated vertically to a position that is coaxial to the nasolacrimal duct. The probe is advanced into the duct and retrieved from beneath the inferior turbinate (which is vasoconstricted with Afrin or similar agent prior to repair).

Following intubation, a 9-0 nylon or polyglactin suture on an atraumatic needle is passed through the ends of the canaliculus but not tied. Soft tissue injuries are then repaired. If the tendon is transected, a mattress or series of simple interrupted sutures is placed between the wound margins but not tied. Because of the delicate nature of the tendon and terminal tarsus, needle size is critical. The Ethicon TG 140-8 needle is preferred over larger needles, which may lacerate the tendon and/or eyelid. Traction is next placed on the silicone tubes to appose the wound margins, and the previously placed sutures are tied, beginning with the canalicular suture. (If the canalicular suture is tied before the edges of the lacerations are apposed, the suture may pull through the tissue.) The tendon sutures are then secured and remaining eyelid lacerations are closed. The silicone tubes are tied beneath the inferior turbinate. A 6-0 prolene suture is placed through the loop into the nasal ala and tied to prevent upward migration of the tube into the nasolacrimal duct.

Bicanalicular intubation is preferred in most canalicular injuries because of the aforementioned advantages and because the tube resists canalicular scarring during healing. It may not, however, be necessary in every case (e.g., an isolated distal laceration of the canaliculus). If bicanalicular intubation is waived, the canaliculus is stented by placing a section of silicone tubing into the punctum and advancing it across the laceration and into the common canaliculus. The canaliculus and soft tissues are then repaired. An 8-0 nylon or prolene suture is then passed through the punctum in horizontal mattress fashion, incorporating the stent, and tied on the anterior surface of the eyelid. The suture retains the silicone during the healing process and is removed after 6–8 weeks. Tubing that extends beyond the punctum is cut flush with the punctal surface. Suture granuloma and premature displacement of the tubes are common problems associated with this method.

Nasolacrimal Duct Cannulation in Difficult Cases

When canalicular laceration is associated with extensive soft tissue edema or maxillary and nasoethmoid fractures, intubation of the nasolacrimal duct is difficult. Intubation is deferred until the fractures are reduced, but, even with proper bone realignment, soft tissue edema may prevent the probe from following the desired course. If attempts to pass the tubes into the nose are unsuccessful, it may be preferable to expose the lacrimal sac and enter its lumen through an incision in the medial wall. The guidewires are then passed through the canaliculus, brought out through the sac, and placed into the nasolacrimal duct under direct vision. The incision in the sac is closed with a fine absorbable suture (e.g., 8-0 polyglactin). In some cases, this method shortens operating time and avoids lacrimal duct trauma, which may cause subsequent stenosis.

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The Clinician's Corner section is intended to provide additional viewpoints on the subject covered in this issue of Focal Points. *Consultants have been invited by the Editorial Review Board to respond to questions posed by the Academy's Practicing Ophthalmologists Advisory Committee for Education. While the advisory committee reviews the modules, consultants respond without reading the module or one another's responses.—Ed.*

Clinician's Corner

1. What is the best way to manage the globe when there is obvious loss of tissue, the wound cannot be closed primarily, and closure will have to be delayed?

Dr. Nowinski: In a serious eyelid injury with tissue loss, when closure or reconstruction cannot be performed right away, the globe and cornea must be protected by constant lubrication until the patient is stable and can undergo definitive eyelid or periorbital repair. The globe is first thoroughly examined for rupture or other injury before using lubrication. Copious amounts of ophthalmic ointment are applied very frequently, and a direct covering of plastic wrap can be placed over the globe. In severe cases, a commercially available moisture chamber can be used to protect the globe. Homemade chambers can be made by surrounding a plastic protective eye shield with plastic wrap to cover the holes and edges.

Dr. Woog: Ocular surface exposure and secondary infection may result from eyelid trauma with loss of tissue preventing primary wound closure. Limited degrees of ocular surface exposure may be managed with frequent instillation of topical lubricant drops or ointments. If sufficient remaining upper and lower eyelid tissue is present, an intermarginal suture (placed over stents prepared from silicone band or red rubber catheter material, and performed without shaving the eyelid margin) may be helpful in protecting the ocular surface. If only one eyelid is intact, a double-armed mattress suture may be placed through an appropriate stent, brought through the anterior eyelid surface, and out the gray line of the eyelid (as a Frost suture). Such sutures may be used in both upper or lower eyelids to achieve corneal protection.

A moisture chamber may also be useful in managing surface exposure. A tarsoconjunctival flap may be mobilized from the intact eyelid and brought over the cornea temporarily, but this procedure may compromise the tissue for subsequent definitive eyelid reconstruction.

