Eyelid Reconstruction

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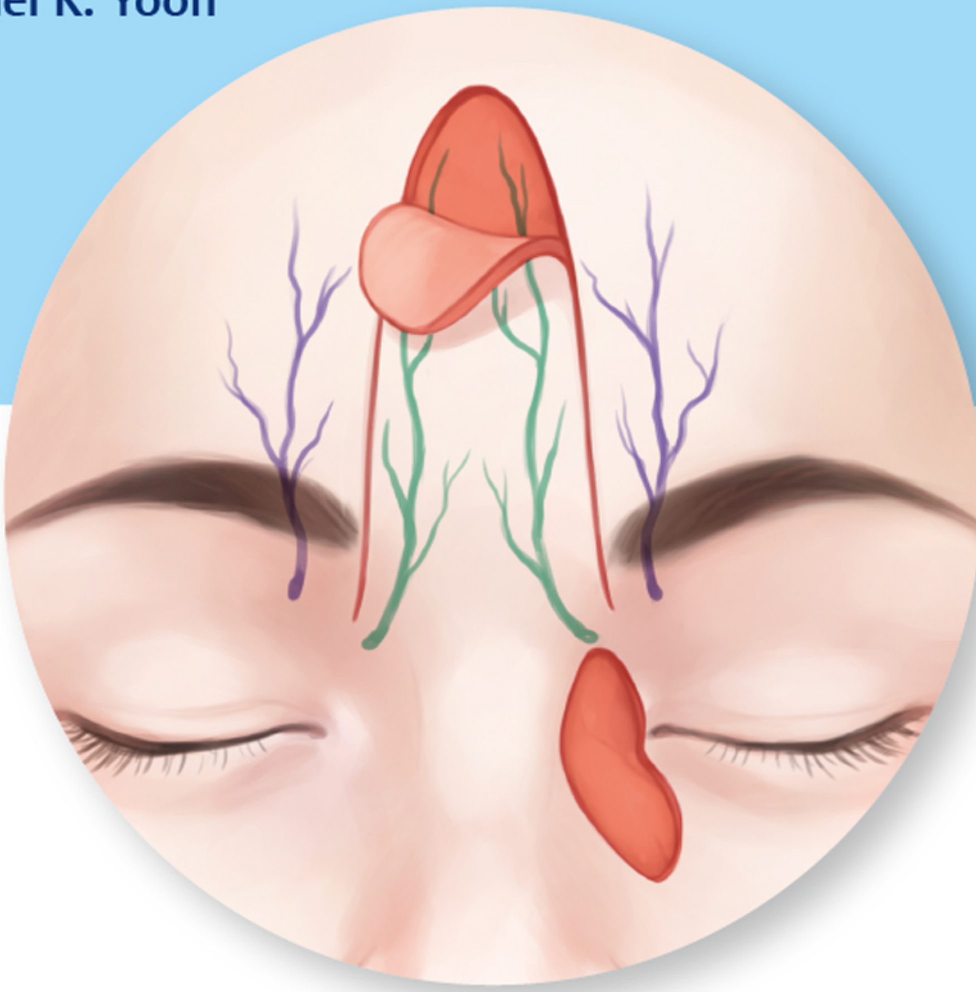

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To my parents, Lu and Robert Freitag, for their love and support that have made my career possible.

Suzanne K. Freitag, MD

To all of my mentors, preceptors, and colleagues throughout my training who have taught me everything I know about eyelid surgery. To my parents, Kiseok and Kyungwon Lee, who inspired and supported my pursuit of academic medicine.

N. Grace Lee, MD

To all of the teachers from whom I have ever learned, my family, my mentors, my patients (who invariably teach me), and the residents and fellows who I am lucky to work with (and learn from).

Daniel R. Lefebvre, MD

To Stacey, Bradley, and Maxwell.

Michael K Yoon, MD

Contents

Preface

This textbook on eyelid reconstruction represents the culmination of 20 years of contemplation on my part. During my ophthalmic plastic surgery fellowship training from 1999 to 2001, I had hoped for a reference textbook that would distill the options for periorbital reconstruction after skin cancer removal. There were many excellent resources available regarding reconstruction after periocular trauma, but no textbooks dealing exclusively with periorbital tumor excision and post-Mohs micrographic surgery reconstruction, hence my learning was primarily from other sources. Many articles existed in the scientific literature on varying flaps and techniques, but these were not organized with one comprehensive thought process and direct comparisons. I am eternally grateful to my fellowship preceptors, Drs. John Woog, Arthur Grove, Katrinka Heher, and Michael Migliori. They were my primary sources of enlightenment on this topic and I appreciate their numerous hours of on-the-job training. The primary textbooks available at that time were the renowned tomes on facial flap reconstruction by Drs. Shan Baker and Ian Jackson, which contain requisite chapters on eyelids; however, I sought deeper knowledge specifically regarding the periocular area. Given this dearth of information, I vowed that someday I would write such a book.

In the intervening 20 years, there have been a few texts published that address this topic in more detail, including the well-known text titled Atlas of Oculofacial Reconstruction by Dr Gerald Harris. However, I feel that a space still remains for another textbook to provide a varied perspective on this topic, given that this is one of our most creative and challenging undertakings as periorbital surgeons.

I spend many hours each year reading the biographical personal statements of ophthalmology residents applying for ophthalmic plastic surgery fellowship. One of the most formative experiences that applicants comment upon - the one that clenched their decision to pursue ophthalmic plastic surgery training - was their involvement in a complex eyelid reconstruction case after tumor removal. They recall not only the genius-level of creativity they believe went into designing the flaps and grafts tailored to the defect, but also the satisfaction in restoring function and aesthetics to the human undergoing the surgery. Periorbital reconstruction is indeed one of the most rewarding surgeries that we perform as ophthalmic plastic surgeons, knowing that a sight- and life-threatening tumor has been eradicated, and that past training and experience have afforded the knowledge to repair the resulting tissue defect to the best of our ability. These are some of the most challenging procedures that we perform, because preparation beforehand is often not possible, given the unpredictable defects that we face after Mohs micrographic surgeons remove tumors or patients present with trauma.

I am fortunate to work with 3 outstanding colleagues at Massachusetts Eye and Ear on the Ophthalmic Plastic Surgery Service, Drs Michael Yoon, Daniel Lefebvre, and Grace Lee. When I proposed this textbook to them, all were enthusiastic to be co-editors and their diligent work on this text has made my dream come to fruition. I am also grateful to Thieme Medical Publishers and specifically Mr. William Lamsback and Ms. Elizabeth Palumbo for their support with this project.

This textbook is a compilation of our cases and experience over many years. It is targeted to benefit students, residents, fellows and experienced surgeons in the fields of ophthalmic plastic surgery, ophthalmology, otolaryngology, facial plastic surgery, plastic surgery, dermatology, Mohs surgery, and maxillofacial surgery who find the need to understand or improve their periocular reconstruction skills. The book is designed to be a logical and simple-to-use surgical reference – the type of book that can be pulled off the shelf when an instant decision is necessary on how to approach the tissue defect of a patient lying on the surgical table in the next room.

The layout of the chapters for this text was straightforward to formulate. A thorough understanding of the highly complex eyelid and periorbital anatomy is critical to performing safe and effective surgery, and this is covered in the first chapter. The second chapter discusses basic principles of performing surgery in the periorbital area. Since many of the tissue defects we repair are secondary to Mohs micrographic surgical excision of tumors, the third chapter provides a comprehensive overview of Mohs surgery in the periorbital area. The next four chapters divide the periorbital region into upper eyelid, lower eyelid, medial canthus and lateral canthus, providing a logical division of these unique areas, each requiring special considerations based on the underlying anatomy, adnexal structures and required functions. These chapters are filled with practical and concise descriptions of the procedures accompanied by numerous photographs and illustrations to enhance comprehension. Finally, the text would be remiss without discussion of periorbital trauma, which comprises the final chapter in the text.

We hope that readers will share our enthusiasm for maximizing their armamentarium of periorbital reconstruction skills with the information compiled in this one concise volume. By adhering to basic principles discussed in this text, even complex defects can be confidently and effectively repaired, resulting in optimal patient outcomes.

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1 Periocular Anatomy

Juan C. Jiménez-Pérez

Summary
A thorough understanding of eyelid and periocular anatomy is crucial for functional and aesthetic success in eyelid reconstruction after trauma, tumor excision, or any procedure that changes the normal eyelid architecture. Proficiency in restoring the eyelids takes experience as well as a fundamental knowledge of the anatomy that is presented in this chapter.

Keywords: eyelid anatomy, eyelid circulation, eyelid innervation, eyelid musculature

1.1 Eyelids

The main function of the eyelid is to protect the eye. The eyelids attach to orbital bones via the medial canthal tendon (MCT) and lateral canthal tendon (LCT) forming two opposite arches. The lateral canthus is usually approximately 2 mm higher than the medial canthus. The horizontal length of the eyelid is about 30 mm and the vertical aperture height (palpebral fissure) is about 10 mm. The adult upper eyelid rests about 1.5 mm below the superior limbus of the cornea, while the lower eyelid rests at the level of the inferior limbus. The peak of the upper eyelid is at the medial border of the pupil, and the lowest point of the lower eyelid margin is the lateral aspect of the pupil. The eyelid margin can be conceptually divided into anterior (skin and orbicularis muscle) and posterior (tarsus and conjunctiva) lamellae for the purposes of eyelid reconstruction.[1,2]

1.2 Eyelid Layers

The layers of the upper eyelid from anterior (superficial) to posterior (deep) are skin, orbicularis oculi muscle, orbital septum, preaponeurotic fat, levator palpebrae superioris muscle, Müller muscle, tarsus, and conjunctiva (▶ Fig. 1.1). It is important to understand that the different layers of the eyelid are not always present in all eyelid sections and vary by vertical height within the eyelid.

1.2.1 Skin

The eyelid skin is the thinnest in the body. It is composed of keratinized stratified squamous epithelium and has no subcutaneous fat. With aging, skin loses elasticity and becomes thinner due to breakdown of collagen. The upper eyelid crease is formed from levator aponeurosis attachments to the skin and pretarsal orbicularis oculi muscle. The crease is usually higher in women and Caucasians compared to men and Asians. The crease is approximately at the same height as the superior tarsal border in Caucasians. In Asians, it is about 4 mm above the eyelid margin due to a lower fusion of the orbital septum with the levator muscle, allowing the preaponeurotic fat to fall more anteriorly and inferiorly in the upper eyelid.[1,2]

1.2.2 Orbicularis Oculi Muscle

The orbicularis oculi muscle is the protractor of the eyelid. It extends from the upper and lower eyelid margin in a circumferential fashion to the superior and inferior orbital rims, respectively. It is anatomically divided into the palpebral (pretarsal and preseptal) and orbital portions (▶ Fig. 1.2). Innervation by the zygomatic and temporal branches of facial nerve (seventh cranial nerve) allows the muscle to contract and close the eyelids. The involuntary closure or blinking is mediated by the palpebral portion, whereas the voluntary closure is mediated by the orbital portion of the muscle. A portion of the orbicularis, the muscle of Riolan, is visualized along the middle of the eyelid margin, forming the gray line.[1,2]

1.2.3 Orbital Septum

The orbital septum is a thin, multilayered, inelastic, fibrinous tissue that demarcates the anterior extent of the orbital soft tissues. The orbital septum arises from the arcus marginalis, a dense periosteal fusion of orbital septum, periorbita, and pericranium that circumferentially lines the orbital rim (▶ Fig. 1.3). It inserts onto the upper and lower eyelid retractors and provides support. Aging causes septum attenuation allowing the orbital fat to move forward via pseudoherniation. The orbital septum is an important anatomical landmark that divides the superficial skin and orbicularis muscle from the deeper structures of the orbit and functions as a barrier to infections and spread of tumors.[1,2]

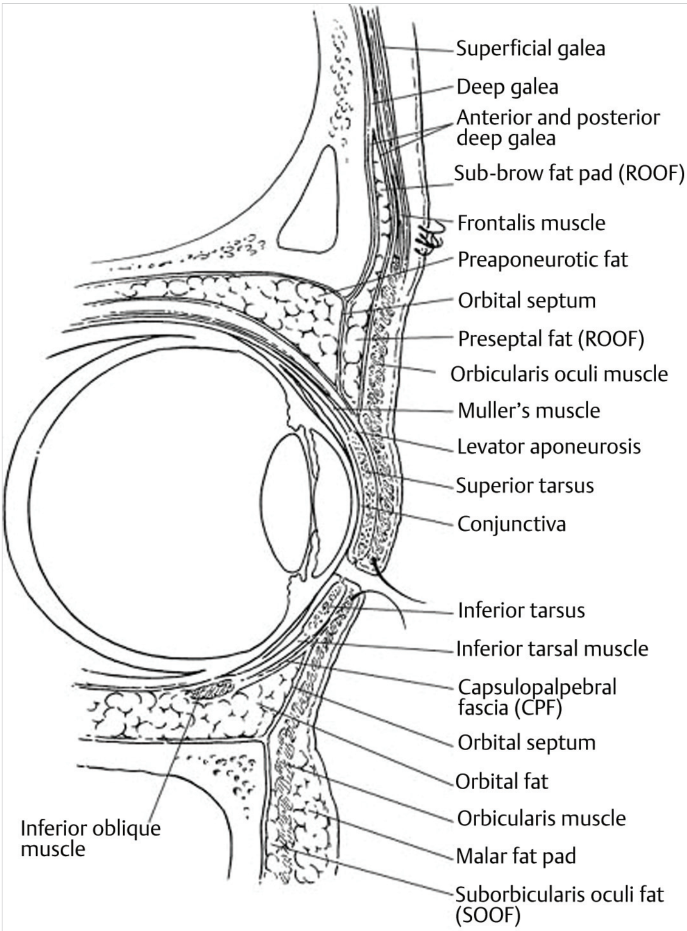

Fig. 1.1 Cross-section of the upper and lower eyelid anatomy. (From Chen WP, Oculoplastic Surgery: The Essentials. New York: Thieme Medical Publishers; 2001.)

