

TITLE: Eyelid Reconstruction

SOURCE: Grand Rounds Presentation, UTMB, Dept. of Otolaryngology

DATE: December 18, 2002

RESIDENT PHYSICIAN: Michael Underbrink, M.D.

FACULTY PHYSICIAN: Karen Calhoun, M.D.

SERIES EDITORS: Francis B. Quinn, Jr., MD and Matthew W. Ryan, MD

"This material was prepared by resident physicians in partial fulfillment of educational requirements established for the Postgraduate Training Program of the UTMB Department of Otolaryngology/Head and Neck Surgery and was not intended for clinical use in its present form. It was prepared for the purpose of stimulating group discussion in a conference setting. No warranties, either express or implied, are made with respect to its accuracy, completeness, or timeliness. The material does not necessarily reflect the current or past opinions of members of the UTMB faculty and should not be used for purposes of diagnosis or treatment without consulting appropriate literature sources and informed professional opinion."

Introduction

The goal of reconstructing eyelid defects is to restore the normal anatomy and function of the eyelid. This can be a challenging endeavor, especially with larger defects and those that involve the lateral and medial canthi. Various reconstructive techniques have been developed and the choice of technique will often depend on what portions of the eyelid are missing and the size of the defect. Due to the complex anatomy and function of the eyelid and the delicate nature of the tissue, a thorough understanding of the surgical anatomy is necessary. This anatomy will be reviewed here and many of the basic reconstructive techniques will be described, which will allow for the successful reconstruction of most eyelid defects encountered by the otolaryngologist-head and neck surgeon.

Surgical Anatomy

The eyelids cover and protect the eye. The functions of the eyelids are to protect the eye from excessive light, injury or dessication. In addition, the lids contain glands that produce the mucus, watery, and lipid components of the tear film. The blinking action of the eyelids moves foreign material or excess mucus away from the cornea toward the medial canthus, while evenly distributing tear film across the eye. The eyelids consist of an anterior lamella of skin and orbicularis muscle and a posterior lamella of tarsus and conjunctiva. The skin of the eyelids is extremely thin with upper lid skin being thinner than lower lid skin. There is very little subcutaneous fat underlying the eyelid skin, which in the upper lid is loose over the orbital septum and somewhat adherent over the tarsus, due to the anterior fibers of the levator aponeurosis.

Tarsus - The tarsal plates are dense, fibrous tissues that give the eyelid its contour and provide its skeleton. They also contain the meibomian glands, which open onto the lid margin. The approximate dimensions of the upper eyelid tarsal plate are 25 mm in length, 1 mm thick, and 10 to 12 mm in height. The lower eyelid tarsal plate is about 4 to 5 mm in height.

Muscles - The main eyelid protractor is the orbicularis oculi muscle, which is part of the superficial musculoaponeurotic system (SMAS). It can be divided into the orbital, preseptal and pretarsal areas. Pretarsal orbicularis muscle is densely fixed to the entire anterior surface of the tarsal plates. The muscle of Riolan is a small portion of the pretarsal orbicularis that corresponds anatomically to the gray line. There are two muscles responsible for opening the upper eyelids, the levator muscle and Müller's muscle. The primary retractor is the levator muscle, which originates in the apex of the orbit, lies immediately superior to the superior rectus. At the orbital aperture, it is supported by Whitnall's ligament, which functions to translate the horizontal force of this muscle into the posterior and vertical motion for lid elevation. It becomes aponeurotic as it passes Whitnall's ligament and splits into the levator aponeurosis anteriorly and Müller's muscle posteriorly. Müller's muscle then travels inferiorly closely adherent to the conjunctiva and inserts on top of the tarsus. The levator aponeurosis fans broadly across the eyelid to form "horns" which insert laterally and medially into the canthal tendons. The remainder of the aponeurosis fuses with the orbital septum at the upper eyelid crease above the tarsus, and below this, fibers branch both anteriorly and posteriorly attaching to the orbicularis muscle fibers and anterior surface of the tarsus, respectively. The anterior interdigitation of the aponeurosis with the orbicularis muscle fibers leads to the formation of the upper eyelid crease.