2. What antibiotic coverage is appropriate for traumatic eyelid lesions?

Dr. Nowinski: The eyelid is extremely vascular, and many clinicians believe that most cases do not need systemic antibiotic coverage. Dog and human bites require special treatment. While use of systemic antibiotics in dog bites is still controversial, it is more generally agreed that their use is warranted in human bites. When an antibiotic is indicated, a broad-spectrum agent that covers ß-lactamase producers should be used. I prefer Augmentin® when an oral antibiotic is called for. Tetanus and rabies must always be considered with any bite or trauma.

Dr. Woog: Rational selection of systemic antibiotic therapy in eyelid trauma is limited by the lack of controlled studies to determine optimal treatment in this setting. In penetrating eyelid trauma following nonanimal bites, I have found a first-generation cephalosporin (such as cefazolin) useful. Penicillin has been recommended as a single agent or part of multiagent therapy in dog bites, due to the presence of DF-2 bacillus, an organism that may be associated with severe infection, particularly in patients with previous splenectomy.

3. It used to be taught that the superior canaliculus could be sacrificed in repairing a canalicular injury if the lower canaliculus could be repaired. Is this approach still valid?

Dr. Nowinski: Some clinicians believe that the superior canaliculus, if injured alone, may be either left to granulate without primary repair

or repaired without addressing the canaliculus. Many residents have been taught that the lower is the more important and thus the only essential canaliculus for normal function. However, recent studies show that both upper and lower systems are of equal value in many patients. This is supported by the clinical observation that patients can exhibit excess tearing following isolated superior canalicular laceration.

Resistance to repairing isolated canalicular lacerations stems partly from concern about injuring the inferior or common canaliculus from manipulation, especially with the older pigtail probes. However, modern repair techniques have significantly decreased this danger. I attempt or offer to repair the canalicular system on every superior canalicular laceration. Benefits and risks are discussed with the patient or parents in detail.

Dr. Woog: Recent evidence suggests that, while a single canaliculus (particularly the inferior) may be sufficient for drainage of basal tear secretion, both canaliculi are required to provide satisfactory tear drainage in the setting of increased tear secretion that may occur on a reflex basis. Therefore, I prefer to repair even isolated superior canalicular injuries whenever possible.

4. How long can closure of a canalicular laceration be safely delayed pending availability of an ophthalmic plastic surgeon?

Dr. Nowinski: It is ideal to repair canalicular lacerations soon after the injury. However, the laceration can be safely repaired up to 48–72 hours following the injury or even more in selected cases. Adequate repair may be achieved at times longer than this. However, collapse and scarring of the canalicular system will make it more difficult to dissect and determine the anatomic relations, and the resulting scar will lead to a decreased success rate, even if the ends can be adequately apposed.

Dr. Woog: In my experience, it is generally preferable to proceed with primary closure of uncomplicated, nonbite eyelid and canalicular lacerations within 24 hours of injury. Satisfactory results may be achieved as long as 5–7 days following injury when circumstances preclude earlier repair.

5. How do you assess maximum acceptable tension in primary closure of eyelid wounds when there has been loss of tissue?

Dr. Nowinski: Evaluating the tension for an amount that permits primary closure of a tissue-loss eyelid wound is very empiric, and each clinician must feel comfortable with his or her own technique. Basically, you must be able to overlap the lid margin slightly to determine if undue tension is present. This is obviously easier in older individuals. However, when there is a large amount of eyelid edema, closure may be difficult to determine. If the wound cannot be closed without a large amount of tension, other procedures (e.g., canthotomy or cantholysis) may be adequate to allow apposition of the cut eyelid margins. In the most extreme cases, complex reconstructive procedures using flaps or grafts may be necessary.

Dr. Woog: In assessing the degree of tension across an eyelid wound, it may be helpful to grasp each side of the laceration with a forceps and gently try to approximate the wound edges. If this is not possible, lateral canthotomy, cantholysis, or other reconstructive techniques may be necessary to achieve satisfactory eyelid closure.

6. Is it still appropriate to use the gray line of the lid as a method for reestablishing the anatomy in a tarsal laceration?