1.2.4 Preaponeurotic Fat

The preaponeurotic fat is a relatively avascular collection of adipose tissue situated between the orbital septum anteriorly and levator palpebrae superioris muscle posteriorly. In the upper eyelid there are two fat pads: the medial and the central. They are each enclosed in a thin fibrous sheath. The medial fat pad is usually paler in color and smaller compared to the distinctly yellow central fat pad.[3] The lacrimal gland fills the analogous space in the lateral upper eyelid. The lower eyelid contains three fat pads: the medial, central, and lateral (▶ Fig. 1.4). When fat is visible through a traumatic eyelid laceration, it indicates that the injury has extended to a depth beyond the orbital septum. In such instances, after proper wound cleaning, exploration, and repositioning of fat, the septum must not be sutured so as to avoid cicatricial eyelid retraction.[4]

1.2.5 Retractor Muscles

Upper Eyelid Retractors

Opening of the upper eyelid is mediated by two muscles: the levator palpebrae superioris and Müller muscles. The levator muscle is responsible for the voluntary elevation of the upper eyelid and is the primary retractor muscle. It originates in the orbital apex from the periorbita of the lesser wing of the sphenoid bone just above the superior rectus muscle origin in the annulus of Zinn. The muscular portion measures 40 mm in length, while the aponeurosis is 14 to 20 mm in length. The muscle traverses in the superior orbit from the apex in an anterior direction until it interfaces with Whitnall

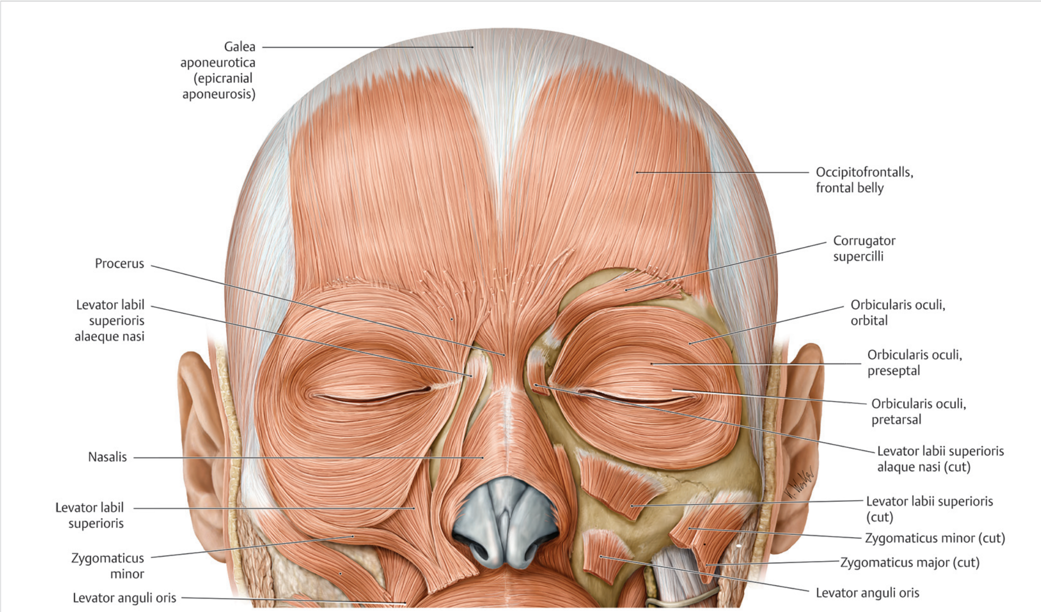

Fig. 1.2 The eyelid protractors. (From Watanabe K, Shoja MM, Loukas M, Tubbs RS. Anatomy for Plastic Surgery of the Face, Head, and Neck. New York: Thieme Medical Publishers; 2016.)

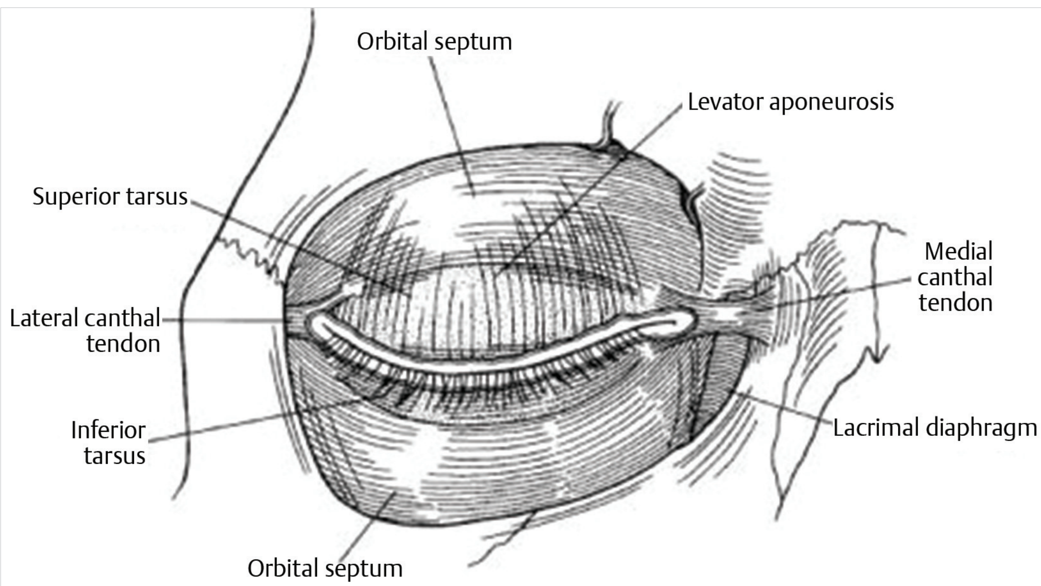

Fig. 1.3 The orbital septum. (From Wobig JL, Dailey RA. Oculofacial Plastic Surgery: Face, Lacrimal System, and Orbit. New York: Thieme Medical Publishers; 2004.)

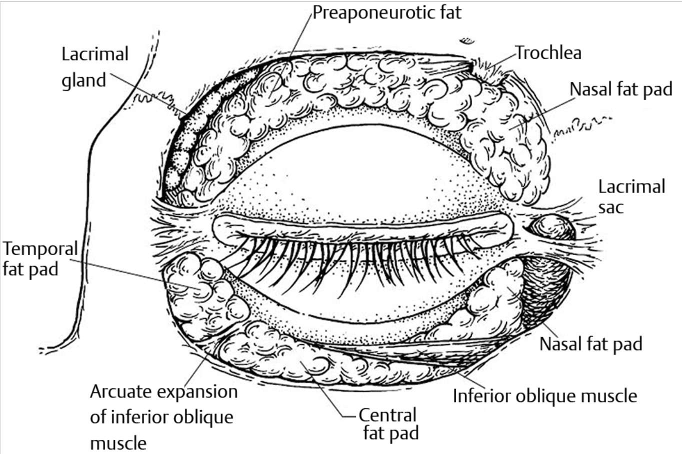

Fig. 1.4 The preaponeurotic fat. (From Chen WP, Oculoplastic Surgery: The Essentials. New York: Thieme Medical Publishers; 2001.)

ligament, where it changes to an inferior direction. The aponeurosis inserts onto the anterior tarsal surface with additional loose attachments to the skin creating the lid crease. As the aponeurosis travels inferiorly, it spreads out creating medial and lateral horns. The medial horn of the levator aponeurosis is thinner and more delicate than the lateral horn. The lateral horn divides the lacrimal gland into palpebral and orbital lobes (▶ Fig. 1.5). The muscle is innervated by the superior division of the oculomotor nerve (third cranial nerve).[1,2,5]

Müller muscle (superior tarsal muscle) is a smooth muscle innervated by sympathetic nerve fibers contributing approximately 2 mm of upper eyelid involuntary elevation. It originates from the deep surface of the levator aponeurosis at the level of Whitnall ligament and inserts at the superior tarsal border (▶ Fig. 1.5). The conjunctiva is deep to Müller muscle, and the peripheral vascular arcade is located superficial to the muscle above the superior tarsal border.[1,2]

Lower Eyelid Retractors

The lower eyelid retractors are analogous to the upper eyelid retractors, but less well defined. The equivalent of the levator aponeurosis is the capsulopalpebral fascia, which originates from the inferior rectus muscle fibers and then divides to encircle the inferior oblique muscle. Lockwood suspensory ligament forms anterior to the inferior oblique muscle and is somewhat analogous to Whitnall ligament in the upper eyelid (▶ Fig. 1.5). Terminal capsulopalpebral fascia fibers insert into

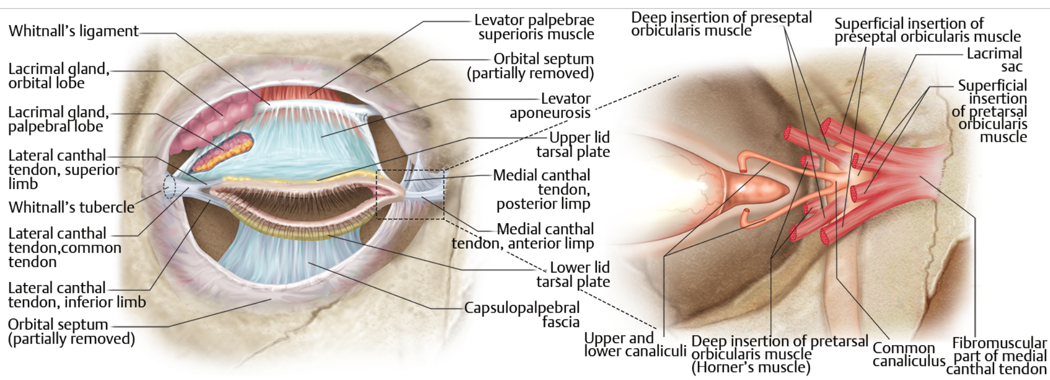

Fig. 1.5 The upper and lower eyelid retractors. (From Watanabe K, Shoja MM, Loukas M, Tubbs RS. Anatomy for Plastic Surgery of the Face, Head, and Neck. New York: Thieme Medical Publishers; 2016.)

both the inferior conjunctival fornix and the lower eyelid tarsus.[1,2,6] The lower eyelid analogue of Müller muscle is the inferior tarsal muscle, which originates from Lockwood ligament, travels between the capsulopalpebral fascia and conjunctiva, and inserts on the lower eyelid tarsus.[1,2,6]

1.2.6 Tarsus

The upper and lower eyelid tarsal plates are composed of dense fibrous tissue and provide structural rigidity to the eyelids. They attach firmly to the periosteum via the MCT and LCT. They measure about 1 mm in thickness and a maximum of 8 to 10 mm in vertical height in the central portion of the upper eyelid and about 4 mm in the lower lid, and taper medially and laterally as they attach to the canthal tendons (▶ Fig. 1.6). The Meibomian glands spiral vertically within the tarsal plates.[1,2]

1.2.7 Conjunctiva

The conjunctiva is a nonkeratinized squamous epithelium that covers the surface of the globe and the posterior surface of the eyelids. This mucous membrane is divided by location into palpebral, forniceal, and bulbar conjunctiva. It contains mucin-secreting goblet cells and the accessory lacrimal glands of Wolfring and Krause.[1,2]

1.3 Vascular and Lymphatic System

The vascular supply to the eyelids arises from the internal and external carotid artery branches and their extensive anastomoses. The internal carotid artery, via the ophthalmic artery, supplies the eyelid through the lacrimal artery, supraorbital artery, and medial palpebral arteries. The external carotid artery supplies the eyelid via the angular artery (terminal branch of the facial artery), infraorbital artery (branch of the maxillary artery), superficial temporal artery, and transverse facial artery (▶ Fig. 1.7). The complex and rich vascular supply contributes to rapid wound healing and a low incidence of infection following eyelid surgery. These arteries communicate to create the marginal arcades located on the anterior surface of the tarsus approximately 4 and 2 mm from the superior and inferior eyelid margins, respectively. They also create the superior peripheral arcade located between the levator aponeurosis and Müller muscle at the superior aspect of the tarsus. In the lower eyelid there may be a rudimentary peripheral arcade.[1,2]

The venous drainage of the eyelids is more diffuse. The tissue posterior to the tarsus drains into the orbital veins and the deeper branches of the anterior facial vein and pterygoid plexus. The tissue anterior to the tarsus drains medially through

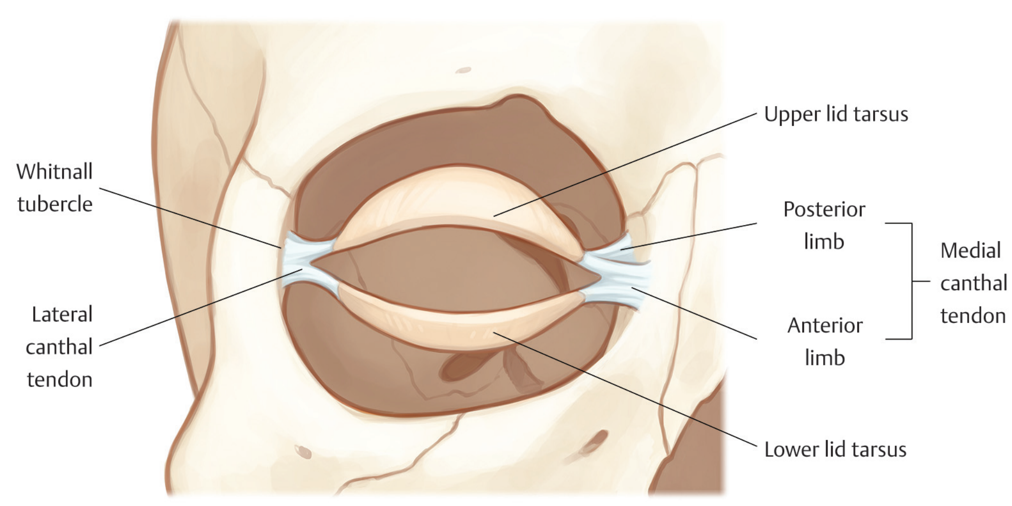

Fig. 1.6 The tarsus and canthal tendons.

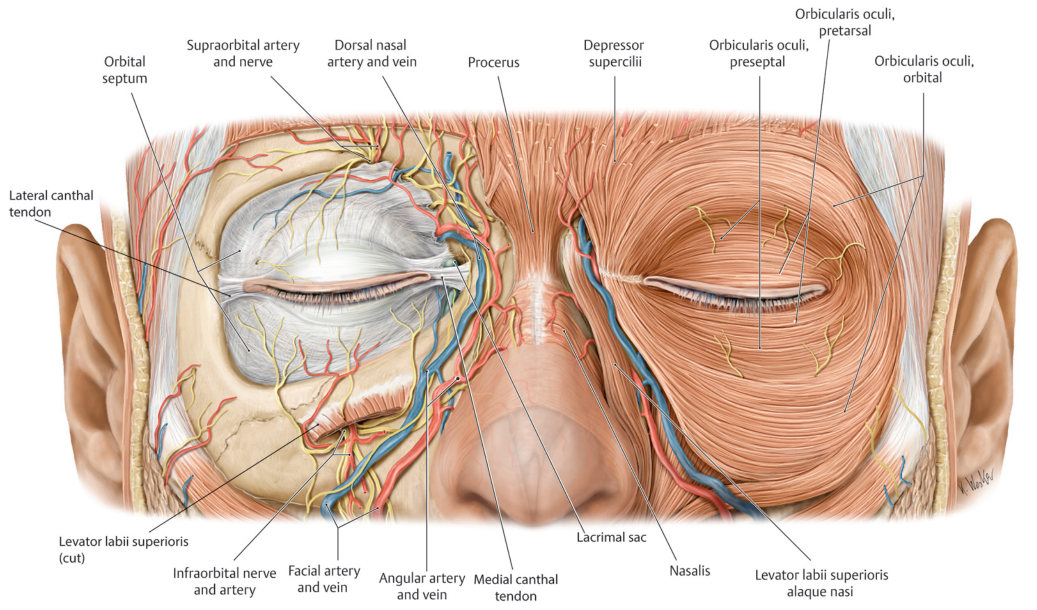

Fig. 1.7 The arterial and venous system. (From Watanabe K, Shoja MM, Loukas M, Tubbs RS. Anatomy for Plastic Surgery of the Face, Head, and Neck. New York: Thieme Medical Publishers; 2016.)

the angular vein and laterally through the superficial temporal vein (▶ Fig. 1.7).[1]

The lymphatic system drains through two systems. The medial aspect of the eyelids drains into the submandibular lymph nodes. The lateral aspect drains first into the superficial preauricular nodes and then into the deeper cervical nodes near the internal jugular vein.[1]

1.4 Nervous System

The nervous system of the eyelid may be divided into the sensory and motor nerves. The sensory innervation is derived from branches of the trigeminal nerve (fifth cranial nerve) (▶ Fig. 1.8). The ophthalmic division of the trigeminal nerve (V1) is divided into three primary branches: the lacrimal nerve that innervates the lateral aspect of the eyelid, the frontal nerve that innervates the medial upper eyelid and the superior portion of the medial canthus through the supratrochlear nerve, and the nasociliary nerve which innervates the inferior portion of the medial canthus through the infratrochlear nerve. The maxillary division of the trigeminal nerve (V2) innervates the lower eyelid through the infraorbital nerve. The zygomaticotemporal and zygomaticofacial nerve branches of the maxillary division of the trigeminal nerve (V2) supply sensation to the skin over the malar region and the lateral orbital rim.[2]

The motor innervation is through the temporal and zygomatic branches of the facial nerve (seventh cranial nerve) to the orbicularis oculi muscle (▶ Fig. 1.9). The superior division of the oculomotor nerve (third cranial nerve) supplies the levator palpebrae superioris, and the sympathetic fibers supply the superior and inferior tarsal muscles.