The capsulopalpebral fascia of the lower eyelid is analogous to the levator aponeurosis of the upper lid. It inserts onto the lower border of the tarsus and fuses with the orbital septum with projections anteriorly to the preseptal orbicularis, which create the lower eyelid crease. This structure is an extension of the inferior rectus muscle, which serves to pull the lower lid on downward gaze.

Orbital Septum - The orbital septum is a thin fascial barrier of the true anatomic orbit that underlies the posterior orbicular fascia. This is one of the key surgical landmarks of the eyelids defining the anterior extent of the orbit and the posterior extent of the eyelids.

Canthal Tendons - The lateral canthus is usually slightly higher than the medial canthus, although this may vary between individuals. The pretarsal and preseptal portions of the orbicularis muscle of each eyelid taper to form the superior and inferior limb of the lateral canthal tendon. This tendon attaches to the inner aspect of the lateral orbital rim on Whitnall's tubercle approximately 1.5 mm posterior to the orbital rim. Medially, these portions of the orbicularis similarly give rise to the medial canthal tendon. However, this tendon is much more complex because of its relationship to the lacrimal system. The medial canthal tendon has an anterior and posterior limb. The anterior limb attaches to the frontal process of the maxilla along the anterior lacrimal crest. The posterior limb attaches at the posterior lacrimal crest, thereby surrounding the lacrimal sac. In addition, the posterior limb of the medial canthal tendon is associated with Horner's muscle (deep head of pretarsal and preseptal orbicularis muscle), which is important to the lacrimal excretory pump function as it draws the eyelids medially and posteriorly when contracting.

Lacrimal System - The lacrimal system includes the lubrication of the eye and the drainage of tears. The tear film produced by the conjunctiva, eyelids and lacrimal gland is distributed across the eye by spontaneous blinking of the eyelids. The "lacrimal pump" as previously discussed propels tears through the lacrimal drainage system eventually into the nose.

The lacrimal drainage system consists of the puncta, canaliculi, lacrimal sac, and nasolacrimal duct. The puncta are located on the most medial aspect of each lid margin about 5 mm from the medial canthus. The upper and lower canaliculi measure 2 mm vertically and 8 mm horizontally. These usually join to form a common canaliculus, which drains into the lacrimal sac. This structure is located within the bony lacrimal fossa and is covered by periorbita and surrounding fascia. It measures 12 mm vertically and about 2 mm wide. The inferior portion narrows to meet the nasolacrimal duct, which travels about 15 mm before it opens into the inferior meatus.

Blood Supply - There are rich anastomoses between the branches derived from the internal and external carotid arteries in the periocular area. Each eyelid has a marginal arcade, which is found on the surface of the tarsus along the eyelid margin. The upper eyelid has an additional arterial supply known as the peripheral arcade, which lies between the levator aponeurosis and Müller's muscle. Each arcade is formed from medial and lateral palpebral arteries. The medial palpebral artery is a branch off the dorsal nasal artery. The lateral palpebral artery is a branch of the lacrimal artery. The extensive anastomoses provide a rich blood supply to the tissues in the periocular area, which prevents infection and promotes healing after trauma and repair.

Related Vocabulary

Ptosis - upper eyelid margin is in an abnormal inferiorly displaced position

Entropion - inward rotation of the eyelid in such a way that the eyelid margin, eyelashes, and skin of the eyelids rub against the globe irritating the cornea.

Trichiasis - acquired disorder of misdirected eyelashes that originate from normally positioned eyelash follicles

Distichiasis - aberrant eyelashes that arise from metaplastic meibomian gland ducts and contact the ocular surface

Epiblepharon - normal eyelashes that are mechanically pushed toward the eye by redundant folds of skin

Epicanthal folds - vertical folds of skin that overlie the medial canthus

Ectropion - eversion of the eyelid margin away from the globe (usually lower lid)