Dr. Nowinski: The gray line is an isolated section of pretarsal orbicular muscle whose gray appearance is secondary to the Tyndall effect. The gray line is just anterior to the tarsus and meibomian gland openings. Many of us were taught during residency the standard Byron-Smith three-suture eyelid repair, in which one suture was placed through the gray line. Although occasionally helpful in aligning the lid, this suture is not necessary. There is no firm tissue beneath the lid margin in this area, and the suture will not prevent tension from pulling apart the wound. Many lacerations can be repaired with one or two eyelid margin sutures without directly incorporating the gray line. However, each surgeon must determine which technique is best, and a gray line suture will do no harm if it helps in closing a lid margin that produces a slight puckering of the wound

toward the globe. Eyelid margin sutures are used primarily for alignment and not to reduce tension. Tension-bearing absorbable sutures should be placed in the tarsus and tied before placing the definitive eyelid margin sutures.

Dr. Woog: Although it may be a helpful anatomic landmark in reconstruction of the eyelid margin, the gray line may vary in prominence from patient to patient. Other useful anatomic landmarks include the edge of the tarsal plate and the posterior eyelash line.

7. What technical errors contribute to failure of a canalicular laceration repair?

Dr. Nowinski: The main technical mistake in repairing a lacerated canaliculus is improper reattachment of the medial canthal tendon. The tendon must be properly apposed to both achieve alignment and relieve tension. If the tendon is improperly attached, undue tension will pull apart any type of canalicular stent. The use of pericanalicular sutures has been emphasized in the past, with less emphasis on suturing of the medial canthal tendon. However, placement of the medial canthus is more important than any pericanalicular suturing. In fact, we have gone full turn—from meticulous microscopic suturing of the canalicular walls, to pericanalicular suturing, to almost no pericanalicular suturing and the use of silicone intubation. A recent description has even popularized the use of one-stitch canalicular repair and silicone intubation with good results.

Dr. Woog: Excess wound tension may contribute to difficulty in repairing canalicular lacerations. Tension in the area may be reduced by placing multiple absorbable sutures in the epicanalicular tissue to securely approximate these tissues.

8. How should the posterior lacrimal crest be most effectively exposed in repair of medial canthal trauma?

Dr. Nowinski: The posterior lacrimal crest is an important point of attachment to the tarsus and is sometimes very difficult to expose, especially following trauma. The caruncle must sometimes be excised to facilitate accurate placement of the medial canthal suture. The lacrimal sac must be retracted anteriorly, and the anchoring suture for the posterior limb should be placed in the firm tissue posterior to the sac. Axial and coronal planes must be addressed. A strong semicircular needle and, usually, a nonabsorbable suture are critical to the success of this repair.

Even for an experienced oculoplastic surgeon, the exposure may be difficult and the anatomy may be obscure. It may also be very difficult to incorporate posterior bites in repair of canalicular lacerations. Most cases do very well with silicone intubation and repair of the strong anterior limb of the medial canthal tendon alone.

Dr. Woog: It is often extremely challenging to place the required sutures to reconstruct the medial canthal tendon and achieve the desired posterior orientation of the medial aspect of the eyelid. Helpful measures in this regard include the use of a silicone tubing stent entering the medial border of the transected or common canaliculus as a guide to the location of the lacrimal sac. Exposure of tissue overlying the posterior lacrimal crest may be facilitated with a narrow malleable orbital retractor to gently retract and protect the orbital contents, as well as a fine skin hook to retract the medial skin edges.

9. Does the sequence of repair of multiple eyelid injuries have any bearing on the ease of repair or surgical outcome?

Dr. Nowinski: Multiple eyelid injuries should follow a logical scheme of repair. Evaluation and status of the globe is always the primary goal. The canaliculus should be identified by visual examination and probing, and any canalicular repair required should then be performed. Eyelid margin laceration repairs follow. By repairing the canaliculus first, undue tension will not be applied to bring the canthal tissues together over a silicone stent, which is especially important if there is any loss of eyelid tissue. If the eyelid margin cannot be repaired primarily, canthotomy or cantholysis might be sufficient to allow medial transposition of the remaining lateral eyelid margin. If these procedures are not adequate, localized flaps or grafts may be necessary.

Once the lid margins are adequately reconstructed, attention is then given to any tears in

the levator aponeurosis or other retractors of the eyelid, which may be signaled by the presence of orbital fat in the wound. These should be explored and repaired, especially taking note of any horizontal or diagonal defects. The orbital septum should be identified but not repaired or sutured. Lastly, the anterior lamella of skin and orbicularis muscle are closed to conclude the repair.

Dr. Woog: In my experience, it is generally helpful to begin with repair of any lacrimal system injuries with silicone intubation. The lacrimal system may then serve as a useful landmark in reconstructing the medial canthus. In general, I have found it helpful to otherwise proceed with repair from posterior to anterior, beginning with the tarsus and conjunctiva and progressing anteriorly through repair of the upper and/or lower eyelid retractors, followed by closure of skin lacerations.

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