1.5 Lacrimal System

The lacrimal system is composed of the main and accessory lacrimal glands that produce aqueous tears and the drainage pathway of the tears. Tears are essential for eye lubrication. The tear film is composed of, in order from posterior to anterior, mucous, aqueous and oil layers, which allow tears to adhere to the surface of the eye, lubricate, and avoid rapid evaporation, respectively. The mucous component is made by goblet cells of the conjunctiva and the oil layer is produced by the sebaceous glands (Meibomian and Zeis) located mainly in the eyelids. Tears travel from the superolateral aspect of the eye to the medial aspect propelled by eyelid blinking. Blinking also helps create a pressure

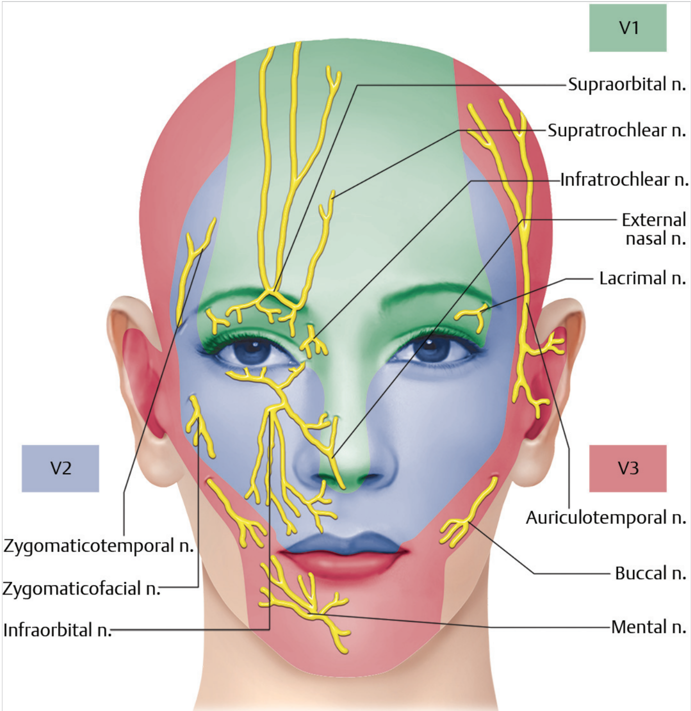

Fig. 1.8 The trigeminal nerve (CN V) cutaneous distribution. (From Watanabe K, Shoja MM, Loukas M, Tubbs RS. Anatomy for Plastic Surgery of the Face, Head, and Neck. New York: Thieme Medical Publishers; 2016.)

gradient to move tears through the nasolacrimal system.[2,7]

1.5.1 Lacrimal Gland

The lacrimal gland is an exocrine gland located in the lacrimal gland fossa of the frontal bone. It rests in the superolateral aspect of the orbit where it is divided by the lateral horn of the levator aponeurosis into two lobes: the deeper orbital lobe and the anteroinferior palpebral lobe (▶ Fig. 1.10a). The lacrimal ductules pass from the orbital lobe through the palpebral lobe to drain into the superior conjunctival cul-de-sac (▶ Fig. 1.10b). The lacrimal gland receives efferent innervation from the facial nerve as a branch that travels from the pons via the greater petrosal nerve. Parasympathetic synapse occurs in the pterygopalatine fossa and then these fibers track into the orbit through the inferior orbital fissure, eventually joining the lacrimal nerve (a sensory nerve of the trigeminal nerve) to enter the lacrimal gland for motor innervation.

1.5.2 Lacrimal Drainage System

The lacrimal drainage system begins with the punctum located in the medial aspect of the upper and lower eyelid margins. The orifice is slightly inverted and in contact with the tear film on the ocular surface. The upper puncta lie more medial than the lower puncta. Each punctum is situated on a surrounding elevation, the lacrimal papilla. After a 2-mm vertical pathway through the puncta, the lacrimal outflow pathway turns 90 degrees to form the canaliculi which run 8 to 10 mm horizontally. The canaliculi are lined by nonkeratinized stratified squamous epithelium and the lumen diameter measures 1 to 2 mm. In most cases the upper and lower canaliculi join together to form a common canaliculus before entering the lacrimal sac. The valve of Rosenmüller, at the distal aspect of the common canaliculus, prevents reflux from the sac back to the canaliculi. The lacrimal sac resides in the lacrimal sac fossa which is formed by the frontal process of the maxillary bone anteriorly and lacrimal bone posteriorly and is bound by the anterior and posterior lacrimal crests. The MCT surrounds the sac with the anterior limb inserting onto the anterior lacrimal crest and the posterior limb inserting onto the posterior lacrimal crest. The lacrimal sac measures 10 to 15 mm in vertical height with the superior third of the sac projecting above the

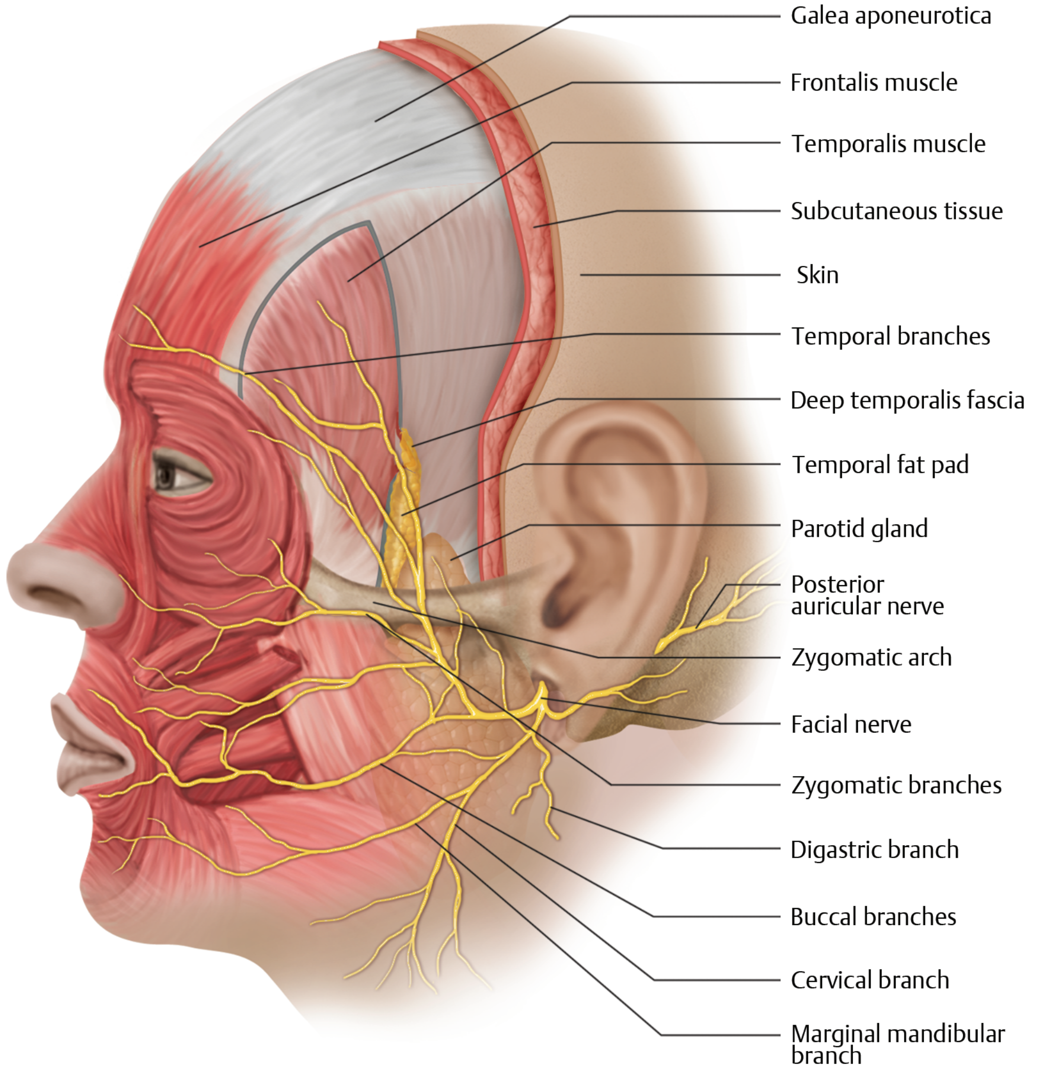

Fig. 1.9 The facial nerve (CN VII) distribution. (From Watanabe K, Shoja MM, Loukas M, Tubbs RS. Anatomy for Plastic Surgery of the Face, Head, and Neck. New York: Thieme Medical Publishers; 2016.)

MCT. The sac then narrows to become the nasolacrimal duct (NLD) measuring 12 to 18 mm in length. The NLD travels through the maxillary bone within the nasolacrimal canal in an inferior, posterior, and lateral orientation until it drains into the inferior meatus of the nose, under the inferior turbinate. The entrance of the NLD is partially covered by a mucosal fold known as the valve of Hasner (▶ Fig. 1.11).[2,7]

1.6 Accessory Structures

1.6.1 Canthal Tendons

The canthal tendons, measuring about 4 mm in length, are bands of fibrous tissue that are intimately associated with orbicularis muscle fibers and attach to the periorbita of the orbital rim.[2,8] The MCT originates from the medial aspects of the

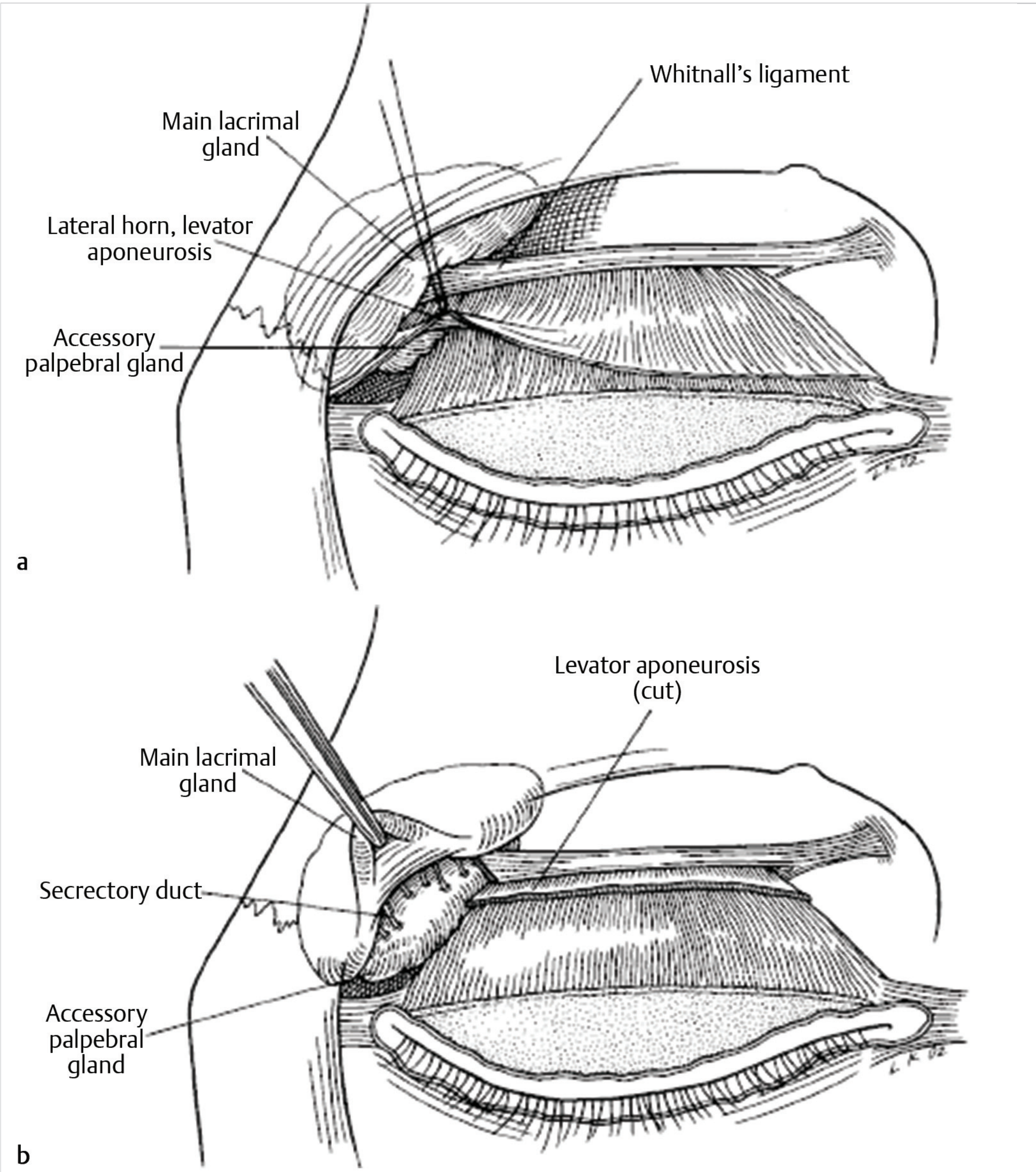

Fig. 1.10 (a) The main lacrimal gland. **(b)** The accessory palpebral gland. (From Wobig JL, Dailey RA. Oculofacial Plastic Surgery: Face, Lacrimal System, and Orbit. New York: Thieme Medical Publishers; 2004.)

upper and lower eyelid tarsal plates. The superior and inferior limbs fuse together before dividing again to form anterior and posterior limbs which surround the lacrimal sac. The anterior limb inserts onto the frontal process of the maxillary bone along the anterior lacrimal crest, and the posterior limb inserts at the posterior lacrimal crest of the lacrimal bone.[1] The posterior limb positions the eyelid against the globe and the puncta into the tear lake while the anterior limb provides the major support for the medial canthal angle (▶ Fig. 1.6).[1,9] Traumatic disruption of the MCT can result in lateral displacement of the eyelid commissure causing telecanthus, an increased intercanthal distance.