Lower Eyelid Reconstruction

Direct Closure - The elasticity of eyelid tissue allows for direct closure of many full-thickness eyelid defects. Defects up to 30% of the lower eyelid in young patients can be corrected with direct closure, and up to 45% in the elderly patient. In borderline cases, a lateral cantholysis may provide additional relaxation of the wound closure. Reapproximation of the defect initially with a pair of skin hooks will provide a good estimate of the feasibility of this approach. The tarsal defect should be squared at the borders, and a temporal slanting of the musculocutaneous layer will help reduce skin redundancy. The orbicularis muscle should be separated from the tarsal plate at the edges to allow for better suture placement. A single 6-0 silk suture is placed through the gray line on either side of the defect to draw the wound together. Next, closure of the tarsal defect with 6-0 vicryl sutures without penetrating the conjunctival edge is performed. The lid margin can then be reapproximated with 7-0 silk sutures. These

sutures should be left long and draped externally to avoid corneal irritation. The musculocutaneous layer can finally be closed with vertical mattress sutures.

Lateral cantholysis may be performed to reduce tension on the wound with larger, borderline defects and provides an additional 5 mm of advancement. This is done by splitting the upper and lower lids at the lateral canthus with scissors. The scissors should then be advanced inferiorly to “nibble” the lower limb of the tendon and periorbital attachments for full mobility. The skin incision should be angled slightly superiorly in case a rotational flap is necessary. Once primary closure of the lid defect is obtained, the lateral canthus should be inspected to see if closure is required. A 6-0 Vicryl buried stitch anchored to the periosteum may be needed to bring the lower lid up into position. Often a 6-0 silk skin-muscle suture is all that is required.

Tenzel Rotational Flap - The Tenzel semicircular rotational flap can be used when lateral cantholysis does not permit direct closure. The important principle of this flap is to perform a cantholysis and have a musculocutaneous flap that arches upward in a semicircular manner. This allows the tissue brought in to follow the natural contour of the lid. In order to avoid lateral droop of the lid, firm fixation of the deep muscle to periosteum at an adequate level superior to the canthal angle must be established. The skin incision should be drawn after which an incision is made through skin and muscle. The lateral canthal tendon is then severed with Westcott scissors, and the skin and muscle is dissected off. The flap is then rotated into the defect, and closure is performed as described. Next the lateral canthus is reformed by choosing the proper place on the flap that matches the upper canthus and using a buried 6-0 Vicryl to bring the orbicularis muscle of the lower flap to the periosteum of the inner aspect of the orbital rim. The fornix conjunctiva is then undermined, advanced to the skin edge of the lid margin and sutured with running 7-0 silk suture. If additional support of the lateral lid margin is required, a periosteal flap hinged at the lateral orbital rim may be sutured to the edge of the tarsus laterally.

Hughes Procedure - For still larger defects unable to be closed with the previous techniques, the Hughes tarsoconjunctival flap can be used. This vertical upper lid to lower lid-sharing technique provides a stable, predictable eyelid reconstruction. With this technique, the posterior lamellar defect is repaired with the tarsoconjunctival flap from above, and the anterior lamella can be reconstructed with either a skin graft or a musculocutaneous advancement flap. This repair is helpful for defects greater than 50% of the lower lid, but a second stage is required to separate the flap.

The upper eyelid is everted over a Desmarres retractor and the flap is marked with methylene blue dye. The flap should be somewhat smaller than the defect to give tightness to the lower lid. A horizontal incision is then made 4.0 mm behind the lid margin, full thickness through the tarsoconjunctival unit. The vertical incisions are then made to the top of the tarsal plate. The flap is then dissected superiorly and Müller’s muscle is dissected off of the conjunctiva. Relaxing incisions are made on the conjunctiva to bring the flap to the lower lid defect. The medial and lateral borders are sewn with lamellar 6-0 vicryl sutures and a running 6-0 vicryl suture is used to fix the inferior portion of the flap to the conjunctiva and lower lid retractors in the lower lid. Next, an advancement of skin from the lower lid can be brought in or a free full-thickness skin graft brought in and closed with 7-0 silk sutures. The flap must be

separated 7 to 10 days later by lifting the flap off of the cornea after anesthesia has been obtained and cutting the flap 1.0 mm or so higher than the desired lower eyelid margin. The conjunctiva is then everted over the new lid margin and sutured with a running 6-0 plain gut suture.

Free Tarsal Grafts - A free tarsal graft can be harvested from the contralateral upper lid and used as a posterior lamellar replacement for lower eyelid defects. This graft does not have a blood supply so it must be covered with a myocutaneous advancement flap. The graft is harvested like the initial stage of the Hughes procedure except that the superior edge of the conjunctiva is cut. The donor site need not be repaired, as it will mucosalize on its own. There must be adequate anterior lamellar of the recipient site to cover the free graft.

Rotational Cheek Flap (Mustarde) - For very large defects the Mustarde cheek flap can be used to bring in tissue from laterally in a single operative procedure. This flap lacks functioning orbicularis muscle and may result in sagging lateral lower lid and epiphora, due to the lack of tone to the lacrimal pump mechanism. However, this flap may be preferable in patients with monocular vision, amblyopia in a child, active corneal disease, or glaucoma. The flap should be drawn with an upward slope with the incision rotating around in front of the ear. To prevent late lateral contraction, the superior limit of the semicircle for a Mustarde flap should be at least as high as the brow. The flap is undermined completely in a subcutaneous plane to avoid injury to the facial nerve. A naso-chondromucosal graft from the septum can be obtained to provide support and mucosal elements for the posterior lamellar defect. Other materials for the posterior lamellar defect include tarsal grafts from either the ipsilateral (Hughes) or contralateral (free) upper eyelid, Alloderm with free cartilage graft, or palatal mucoperiosteum. Once the posterior lamella has been reconstructed, the medial edge of the upper border of the chondromucosal graft is sutured to the superior margin of the cheek flap by running 5-0 cat gut suture to form the eyelid margin. Next, the lateral canthus is formed by suturing the deep layer of the dermis of the rotational graft to the superior and inner aspect of the lateral orbital rim near the lateral border of the chondromucosal graft. Additional upward traction at the apex of the flap can be provided by using 4-0 vicryl sutures to the lateral rim periosteum. Skin can now be closed with running 6-0 nylon suture. The eyelids may be sutured together with a tarsorrhaphy stitch to provide additional upward tension on the flap and removed after a week.

Upper Eyelid Reconstruction

Direct Closure - As described for lower lid defects, direct closure is a good option for upper eyelid defects of up to 33% in younger patients and up to 40% in older patients with increased laxity of tissues. The edges of the tarsal defect, as in lower lid repair must be perpendicular throughout the entire height of the tarsus. Again, lateral cantholysis can be performed to provide additional relaxation. The incision for upper lateral canthotomy should be angled slightly inferiorly and the lateral cantholysis should include the upper limb of the tendon. Direct closure can then be achieved similar to that described for lower lid repair.

Tenzel Flap - Central upper lid defects of up to 40 - 60% of the original lid margin can be closed by the Tenzel flap as described above. The semicircular flap instead is outlined instead with an inferior arch. Lateral lid support is obtained and canthal formation is accomplished by suturing the edge of the flap to the inner periosteum of the lateral orbital rim with fixation to the

inferior ramus. Conjunctiva can be undermined and advanced to the edge of the flap margin. Closure is the same as that described for lower lid repair.

Sliding Tarsconjunctival Flap - Isolated medial or lateral defects of the upper lid that are too large for direct closure can be closed by horizontally sliding a section of tarsus from the remaining lid segment into the defect and covering the external surface with a skin graft. After local anesthesia is applied, the lid remnant is everted over a Desmarres retractor. A horizontal incision is made through the tarsconjunctiva 4 mm above the lid margin and approximately the width of the defect. A vertical incision is then made at the tarsal end of the horizontal incision through tarsus and conjunctiva to the superior border of the tarsus. The flap is sharply freed and dissection may need to be carried superiorly through conjunctiva and Müller's muscle to enable the flap to slide into place without tension. The edge of the flap is then sutured to the inside of periosteum near the lateral orbital tubercle or in the case of medial defects to the periosteum near the posterior lacrimal crest. The superior edge of the tarsal flap is sutured to the remaining levator aponeurosis. The original remaining lid margin is then sutured to the inferomedial/lateral portion of the tarsconjunctival flap with 4-0 silk suture after removing a small notch of tarsus from the flap. The anterior lamellar defect can then be closed with a retroauricular skin graft or advancement skin or musculocutaneous flap sutured to the skin edges. The lid margin must have a smooth conjunctival surface to prevent irritation of the cornea. The upper lid is then splinted to the lower lid with a tarsorrhaphy for a week.