The LCT emerges from the lateral aspect of the upper and lower eyelid tarsal plates. The upper

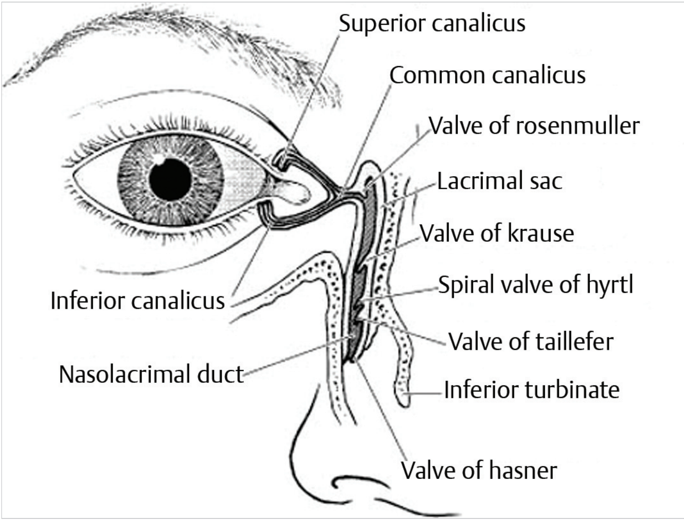

Fig. 1.11 The nasolacrimal excretory system. (From Chen WP, Oculoplastic Surgery: The Essentials. New York: Thieme Medical Publishers; 2001.)

and lower crura fuse before inserting onto the lateral orbital (Whitnall) tubercle, a small bony protuberance in the zygomatic bone of the orbit just inside the lateral orbital rim and approximately 10 mm inferior to the frontozygomatic suture. The LCT is about 2 mm higher than the MCT giving the typical upward eyelid slant from medial to lateral.[1,10] The LCT measures 10.5 mm in length (▶ Fig. 1.6).[8,9] Aging causes the LCT to stretch and become disinserted, allowing the LCT to move medially, producing eyelid laxity and shortening of the horizontal palpebral fissure.[8]

1.6.2 Eyelashes

The eyelashes emerge at the eyelid margin anterior to the gray line. They project anteriorly and then curve superiorly in the upper eyelid and inferiorly in the lower eyelid creating a protective barrier. They are sensitive to touch, signaling the eyelid to close if an object is nearby. There are about 100 lashes in the upper eyelid arranged into 3 to 4 irregular rows and 50 in the lower eyelid arranged into 1 to 2 irregular rows. There are two types of glands associated with lash follicles: the glands of Zeis which are sebaceous glands and the glands of Moll which are modified apocrine sweat glands (▶ Fig. 1.12).[1,2]

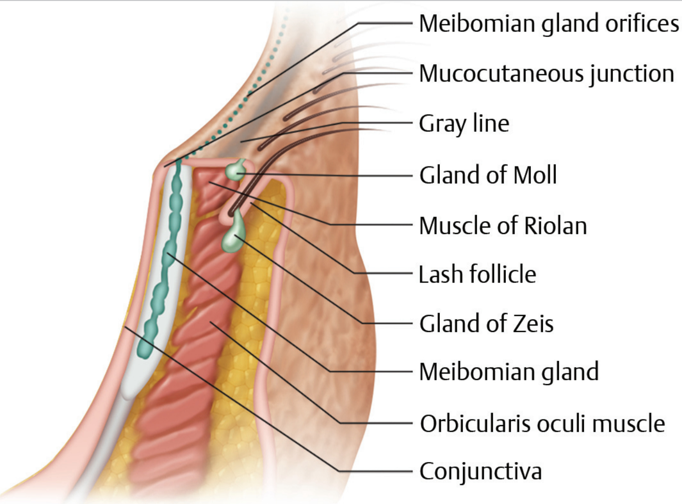

Fig. 1.12 The eyelid margin. (From Watanabe K, Shoja MM, Loukas M, Tubbs RS. Anatomy for Plastic Surgery of the Face, Head, and Neck. New York: Thieme Medical Publishers; 2016.)

1.6.3 Meibomian Glands

The Meibomian glands are holocrine sebaceous glands that secrete oil which prevents tear film evaporation. The superior eyelid has about 30 to 40 glands and the lower eyelid about 25 to 30 glands. They are vertically oriented ducts that spiral through the tarsus with orifices that open at the eyelid margin posterior to the gray line and anterior to the mucocutaneous junction (▶ Fig. 1.12).[1,2]

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2 Periorbital Surgical Principles

Victoria Starks and Suzanne Freitag

Summary
Many carefully planned steps are required to yield uneventful surgery with a desired outcome and a satisfied patient. This begins with thoughtful preoperative patient evaluation and counseling. Surgical planning requires creativity and in-depth knowledge of anatomy and the breadth of techniques of reconstruction. Furthermore, understanding the appropriate incision placement, tissue planes, and the use of tissue flaps and grafts empowers the surgeon to address myriad tissue defects. Intraoperatively, efficient and careful handling of tissue allows the minimal amount of tissue damage and leads to better histopathology specimens, well-healed incisions, and improved cosmesis. Adhering to sound surgical principles and techniques will optimize outcomes.

Keywords: eyelid reconstruction, periorbital surgery, surgical technique, surgical principles, skin graft

2.1 Preoperative Assessment and Counseling

Patient safety and satisfaction with surgical outcomes depend on complete preoperative assessment and counseling. Medical comorbidities should be optimized and elective procedures should be scheduled so as to allow for medical clearance by other specialists as needed. Incisional biopsy of potentially malignant lesions or other small eyelid biopsies may often be safely performed without cessation of anticoagulation. For more invasive, nonemergent procedures, stopping anticoagulation should be considered and discussed with the physician managing the anticoagulation. In a large, randomized, controlled trial, the continued use of aspirin increased the risk of major bleeding in the perioperative period and did not affect the risk of death or myocardial infarction.[1] The risk of thrombosis with withdrawal of anticoagulation and the need for bridging must be assessed individually for each patient.

If the decision is made to hold anticoagulation, the specific plan should be agreed upon and carefully documented with the prescribing physician. In general, warfarin is held for 4 to 5 days, and a preoperative international normalized ratio (INR) is checked with a goal of < 1.5. Aspirin is held for at least 5 to 7 days and platelet $P2Y_{12}$ inhibitors, such as clopidogrel, for at least 7 days. Direct thrombin and factor Xa inhibitors (e.g., apixaban and rivaroxaban) are held for 2 to 3 days. Careful history taking and cross-checking with medication lists are necessary to elicit anticoagulation use. Nearly one out of five patients may under-report use of anticoagulation, especially aspirin.[2] Patients should also be instructed to hold vitamins and supplements with anticoagulative properties, such as garlic, omega-3, and vitamin E. In many cases, patients may safely resume anticoagulation on the first postoperative day.

A careful ophthalmic examination should be performed on all patients undergoing periorbital reconstructive surgery. If a patient is functionally monocular, consideration should be given to not covering the seeing operative eye, or if necessary, patching for as short a period as possible during the postoperative period. Care must be taken intraoperatively to avoid damage to the eye, especially if there have been previous surgical interventions such as corneal transplants or glaucoma blebs. In trauma cases, a careful ophthalmic exam to rule out an open globe should be completed prior to addressing any periorbital or orbital injuries. In addition, the status of tetanus immunization must be assessed. If the most recent tetanus booster was more than 5 years ago, a tetanus toxoid booster should be given. In the case of a contaminated penetrating injury when the tetanus immunization status is unknown or fewer than three doses of tetanus toxoid have been administered, tetanus immune globulin is given in addition to the full vaccination series.

2.2 Perioperative Antibiotics

The infection rate for routine eyelid surgery is very low.[3] Many surgeons routinely treat patients with a prophylactic course of systemic antibiotics intraoperatively or after reconstructive eyelid surgery. However, some surgeons do not routinely use systemic antibiotics. It is especially important to consider antibiotic use in cases of trauma or when using a full- or split-thickness skin graft. In such cases, intraoperative intravenous antibiotic may be given followed by an appropriate postoperative oral antibiotic for approximately a week. The prophylactic use of topical antibiotics in the form of an ophthalmic antibiotic ointment for 1 to 2 weeks postoperatively should be considered. In addition to preventing infection, the ointment functions as an ophthalmic lubricant.

2.3 Local Anesthesia and Surgical Site Preparation

The periorbital area has a generous blood supply, with eyelids having arcades of vessels that are supplied by both the internal and external carotid arteries. For intraoperative hemostasis, consideration should be given to the use of local vasoconstrictive agents. This can be accomplished by injecting local anesthetic consisting of 1 or 2% lidocaine with 1:100,000 epinephrine. The addition of bupivacaine extends the duration of anesthesia. Including hyaluronidase in the block allows the anesthesia to diffuse farther, which is often beneficial but should be avoided in certain cases, such as levator advancement. Local anesthesia distorts tissue planes; therefore, measurement of defects or skin marking is best performed prior to this step.

In trauma cases, wounds should be irrigated with normal saline and any foreign bodies should be removed. Skin preparation with an iodine-containing solution or other antiseptic is routinely performed. If an alcohol-containing preparation is used, as may be done in cases of iodine allergy, adequate time for drying must be allowed prior to the use of cautery to reduce the fire risk in the surgical field. Chlorhexidine should never be used in the periocular region because of the risk of permanent corneal injury. Isolation of the surgical field with sterile drapes is then performed. Often the full face is prepped and exposed with drapes for periorbital surgery, to allow for monitoring of the unoperated eye, for comparison to the contralateral side for purposes of symmetry, and for patient comfort.

2.4 Instrumentation

Thin eyelid skin necessitates the use of fine suture and precision instruments. There are a multitude of specialized instruments available. A basic periorbital set is discussed in this section

Fig. 2.1 Standard periorbital surgery instruments. From *left* to *right*: Number 15 blade on blade handle, Castroviejo needle holder, Adson forceps, 0.5 mm Castroviejo forceps, Bishop-Harmon forceps, straight iris scissors, curved Stevens tenotomy scissors, Westcott scissors, skin retractor, Desmarres retractor, fine hemostat. Superiorly: lacrimal irrigation cannula, punctal dilator, lacrimal probe.

(▶ Fig. 2.1). Locking, fine-tipped needle holders, such as Castroviejo needle holders are ideal for control and manipulation of fine suture and needles. Fine-tipped toothed forceps such as Bishop-Harmon forceps or 0.5 mm Castroviejo forceps work well for gentle handling of eyelid tissue. Sharp dissection in the periorbital area is often performed with fine spring handle scissors, such as Westcott scissors. Blunt dissection may be performed with larger scissors such as Stevens tenotomy scissors or a fine hemostat. Eversion of the eyelid can be easily performed with the use of a Desmarres retractor and a traction suture placed in the eyelid margin. When elevating a skin flap, a fine skin hook may be used to prevent crush injury to the flap edges.

Punctal dilators, lacrimal probes, and lacrimal irrigation cannulas are used for evaluation of the lacrimal drainage apparatus. Stenting of the lacrimal drainage system may be performed with monocanalicular or bicanalicular silicone stents. Monocanalicular stents are seated in the punctum with a flange that fits tightly within the natural punctum. Bicanalicular stents pass through the upper and lower canaliculi and are secured in the nose forming a loop.

When possible, it is advantageous to have cautery available, as the periorbital area is quite vascular. Hand-held battery-operated hot-wire cautery units are useful for controlling minor bleeding and may also be used as a cutting or dissecting tool. Small vessel bleeding may be controlled with high-frequency unipolar or bipolar electrocautery. Significant arterial bleeding from larger vessels may rarely require ligation with silk ties. Caution should be exercised to reduce fire risk when using cautery. Supplemental oxygen and blowing air should be turned off prior to using cautery, and flammable substances such as dry gauze sponges, cotton-tipped applicators, or paper drapes should not come in contact with the tip of the cautery unit. When the source of bleeding is diffuse, topical methods of hemostasis may be used. Applying firm, uninterrupted pressure to the wound will frequently stop the bleeding. However, this is not advisable in cases where the blood may track post-septal into the orbit and result in compartment syndrome. Cotton pledgets soaked in local anesthetic with epinephrine can be applied to the bleeding surface. If bleeding persists, thrombin-soaked compressed sponges may be packed into the wound.

2.5 Suture Selection

Suture should be selected after consideration of the desired duration of suture within the tissue and concern about inflammatory reaction, absorption, and susceptibility to microbial colonization of the various available suture materials. Braided suture handles easily with low memory and holds knots well, but is more susceptible to bacterial colonization. Nonabsorbable sutures are more resistant to hydrolysis and as a result they are often less inflammatory. When there is concern for hypertrophic scarring, it is best to use a minimally tissue-reactive suture, such as polypropylene or nylon, for skin closure.

There is a range of reactivity and elasticity among nonabsorbable sutures (▶ Table 2.1). Nonabsorbable skin sutures are typically removed at 1 week after placement, when wound healing is adequate. Sutures in the eyelid margin are often left in place for 2 weeks to ensure adequate strength and wound healing.

Table 2.1 Characteristics of absorbable and nonabsorbable sutures

Suture material	Type	Filament type	Tissue reaction	Elasticity	Uses
Silk	Nonabsorbable	Braided	Moderate	None	Lid margin, vascular ties
Polyamide (nylon)	Nonabsorbable	Monofilament	Nonreactive	Minimal stretch	Skin
Polypropylene (Prolene)	Nonabsorbable	Monofilament	Nonreactive	Moderate stretch	Skin, tarsal strip
Polyester (Dacron, Mersilene)	Nonabsorbable	Braided or monofilament	Moderate, becomes encapsulated	Minimal stretch	Subcutaneous placement
Plain gut	Absorbable	Monofilament	Mild to moderate	Very brittle	Cutaneous when minimal tension
Fast absorbing plain gut	Absorbable	Monofilament	Mild	Very brittle	Cutaneous
Chromic gut	Absorbable	Monofilament	Mild	Brittle	Cutaneous
Polyglycolic acid (Vicryl, Dexon, Polysorb)	Absorbable	Braided	Mild	Minimal elasticity	Cutaneous
Polydioxanone (PDS)	Absorbable	Monofilament	Mild	Minimal elasticity	Subcutaneous, cutaneous
Polytrimethylene (Maxon)	Absorbable	Monofilament	Minimal	Minimal elasticity	Subcutaneous

Absorbable sutures obviate the need for subsequent suture removal which occasionally causes discomfort and are a good choice in young children or when there is uncertainty over a patient's reliability to return for follow-up. The wound is temporarily supported by absorbable sutures while tissue remodeling and healing occur. The suture is broken down by enzymatic degradation. The tensile strength of the suture is diminished long before the suture material is completely absent from the body. There are many absorbable sutures available with a range of tissue durations and tendencies to incite inflammation (▶ Table 2.1).

Selection of the size (diameter) of the suture filament is dictated by the thickness of the tissue. Thin eyelid skin can be approximated with fine suture, such as 6–0. Thicker glabellar, brow, or cheek skin can be closed with larger suture, such as 4–0 or 5–0. Finer 7–0 suture may be used in the eyelid margin or at the eyelash line.

When suturing, it is important to select the appropriate needle. Reverse cutting or cutting needles pass most easily and atraumatically though tissue. Spatulated needles allow the creation of partial thickness lamellar passes through dense tissue, such as tarsus or sclera, while minimizing the risk of full-thickness penetration of these tissues (▶ Fig. 2.2). The degree of curvature of the needle also impacts its utility. Moderately curved needles, with 1/4th circle or 3/8th circle curvature, are commonly used to suture skin or tarsus. More highly curved semicircular needles are useful for locations with limited working space or for buried sutures (▶ Fig. 2.3).