Posterior Lamellar graft with local myocutaneous flap - In patients who have laxity or redundancy of skin in the upper lid and periorbital area, musculocutaneous flaps can be brought in to cover the anterior lamellar defect. The posterior lamella defect is repaired with conjunctiva from the upper lid fornix or an advancement from the conjunctiva of the lower lid. These conjunctival flaps can be supplemented with ear cartilage for support. Free grafts of tarsconjunctiva from the opposite upper lid or palatal mucoperiosteum may also be used. The musculocutaneous flap required to provide a blood supply to the posterior lamellar graft can either be advanced from redundant upper lid and brow tissue or rotated from the temporal area (Tenzel).

Cutler-Beard (Bridge) Flap - The bridge flap is used to repair full thickness upper lid defects from 60% to the entire upper lid. This procedure borrows skin, muscle and conjunctiva from the lower eyelid, which is advanced into the upper lid defect. The incision must be 5 mm below the lower lid margin in order to preserve its blood supply, therefore it contains no tarsus and autogenous cartilage must be sandwiched between the advanced conjunctiva and musculocutaneous layer. The upper eyelid defect should be fashioned into a rectangle. The flap from the lower eyelid should be fashioned at approximately the same width as the defect, but can be made smaller if the medial and lateral remnants of the upper lid defect can be pulled together. The full thickness horizontal incision is made 5 mm below the lower lid margin and then vertical incisions are carried out 10 to 15 mm inferiorly with a globe protector in place. These incisions are carried out to the lowest aspect of the inferior fornix on the conjunctival side of the flap. The flap is then divided into a conjunctivo-capsulo-palpebral layer and skin-orbicularis muscle layer with sharp scissors. Both layers are then advanced under the bridge flap and the conjunctiva is fixed to the conjunctiva of the defect using a running 6-0 plain gut suture. Relaxing incisions in the capsulopalpebral fascia are sometimes necessary to facilitate this closure. Autogenous

cartilage, usually from the ear, is then sutured in place to the tarsal or canthal remnants and superiorly to the levator or orbicularis. The musculocutaneous portion of the flap is then sutured in place. Separation of the flap is carried out 8 weeks later. The flap is cut 2 mm longer than the desired position and this amount of skin and muscle are removed from the inferior edge to leave conjunctiva in order to cover the new lid margin.

Temporal Forehead (Fricke) Flap - An additional technique to supply tissue for very large upper lid defects is the transposition of a temporally based flap from the supra brow area. This is a thick flap and requires lining with advanced conjunctiva or buccal mucous membrane, but no replacement for tarsus is required. The graft is based on the superficial temporal artery that travels along the lateral orbital rim above the brow. The artery should be included in the base of the flap, which is designed long enough to fill in the defect. Subcutaneous fat is usually included, but can be thinned. A buccal mucous membrane graft is fixed to the edges of conjunctiva with 6-0 plain gut suture and the flap is then secured. The flap can be fixed medially to remnants of the medial canthal tendon or periosteum at the posterior lacrimal crest. At 3 weeks the flap pedicle can be divided.

Lateral Canthal Reconstruction

Small defects of the lower or upper eyelid, which involve the lateral canthus, can be repaired with the lateral tarsal strip operation (described above). If the lid does not stretch to the periosteum, periosteal strips from the lateral rim can be fashioned to fill in the defect and provide support. For upper lid defects, a 5 mm strip of periosteum angled inferiorly starting slightly below where the lateral canthal tendon should be can be made. Similarly, lower lid defects can be repaired with a periosteal strip fashioned in the opposite manner. If no periosteum is available, drill holes than open on the inner aspect of the rim can be made and permanent suture threaded through the holes will secure the edges of the tarsus and provide support.