2.6 Principles of Suturing Technique

2.6.1 Tissue Handling

Delicate handling of tissues is important in the periorbital area. The fine instruments described previously in the chapter help the surgeon minimize crush injury, which can affect healing as well as impair histopathologic analysis of specimens. Forceps injury can cause microtrauma to the skin or lacerations which may delay healing or affect the final cosmetic result. Tissue should be grasped with the minimum force necessary and ideally not be regrasped. The instrument used to grasp tissue should be toothed to minimize crush injury and should be appropriately sized. Grasping across the eyelid margin should be avoided as this may result in notching of the margin. Deeper tissues, such as orbicularis oculi muscle, may be grasped instead of skin. Minimizing unnecessary tissue handling will also reduce edema and better preserve the anatomy, thus facilitating surgical repair.

Prior to beginning wound closure, the tissue should be inspected. If granulation has begun along the wound edges, these may be freshened

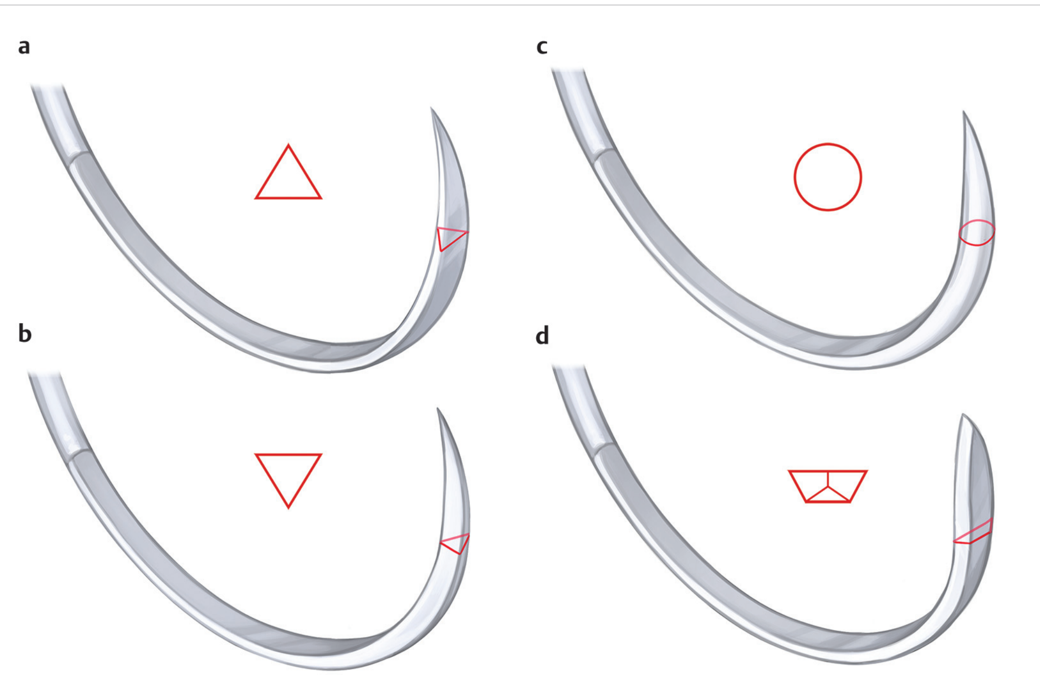

Fig. 2.2 (a–d) Needle styles used in periocular surgery.

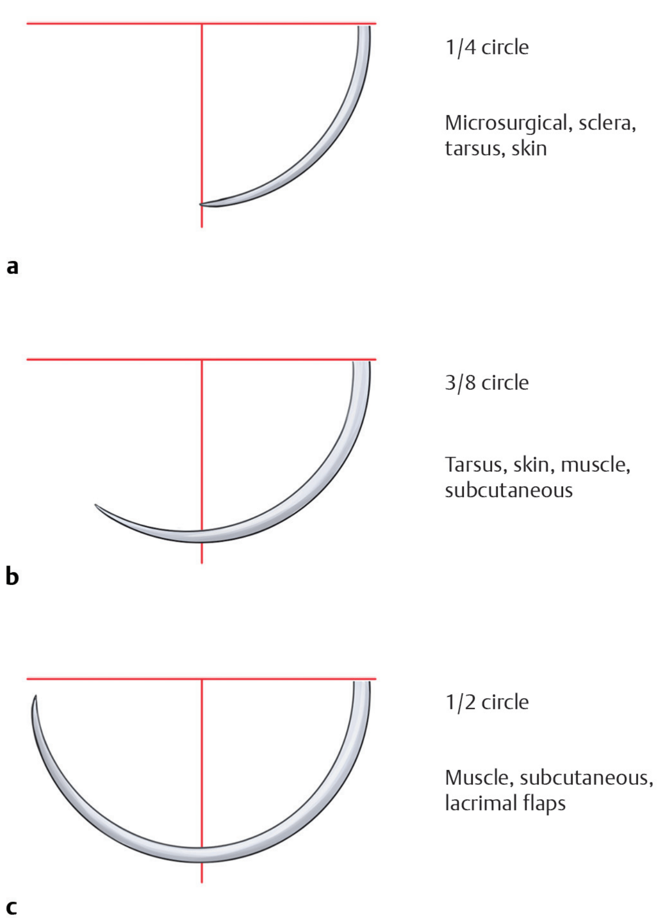

Fig. 2.3 (**a–c**) Options for needle curvature used in periocular surgery.

with fine scissors or a scalpel. Carefully preparing the skin edges will minimize the width of the resultant scar and help to ensure adhesion of the tissue edges during healing.

Wound closure in the periorbital area is most commonly accomplished with sutures. However, linear, nonmarginal wounds are occasionally closed with cyanoacrylate tissue adhesive. Small defects in the epithelium may, depending on anatomic location, be allowed to heal by secondary intention. Allowing tissue to granulate to fill small defects may be preferable to rearranging adjacent tissue.

2.6.2 Skin Incisions

When planning an incision, it is best to mark prior to infiltrating the tissue with local anesthetic because this can distort the anatomy. Skin should be held taut while making an incision to prevent the tissue from rolling unpredictably under the blade. When using a scalpel to incise skin, the blade is held perpendicular to the tissue unless there is a reason to bevel the incision, such as preserving hair follicles in the brow region. The incision is begun with the tip of the blade. The handle of the blade is then lowered so that the belly of the blade is drawn across the skin. The incision is then completed with the tip of the blade. The incision should be through the dermis and is often best performed using a single pass. When creating a skin flap or harvesting a skin graft, it is best to use a steel blade to incise the skin and then undermine with a blade or fine scissors rather than cautery to minimize shrinkage of the tissue.

2.6.3 Suturing

Grasping and stabilizing tissue immediately adjacent to the planned location of suture entry allows precise control of tissue and suture placement and facilitates the needle entering perpendicular to the plane of the skin. When tying the suture knot, overtightening should be avoided to prevent an irregular wound and strangulation of the skin edges. Skin sutures should create slight eversion of the wound edges, which prevents the formation of a depressed scar as the tissue undergoes expected contraction during healing.

Interrupted sutures in cross-section should assume the shape of a simple, looped trapezoid. Tightening the suture creates mild skin eversion (▶ Fig. 2.4). Simple interrupted sutures are useful for skin closure with minimal or no tension. In addition, irregularly shaped wounds, as often encountered in trauma or cancer reconstruction, are best repaired with interrupted sutures as these allow precise realignment of the anatomy.

Buried sutures can be placed below the skin to reduce wound tension. These sutures are passed from deep within the wound to more superficially, but still below the epidermis, and then from superficial to deep on the apposing side of the wound (▶ Fig. 2.5). This allows the knot to lie deep within the wound, preventing the prolapse of suture tails through the wound that may result in discomfort and suboptimal wound healing and provide a conduit for infection. If the deep sutures are appropriately placed such that the needle exits and enters at the dermal–epidermal junction, the skin edges should appear well-apposed even prior to placement of superficial skin sutures.

A larger degree of skin eversion can be obtained with a vertical mattress suture. This suture consists of two layered passes which evert the deeper and more superficial tissue. Care must be taken not to overevert such that the wound edges are not approximated as can occur if the inner bites are too far from the wound edge. This suture is often used for eyelid margin repair (▶ Fig. 2.6).

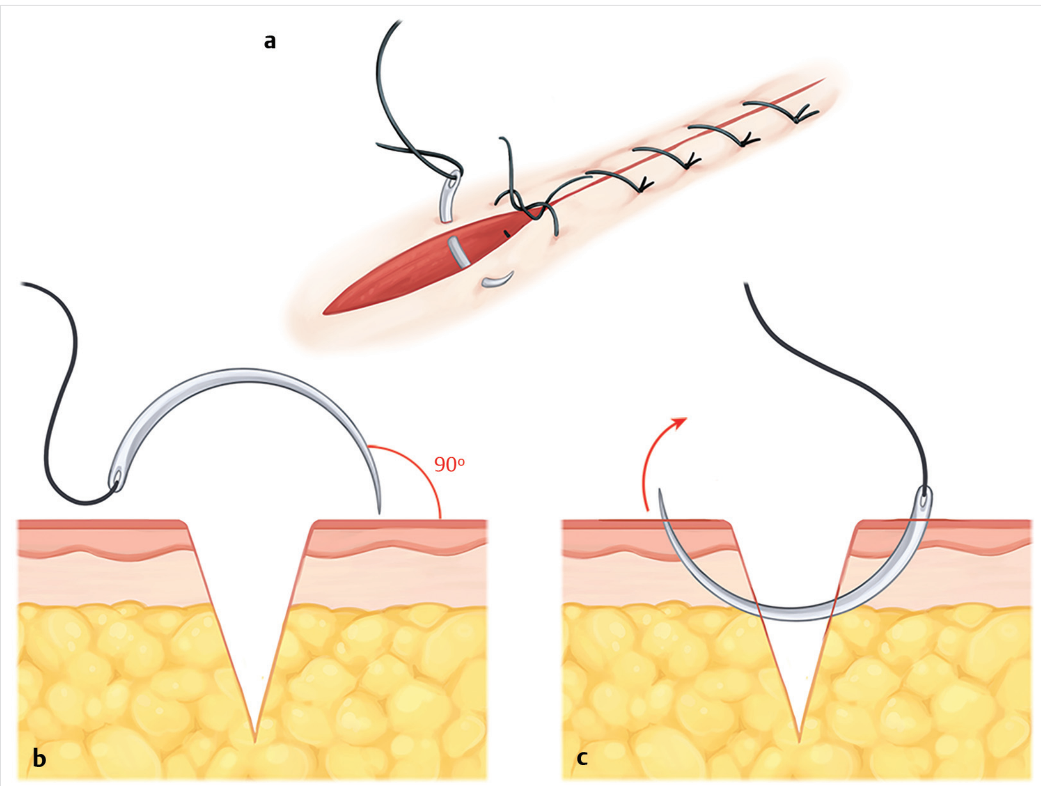

Fig. 2.4 **(a–c)** Simple interrupted suture with eversion of wound edges.

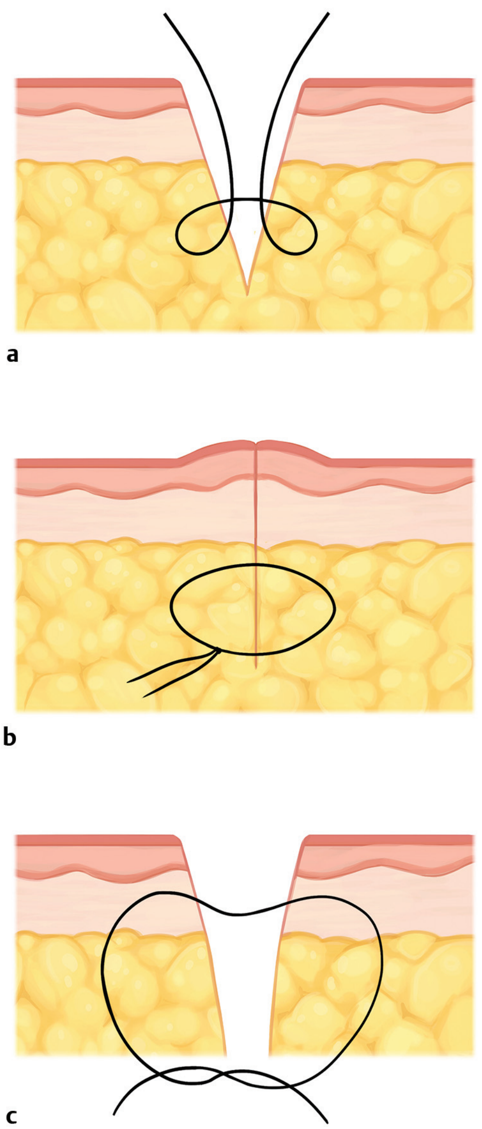

Fig. 2.5 (a–c) Buried suture with approximation of deep tissue.

A buried horizontal mattress suture is useful for closing deep tissue planes especially in large wounds. In addition, a half buried horizontal mattress suture is useful for corners or approximation of three flaps at one point. This deep suture placement at the tip of flaps is useful in preventing tip necrosis (▶ Fig. 2.7). The lateral aspect of the lower eyelid tarsus is often secured to the periosteum of the lateral orbital rim with a horizontal mattress suture when resuspending the lower eyelid.

Continuous running sutures allow for efficient closure of regularly shaped wounds under minimal or no tension (▶ Fig. 2.8). A continuous locking suture is an efficient method of closure when there is mild tension, such as closing the retroauricular space after harvesting a graft (▶ Fig. 2.9).

2.6.4 Eyelid Margin Repair

A smooth, contiguous eyelid margin allows maintenance of a healthy corneal surface and is cosmetically important. The eyelid margin tends to heal with a notch if not repaired or improperly repaired. For full-thickness or partial-thickness defects of the eyelid margin, measures must be taken to restore the structural integrity of the tarsus and evert the edges of the margin laceration. In cases of partial thickness loss of tarsus or involvement of the margin, conversion to a full-thickness defect is often the preferred method of reconstruction. As long as there is adequate tissue to close a full-thickness defect, a pentagonal wedge of full-thickness eyelid can be excised to create new wound edges with intact tarsal tissue.

Some surgeons prefer to use 5–0 or 6–0 silk suture in the margin while others use 6–0 or 7–0 polyglactin suture. Reapproximation of the margin begins with a vertical mattress suture through the tarsus using the meibomian gland orifices as landmarks to align the suture on either side of the wound. The tarsal vertical mattress suture is passed first through the side of the defect that is furthest from the cornea such that the knot will be positioned away from the cornea. The tails of this suture are left untied and long. A second vertical mattress suture is placed anterior to the first in or just anterior to the gray line. Similarly, the tails are left long. The nonmarginal vertical cut edges of the tarsus are then reapposed with 6–0 polyglactin suture on a spatulated needle which is passed partial thickness through the tarsus to avoid contact with the cornea and tied down such that it is buried within the wound, on the anterior surface of the tarsus. Several such sutures may be placed if there is a tall segment of tarsus to reapproximate. Once these sutures are tied down, the margin sutures are tied and left long. The eversion of the margin wound should be notable at this point. A third margin suture may be placed in the lash line to realign the lashes on either side of the defect and the tails are also left long. The skin is then closed with interrupted sutures and the long tails are

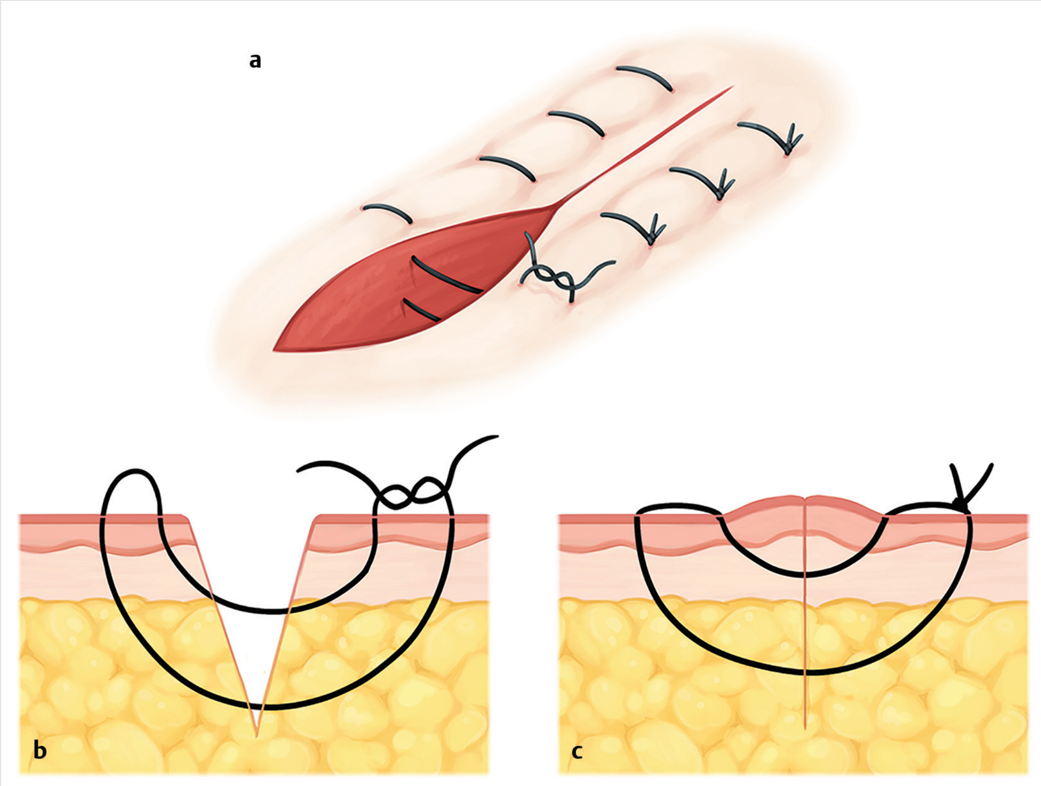

Fig. 2.6 (a–c) Vertical mattress suture with more eversion of wound edges.

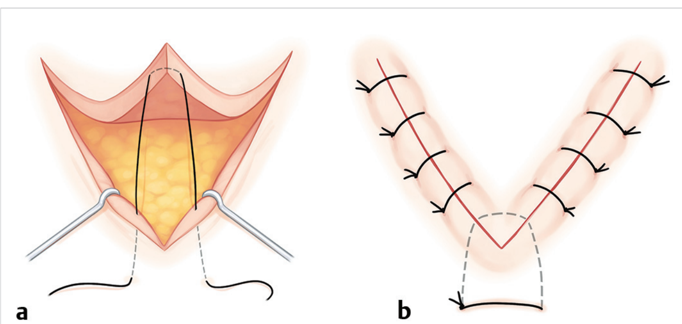

Fig. 2.7 (a,b) Partially buried horizontal mattress suture.

incorporated into these sutures to hold knots and suture ends away from the cornea. The margin sutures are removed at 2 weeks after placement (▶ Fig. 2.10).

If there is insufficient tissue to close the eyelid margin, a small lateral inferior cantholysis can be performed. This adds an additional few millimeters of horizontal eyelid mobility (▶ Fig. 2.11). After the eyelid margin defect is closed, repair of the lateral canthus is often not necessary or may be performed with placement of a cutaneous suture in the lateral canthal angle.

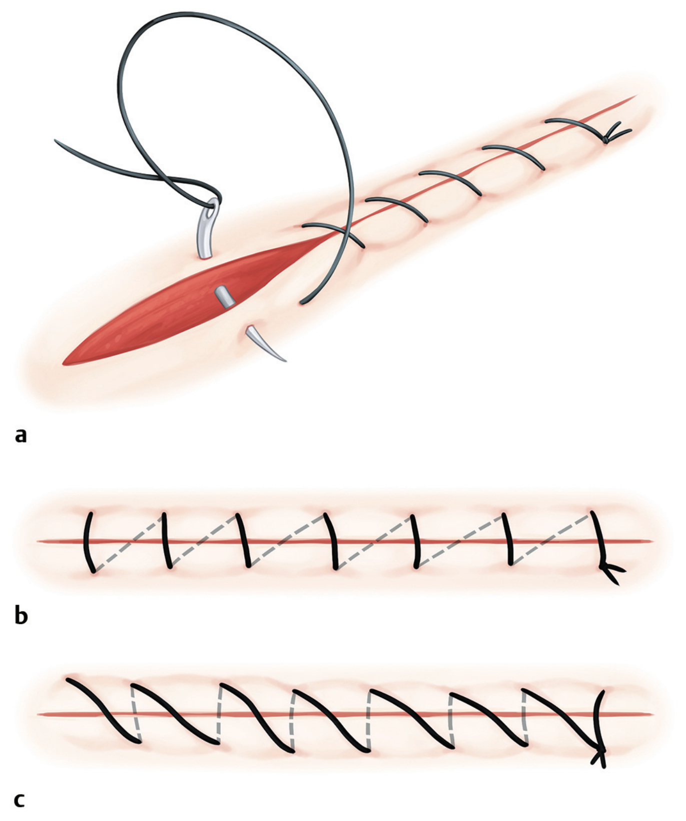

Fig. 2.8 (a–c) Continuous (running) suture.

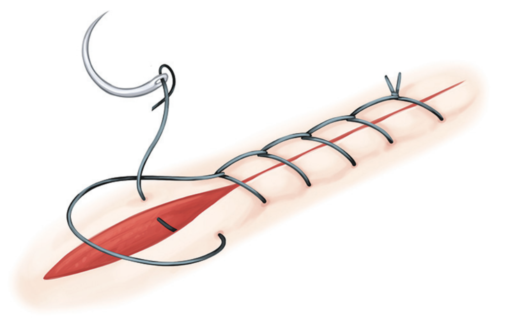

Fig. 2.9 Continuous locking suture.

2.7 Principles of Surgical Planning

2.7.1 Relaxed Skin Tension Lines

The muscles of facial expression create natural skin tension lines. When possible, flaps or incisions should be planned to take advantage of these lines, as they allow scars to be better concealed and reduce tension on wounds. Placing an incision in the eyelid crease, for example, allows the best possible concealment of the scar.

2.7.2 Hierarchy of Repair

There are numerous surgical options for reconstruction of the periocular area. Many are listed below in order of increasing invasiveness. For the best functional and cosmetic results, the least invasive yet most anatomically effective technique should be employed.

Secondary Intention

Very small periorbital cutaneous defects, such as after excision of small eyelid lesions, may be left to heal by secondary intent.

Direct Closure

Primary closure of a skin defect may be performed if the skin edges can be opposed with minimal

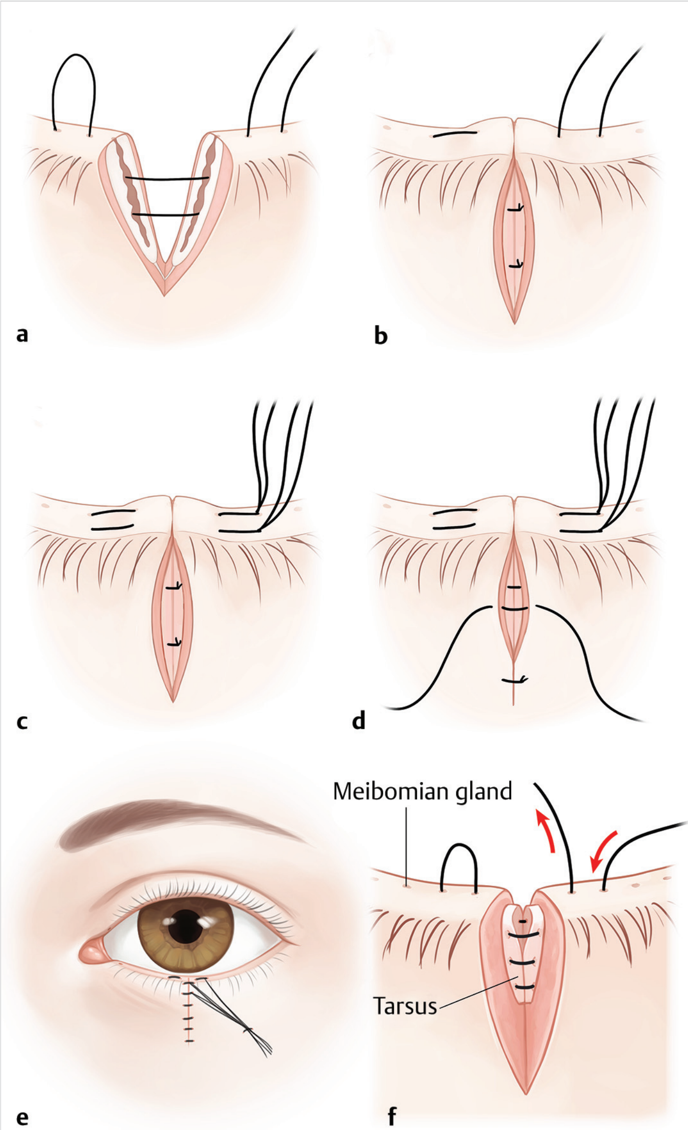

Fig. 2.10 (**a–f**) Eyelid margin repair: vertical mattress sutures through the eyelid margin, buried sutures through the tarsus, and direction of the tails of the marginal sutures away from the cornea.

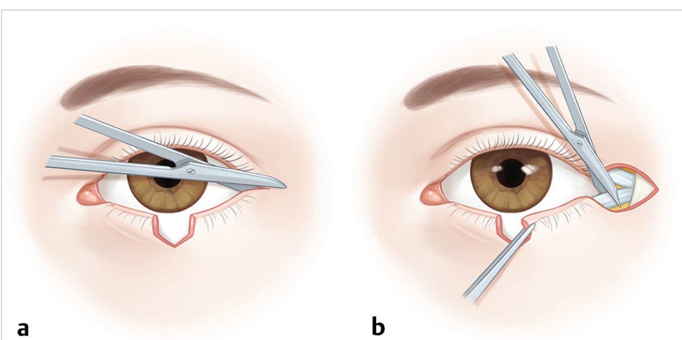

Fig. 2.11 (**a,b**) Lateral canthotomy and inferior cantholysis.

tension and without significant vertical tension on the eyelid. In the periorbital area and particularly the lower eyelid, tension should be oriented horizontally (incision line is vertical, sutures are horizontal) to prevent secondary retraction of the eyelid and lagophthalmos. Undermining the tissue edges to create a small sliding flap on both sides of the wound facilitates direct closure. The optimal shape for direct closure is an ellipse with a ratio of 1:3 or 1:4 between the axes. A small skin defect of another shape may be converted to an ellipse for primary closure. The double-S ellipse closure, O-to-Z plasty, or M plasty are modified elliptical closures that allow preservation of more normal tissue than extending the incision to a complete ellipse (▶ Fig. 2.12, ▶ Fig. 2.13, ▶ Fig. 2.14).[4] If it is not possible to close the skin edges without tension, additional tissue can be recruited by means of a flap or full-thickness skin graft.

Skin Flaps

Numerous flaps can be utilized in the periorbital area. The ensuing chapters will describe various flap options by location.

After a flap is undermined and mobilized into the recipient bed, excess tissue may result at corners or at the ends of incision lines. A Burrow triangle, a small triangle of excess tissue, can be excised to allow the tissues to lie flat (▶ Fig. 2.15). A mismatch between skin length on either side of an incision can lead to redundancy of the skin forming a standing cone deformity or "dog ear." The dog ear may be excised by holding the redundant skin tautly above the incision. The incision is extended into the cone and the remaining skin is then folded over the incision and truncated (▶ Fig. 2.16).

Full-Thickness Skin Grafting

Skin grafts are useful for repair of a variety of defects in the periocular area, but must be implemented with caution because of the limited ability to direct wound tension, which is exerted in all directions with a skin graft. Prior to harvesting a graft, the dimensions of the recipient bed are determined allowing accurate marking of the donor site. The size of a full-thickness skin graft should

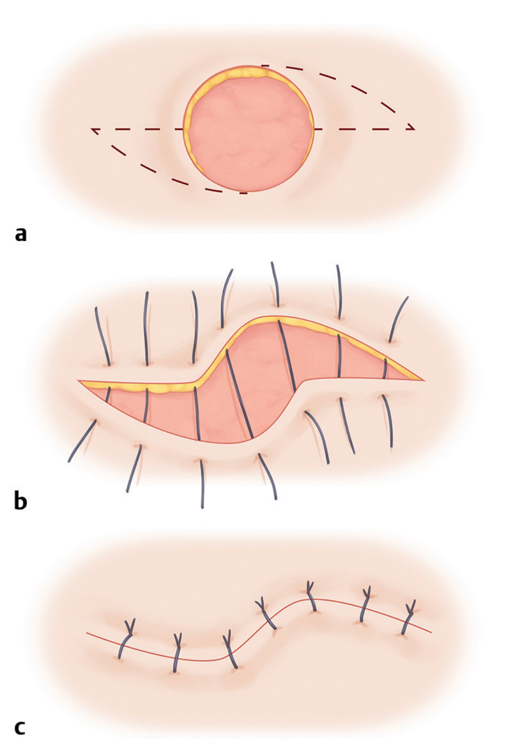

Fig. 2.12 (a–c) Double S plasty.

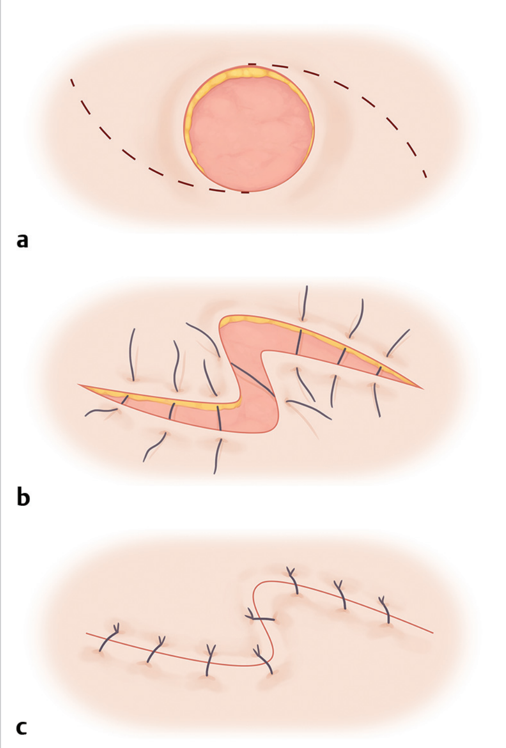

Fig. 2.13 (a–c) O-to-Z plasty.