Medial Canthal Reconstruction

Medial canthal defects are more difficult to repair than lateral canthal defects. One difficulty is the lacrimal drainage system, which usually needs repair in a medial canthal defect. The other difficulty is that to anatomically reconstruct the medial canthus, the attachment needs to be at the posterior lacrimal crest. If one canaliculus is cut, an attempt at reconstruction should be made with either a pigtail probe or Crawford stents. If the punctum has been removed, the cut end of the canaliculus should be marsupialized into the conjunctival fornix. If the canaliculus is not reconstructed, then the medial canthus should be reattached at the posterior lacrimal crest with a permanent suture. Occasionally, the remaining tendon will need to be reattached via transnasal wiring.

Conclusion

Closure of defects involving the upper and lower eyelids requires a thorough understanding of eyelid anatomy and the dynamics of eyelid closure. There are a variety of basic techniques that allow for the successful reconstruction of the anatomical nature of the eyelids. A thorough understanding of the basic reconstructive techniques described here can help with most

problems encountered in full thickness eyelid defects. More complex reconstructive techniques should probably be referred to more experienced oculoplastic surgeons. The complex nature of the eyelid anatomy and the difficulty reproducing aesthetically pleasing results make this problem a challenge for the surgeon, however, successful results can be obtained with careful attention to details and a delicate surgical technique.

Decision Making for Eyelid Reconstruction

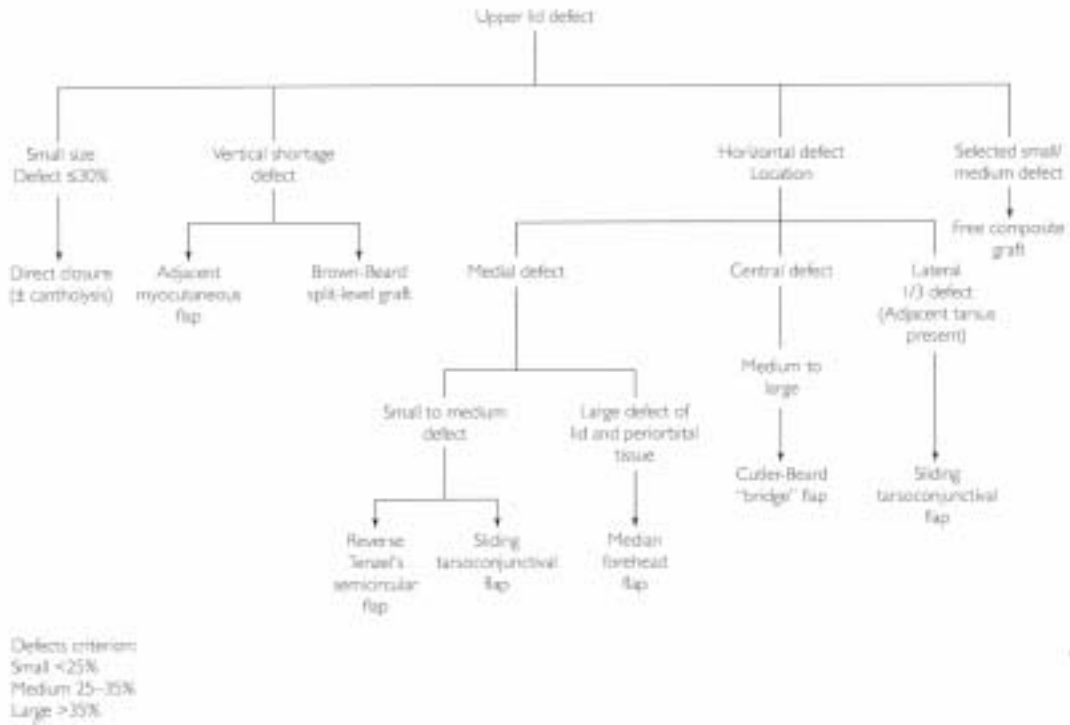


FIGURE 17-17 Clinical pathway—management of full-thickness upper eyelid defects.