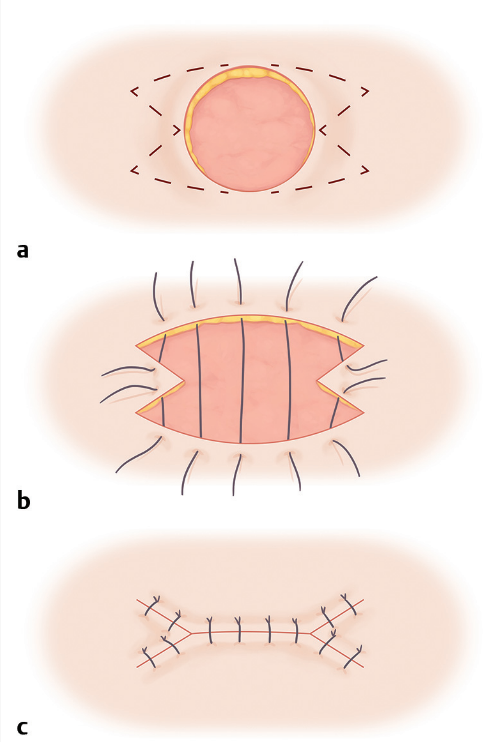

Fig. 2.14 (a–c) M plasty.

be approximately the same as the recipient site or slightly oversized. Local anesthetic is injected into the subcutaneous space of the donor site and the graft is harvested using a blade or scissors rather than cautery in order to minimize tissue thermal damage. Subcutaneous tissue is best not harvested with the graft, as the retention of subcutaneous tissue will impede the ingrowth of blood vessels from the recipient bed and may lead to graft necrosis. If subcutaneous tissue is present at the time of harvest, it can be removed by inverting the graft over a gloved finger and excising excess subcutaneous tissue with a fine scissor until the white dermis is visible and appendages such as hair follicles are gone (▶ Fig. 2.17).

The ideal skin graft is similar in appearance and texture to the recipient area. In the case of eyelid skin, the donor skin should be a good match for color, actinic damage, skin thickness, and absence of prominent hair follicles. The ipsilateral or contralateral upper eyelid is an excellent source of well-matched skin. The graft may be harvested by marking a typical blepharoplasty incision. The resulting scar is hidden within the eyelid crease. If there is insufficient skin available on the upper eyelid, retroauricular skin is a good alternative. The benefits of retroauricular skin are the concealment of the scar and its good match with eyelid

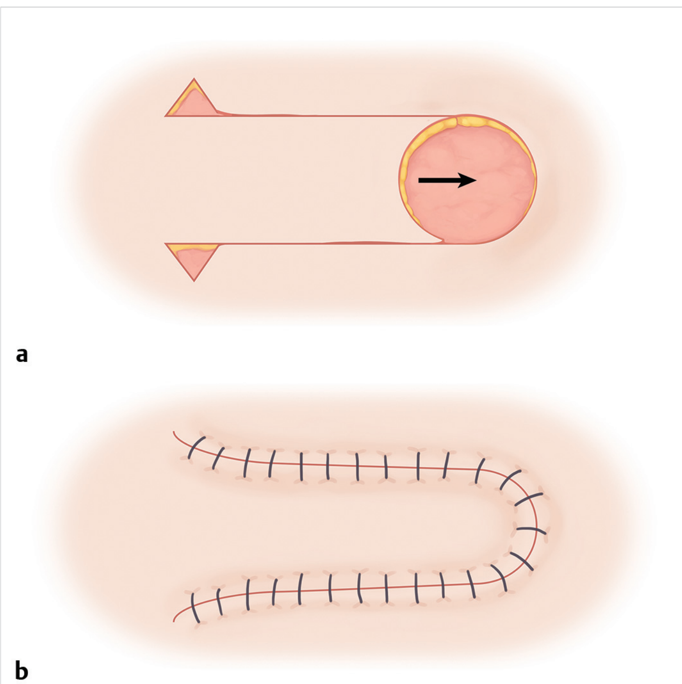

Fig. 2.15 (a,b) Excision of a Burrows triangle.

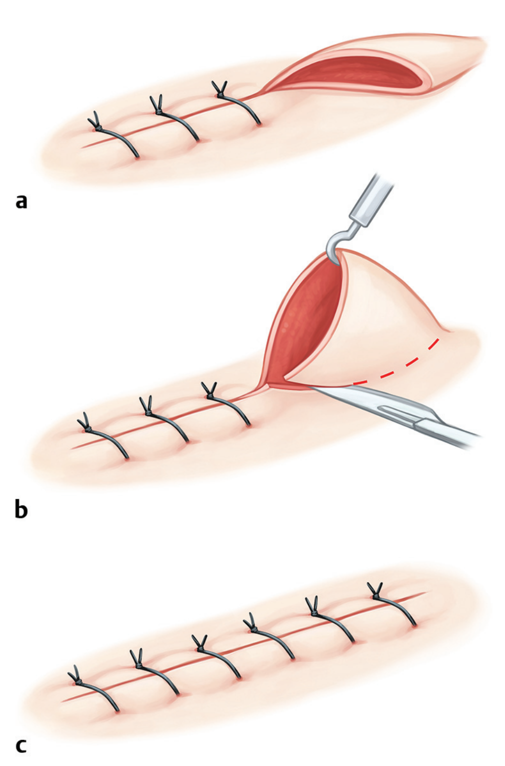

Fig. 2.16 (**a–c**) Excision of a standing cone deformity (dog ear).

skin. The retroauricular space is marked in an ellipse with the long axis of the ellipse overlying the crease between the ear and the scalp. A traction suture through the skin of the helix of the ear may be used to retract the ear and improve visualization. This suture should pass through skin only, as violating the cartilage may cause painful chondritis. Once the graft is harvested, the retroauricular space is then closed in layers, again avoiding the cartilage. Deep buried interrupted sutures, such as 4–0 or 5–0 polyglactin, can be used to reduce the tension. A running suture may then be placed to close the skin. The final result is a well-concealed scar, which may rarely cause slight pinning back of the ear (▶ Fig. 2.18).

If the skin requirement exceeds the amount available from the retroauricular space, more tissue may be harvested from the supraclavicular skin. In hirsute individuals, adequate thinning of the donor skin is important to achieve a hair-free graft. The technical components of harvesting the

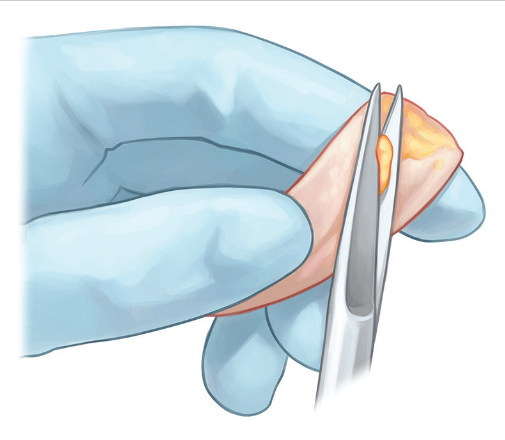

Fig. 2.17 Technique of thinning a full-thickness skin graft.

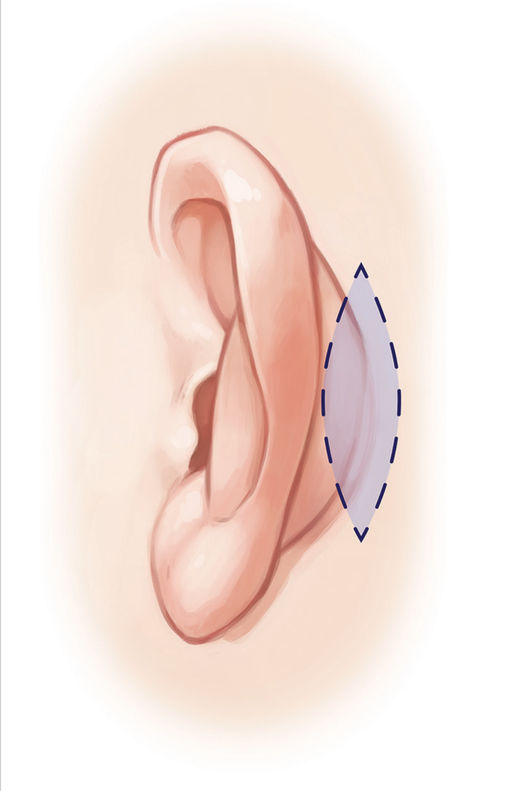

Fig. 2.18 Correct location to harvest a retroauricular skin graft.

graft and closing the donor bed are similar to those described above.

Securing the graft into the recipient bed is best initiated with cardinal interrupted sutures to prevent a gradual shift of the graft from a running suture. Once the graft is secured at the cardinal points, continuous running sutures may be used to more efficiently complete the skin closure. Use of absorbable suture in the periocular area is effective and eliminates the need to subsequently remove sutures from the delicate graft–host junction. For vascularization of the graft, there must be direct apposition of the graft to the recipient bed with minimal shearing forces. A bolster may be placed over the graft for 5 to 7 days, although because of the rich vascular supply in the periorbital area, many surgeons use a pressure patch rather than a formal bolster. Dressing material adjacent to the graft should be nonadherent. If the graft is large, several small, full-thickness slit incisions may be created to prevent the accumulation of a hematoma or seroma below the graft preventing vascularization. As adequate vascularization of the graft is of paramount importance, some surgeons will not perform a skin graft in patients who are active smokers or significantly anticoagulated.

The surgeon must be cognizant of the tendency of skin grafts to contract. Some surgeons oversize the graft slightly; however, this must be balanced with the risk of poor vascularization and cosmesis if there is redundancy and corrugation of the graft. When placing a skin graft in the lower eyelid, a temporary tarsorrhaphy or Frost suture may be useful for the first weeks to combat tissue contraction leading to ectropion or eyelid retraction. It can also be useful to perform lateral canthoplasty if there is laxity of the lower eyelid.

Split-Thickness Skin Grafting

A split-thickness skin graft is well-suited to cover a large surface area because the large donor site does not need to be closed, however the thin graft is at risk of sloughing. In periorbital surgery, split-thickness skin grafts are rarely used, due to their contraction and poor cosmesis. They are most commonly used to line an exenterated orbit. The graft is harvested with a dermatome, typically from the anterior thigh. The dermatome thickness is set to 12 to 15/1000 of an inch. The tissue can be meshed to allow for increased surface area. The donor site is then dressed with iodoform gauze, dry sterile gauze, and a loose circumferential wrapping of the thigh or a clear adhesive dressing.

Tarsoconjunctival Grafts

Grafting the posterior eyelid lamella presents unique challenges including the need for structural support to replace lost tarsal tissue and an appropriate surface material that safely and comfortably abuts the eye. A tarsoconjunctival graft from the ipsilateral or contralateral eyelid is the ideal composite graft, although is limited by the amount of tissue available to donate.[5,6] The graft is harvested by placing a traction suture through the margin and everting the upper eyelid. A caliper set to 4 mm is used to measure this distance from the margin along the posterior face of the tarsus. The line may be marked with a marking pen or with a blade. The marking should be curvilinear to follow the contour of the eyelid to allow maximization of the graft line. Preservation of at least 4 mm of the inferior tarsus including the eyelid margin is critical to preserve the integrity of the upper eyelid and prevent tarsal kink or instability. The tarsal incision is created with a scalpel, such as a number 15 blade, taking care to remain perpendicular to the tissue and to not pass full thickness through the eyelid. Grasping the tarsoconjunctival graft and retracting it away from the eyelid, the attachments of the levator muscle are then sharply dissected away with fine scissors. The tarsoconjunctival graft is then excised with a small cuff of conjunctiva at the superior aspect. Hemostasis is obtained in the upper eyelid and the donor site is left to close by secondary intention. The conjunctival side of the graft may be marked with a marking pen for later identification, and the graft is placed in a saline soaked gauze until it is used.

The tarsoconjunctival graft is secured in the recipient bed with margin sutures at both ends of the graft, attaching the graft to the tarsus remaining in the recipient bed. Silk or polyglactin sutures are appropriate for this purpose, taking care to leave the ends long and incorporated into external cutaneous sutures to prevent corneal touch. If there is inadequate recipient tissue to form a complete posterior eyelid lamella, periosteal grafts from the medial or lateral aspects of the orbital rim may be utilized and attached to the ends of the free tarsoconjunctival graft. Suture is then run along the conjunctival aspect of graft, attaching it to the residual conjunctiva in the fornix of the defect to be repaired (▶ Fig. 2.19). Decisions are then made for creation of an anterior lamellar flap on this reconstructed area of the eyelid, keeping in mind that a graft placed on a graft will not survive due to lack of blood supply.

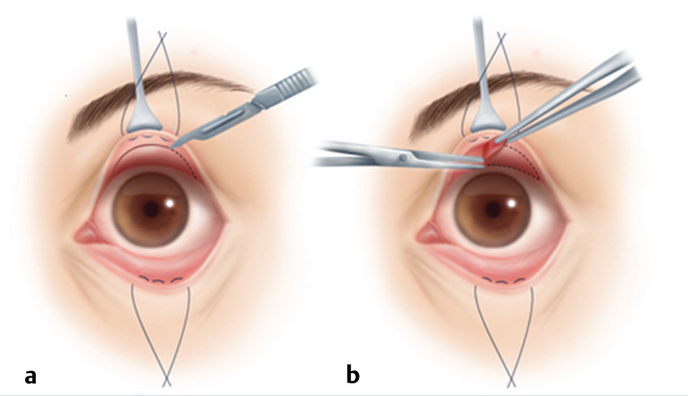

Fig. 2.19 (**a**) A traction suture is placed through the margin of the upper eyelid and the eyelid is everted over a Desmarres retractor. A 15 blade is used to incise the full-thickness tarsus at a level of 4 mm from the margin. (**b**) The tarsal segment is dissected free from attachments to the levator palpebrae superioris and then the conjunctiva using Westcott scissors. (From Bleier BS, Freitag SK, Sacks R. Endoscopic Surgery of the Orbit: Anatomy, Pathology, and Management. New York: Thieme; 2019.)

Oral Mucous Membrane Grafts

Another option for replacing conjunctival mucosa is oral mucous membrane.[7] This graft lacks the structural stability of the tarsoconjunctival composite graft and should not be used as a stand-alone posterior lamellar substitute. It is best used to replace excised conjunctiva or to cover intact tarsus in cases of cicatricial conjunctival disease. To harvest the graft, the lower lip is everted and the mucosa is dried with a sterile gauze. An oversized graft is marked anticipating graft shrinkage after harvest, and avoiding the margin of the lip, the gingival tissue, and salivary ducts. Local anesthetic with epinephrine is infiltrated below the mucosa. The markings are then incised with a blade, and the mucosa is carefully excised with fine forceps and scissors (▶ Fig. 2.20). Larger mucosal grafts may be harvested from the oral cavity inside the upper lip or cheek; however, care must be taken to avoid injury to Stensen's duct. The donor site does not require closure. The graft is secured in place with the mucosa oriented toward the eye with absorbable suture with buried knots carefully placed to avoid corneal contact. Postoperative antibiotics should be considered since the oral cavity is considered a contaminated graft source.

Fig. 2.20 Correct location to harvest an oral mucous membrane graft.