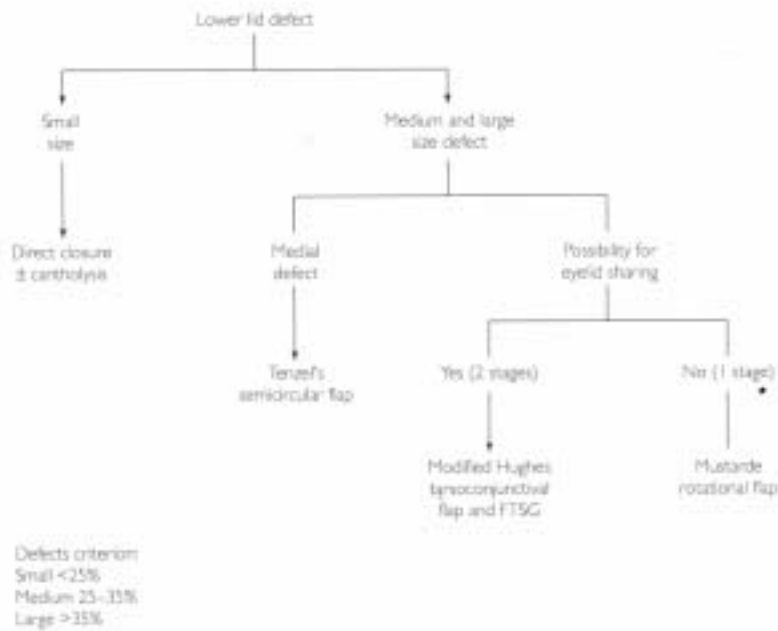


FIGURE 17-18 Clinical pathway—management of full-thickness lower eyelid defects.

References

Nerad, J.A. Oculoplastic Surgery: The Requisites in Ophthalmology. Mosby Inc. St. Louis, MO. 2001.

Chen, W.P. Oculoplastic Surgery: The Essentials. Thieme New York. New York, NY. 2001.

McCord, C.D., Codner, M.A. Eyelid Surgery: Principles and Techniques. Lippincott-Raven. Philadelphia, PA. 1995.

Hornblass, A. Oculoplastic, Orbital and Reconstructive Surgery. Vol. 1. Williams and Wilkins. Baltimore, MD. 1988

Rathbun, J.E. Eyelid Surgery. Little, Brown and Company. Boston, MD.

Fischer T, Noever G., Langer M., Kammer E. Experience in upper eyelid reconstruction with the Cutler-Beard technique. Annals of plastic Surgery. 47(3): 338-42, 2001 Sep.

Maloof A., Ng S., Leatherbarrow B. The maximal Hughes procedure. Ophthalmic Plastic & Recon Sur. 17(2): 96-102, 2001 Mar.

Rohrich RJ. Zbar RI. The evolution of the Hughes tarsoconjunctival flap for the lower eyelid reconstruction. Plastic & Recon Sur. 104(2): 518-22, 1999 Aug.

Patrinely JR, O'Neal KD. Kersten RC, Soparkar CN. Total upper eyelid reconstruction with mucosalized tarsal graft and overlying bipedicle flap. Arch of Ophthal. 117(12): 1655-61, 1999 Dec.

Matsumoto K. Nakanishi H. Urano Y. Kubo Y. Nagae H. Lower eyelid reconstruction with a cheek flap supported by fascia lata. Plastic & Recon Sur. 103(6):1650-4, 1999 May

Perry MJ. Langry J. Martin IC. Lower eyelid reconstruction using pedicled skin flap and palatal mucoperiosteum. Dermatologic Sur. 23(5): 395-7, 1997 May.

Werner MS. Olson JJ. Putterman AM. Composite grafting for eyelid reconstruction. Amer J of Ophth. 116(1):11-16, 1993 Jul.

Cohen MS. Shorr N. Eyelid reconstruction with hard palate mucosa grafts. Ophth Plastic & Recon Sur. 8(3):183-95, 1992.