Hard Palate Mucosa Grafts

The hard palate mucosa is sturdier than oral mucous membrane and can provide good structural support to the eyelid in addition to providing a smooth mucosal surface to abut the cornea.[8,9,10] The nonkeratinized epithelium makes it an option as a posterior lamellar upper or lower eyelid graft. The hard palate is marked on either side of the midline beginning posterior to the alveolar ridge and ending prior to the soft palate. The tissue is infiltrated with local anesthetic. A full-thickness incision is made with a blade. The graft is then undermined and excised using an angled blade or a fine scissor (▶ Fig. 2.21). Submucosal fat is excised from the deep surface. After soaking in iodine solution, the graft is secured to the recipient site in similar fashion to other posterior lamellar grafts. The donor site does not require closure. Patients may experience pain postoperatively from the donor site and are advised to eat soft foods and avoid foods with extreme temperatures for 2 to 4 weeks.

Auricular Cartilage Grafts

The structural stability of auricular cartilage makes it a strong posterior lamellar spacer graft. However, its stiffness provides a challenge in creation of a well-contoured and comfortable eyelid graft.

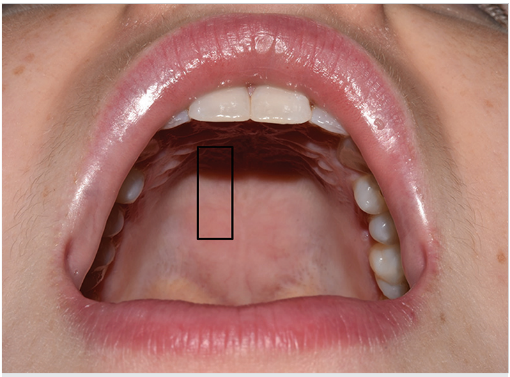

Fig. 2.21 Correct location to harvest a hard palate graft.

To harvest the graft, the anterior and posterior subcutaneous ear tissue is infiltrated with local anesthetic without epinephrine, which can cause vasoconstrictive necrosis of the ear. The helix of the ear is reflected forward and the posterior aspect is marked. The incision runs parallel to the helix of the ear and is placed at least 4 mm from the edge of the cartilage of the ear to prevent ear deformity. The skin incision is then created with a blade and the subcutaneous tissue is sharply dissected with fine scissors to expose the cartilage. The incision into the cartilage is begun with a blade taking care not to pass through the full thickness of the ear. It is then extended with fine scissors. The anterior face of the cartilage is cleared of attachments with a periosteal elevator. The graft is then excised with scissors and placed in a saline moistened gauze until its use.

The combination of ear cartilage with oral mucosa allows replacement of the entire posterior lamella.[11] A chondromucosal graft can be created by harvesting ear cartilage and inserting it into a submucosal pocket in the patient's cheek. After several weeks, the composite chondromucosal graft can be excised and implanted.

2.8 Conclusion

In summary, careful attention to pre- and postsurgical planning as well as intraoperative detail will provide the best chance of surgical success. Satisfactory outcomes start with good communication with the patient. Utilizing careful tissue handling techniques along with judicious choices of suture and surgical technique contribute to a functional and cosmetically pleasing outcome. Finally, in-depth understanding of proper techniques for harvesting grafts and tissue rearrangement allows the surgeon to successfully repair myriad periorbital tissue defects.

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3 Mohs Micrographic Surgery for Periorbital Cutaneous Malignancies

Molly Yancovitz, Sherry H. Yu, and Jessica Fewkes

Summary
Mohs surgery is a technique used to treat skin cancers that provides complete margin evaluation while sparing surrounding normal tissue and is the treatment of choice for many periorbital tumors. Utilizing Mohs surgery, tumors can be removed and defects repaired the same day with the lowest possible risk of recurrence.

Keywords: Mohs surgery, periorbital skin cancer, basal cell carcinoma, squamous cell carcinoma

3.1 Introduction to Mohs Micrographic Surgery for Periorbital Cutaneous Malignancies

Skin cancers are the most common cancers in the United States, with an incidence of over 5.4 million cases of nonmelanoma skin cancers annually.[1] The incidence of these cancers is increasing and treatment of skin cancers accounts for a significant health care expenditure.[1] Periorbital tumors comprise 5 to 10% of cutaneous malignancies[2] and pose unique challenges in presentation, morbidity, and reconstruction. Given the risks associated with periorbital tumors, timely and effective diagnosis and treatment are essential. Mohs surgery provides the highest cure rate of all currently available skin cancer treatments while simultaneously conserving the maximum amount of surrounding noncancerous tissue and is thus the optimal treatment for periorbital tumors.

3.2 Definition

Mohs micrographic surgery is a surgical and histopathologic technique used to treat skin cancers that provides 100% margin evaluation of an extirpated tumor using frozen section processing. Its two hallmark features are color-coded mapping and thorough microscopic examination by the Mohs surgeon. It provides several advantages over standard surgical excision in its ability to detect and track subclinical tumor extension, minimize the removal of surrounding normal tissue, and provide quick processing time so that inadequate margins can be assessed and more tissue can be taken as needed to clear a tumor during the same clinical visit. This technique maximizes margin evaluation while minimizing the size of the overall wound. Taking out less normal tissue around a tumor is crucial in critical locations, especially periorbitally, in order to minimize the functional and cosmetic impact of tumor removal.

3.3 History

Frederic Mohs first developed the technique of Mohs surgery at the University of Wisconsin in the 1930s.[3] His initial technique involved the application of zinc chloride paste (hence the original name of chemosurgery) to a cancerous lesion 24 hours prior to surgical extirpation which fixed the tissue in situ. The tumor was then excised, sectioned, and inked with colored dye for orientation purposes. The excised tissue was subjected to systematic microscopic evaluation. If positive margins were identified, the process was repeated over several days until negative margins were found. In 1974, Tromovitch and Stegman described the evolution of the technique using fresh frozen sections without prior application of the paste, which Dr. Mohs first used in 1953 to treat a periocular tumor, and this technique is the standard method in use today.[4,5] This variation avoided the pain associated with the paste and enabled several stages to be done in one day and reconstruction to follow immediately thereafter.

3.4 Technique

Mohs surgery is a step-wise process of tumor removal with complete margin evaluation. It is generally performed under local anesthesia in the outpatient setting. By definition, the Mohs surgeon functions as both the surgeon and the pathologist, which allows for more precise mapping and tumor removal.

3.4.1 Steps of Mohs Procedure

The key steps involved in Mohs surgery are described listed below, and illustrated by a clinical example in ▶ Fig. 3.1.

The tumor is identified, prepped, and injected with a local anesthetic.

The tumor is typically debulked by curettage to better elucidate the extent of the tumor prior to initial extirpation.

The tumor and a narrow margin of normal-appearing skin is excised, with the scalpel angled away from the tumor at 45 degrees to create beveled margins, and orienting hash marks are placed prior to removal of the tissue.

A precise map is drawn of the removed tissue, and the tissue is labeled with ink and cut as needed.

The tissue is frozen in blocks in a way that places the deep and peripheral margins in a single plane of sectioning. Thin (5–10 mm) slices are cut and placed on slides and stained.

The corresponding map is marked to indicate how the sections were cut and inked.

The slides are examined microscopically by the surgeon, and any tumor is noted on the map at its precise location by using the color and hatch mark coordinates.

The second and any subsequent stages are performed by removing tissue from tumor-laden

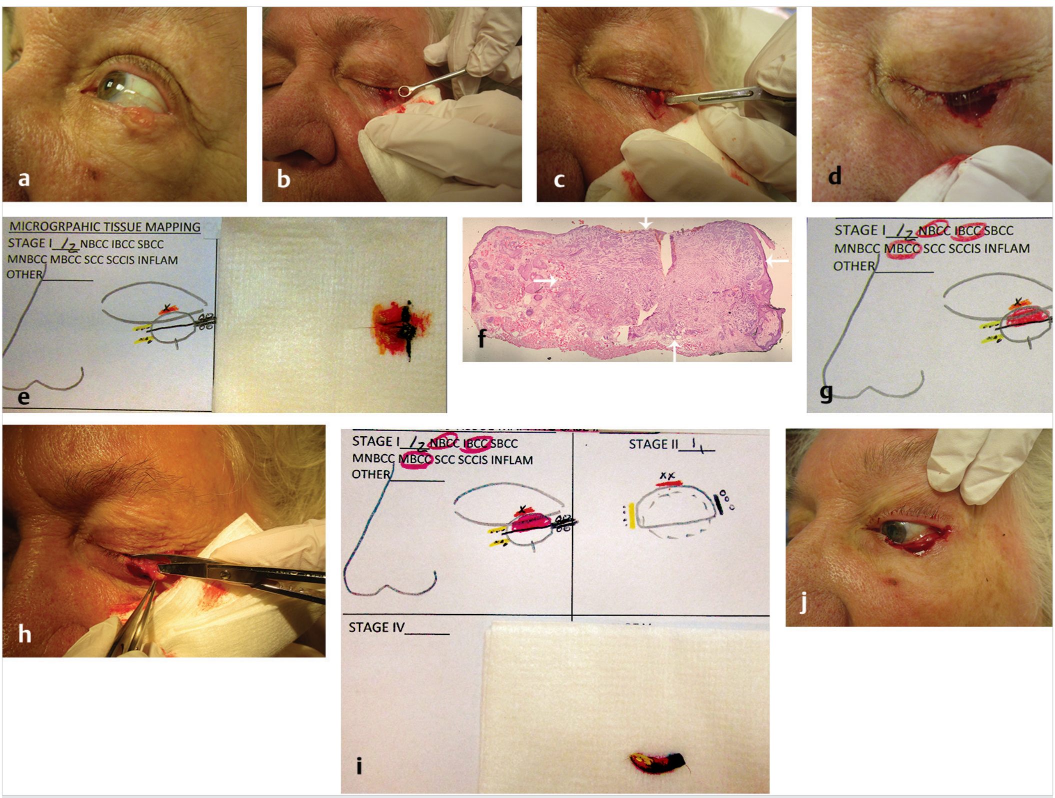

Fig. 3.1 Periorbital tumor treated with Mohs. **(a)** Preoperative image of basal cell carcinoma on the left lower eyelid. **(b)** Tumor is debulked via curettage. **(c)** Clinically evident tumor and narrow margin of normal appearing skin is excised with a beveled margin, orienting hash marks placed. **(d)** Defect after first stage excised. **(e)** A map corresponding to the first stage is drawn, and the tissue and corresponding map are inked for orientation purposes (here, using *yellow*, *orange*, and *black* ink). **(f)** Hematoxylin and eosin stained histopathologic section of superior half of stage 1, showing infiltrative, nodular and morpheaform basal cell carcinoma spanning the specimen (indicated by *arrows*). **(g)** Areas of residual tumor are noted on the map in red ink. **(h)** Second Mohs stage with excision of residual BCC. **(i)** Tumor and map are inked for orientation purposes. **(j)** Postoperative defect after four stages, when margins are free of tumor.

areas as guided by the map. This process is repeated until clear margins are obtained, at which point the resulting surgical defect can be immediately reconstructed.

The key feature of Mohs surgery is the processing of the tissue to enable 100% margin evaluation. The technique is frequently compared to standard surgical excision, which is very effective for many tumors, but has certain limitations compared to Mohs. Generally, when a tumor is excised and sent for histologic examination, the tissue is most commonly processed using the "bread-loaf" technique in which serial cross-sections of the specimen are examined to evaluate for tumor involvement at the margins (▶ Fig. 3.2a). This process examines only a small portion of the total true margin of the specimen, equivalent to 1 to 2% of the total margin,[6] and will miss tumor that extends between the cross-sections. Thus when compared to Mohs, which examines 100% of the excised margin, routine excision is more likely to result in false negative margins (▶ Fig. 3.2b).

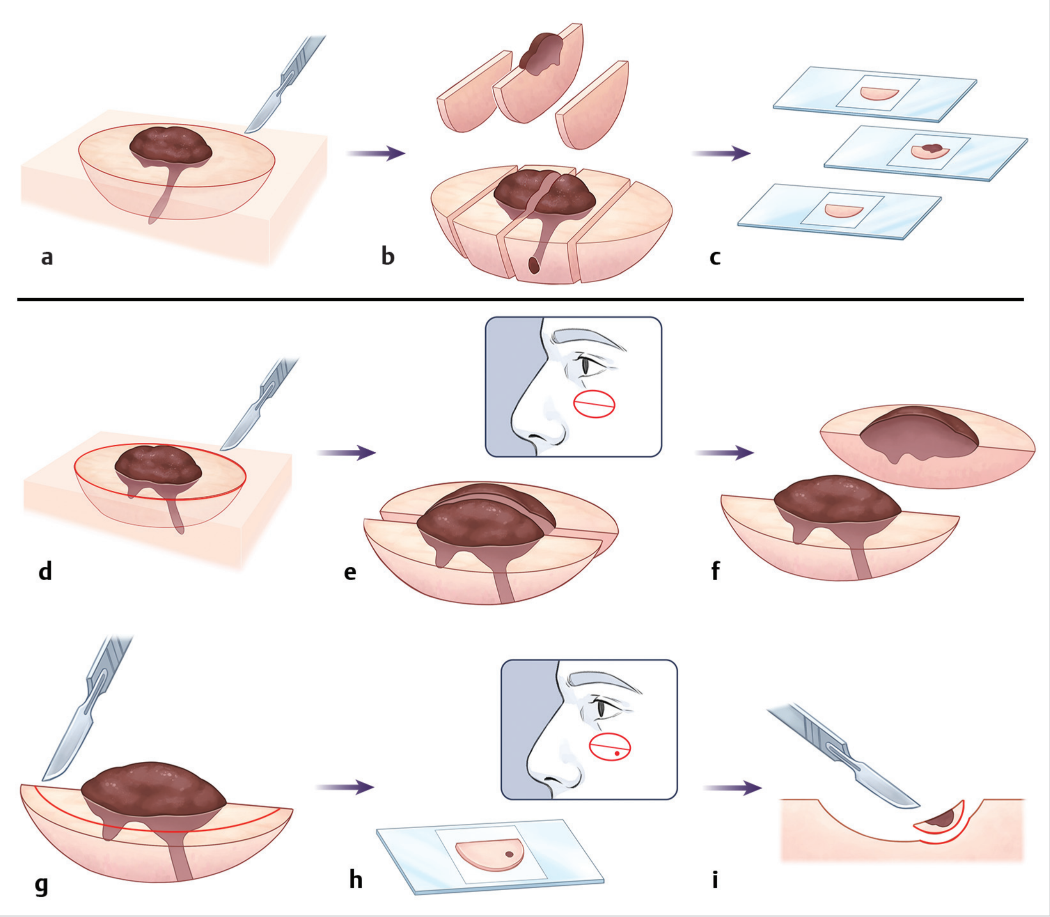

Fig. 3.2 Vertical sectioning compared to Mohs: **(a,b,c)** Vertical sectioning: in a standard surgical excision, the surgical specimen is cut in several vertical sections, and these are examined microscopically. As shown here, this may fail to detect tumor at the margin (tumor shown in *brown*). **(d-i)** Mohs sectioning: **(d)** The tumor and a narrow margin is excised with beveled edges **(e,f)** The specimen is cut into sections and mapped to the surgical site **(g)** A thin layer of tissue is cut from each section, encompassing the entire deep and peripheral margin in one plane of tissue, so that the entire margin can be examined microscopically. **(h,i)** Any areas of residual tumor are noted on the map, and another excision is performed of the positive areas. Specimens are processed and read, and the additional stages are taken as needed until clear margins are obtained.

3.4.2 Advantages and Disadvantages

Mohs surgery provides complete margin evaluation of extirpated tumors, which can identify and remove subclinical extension of tumors and results in higher cure rates. Tumors can be excised with narrow margins, keeping the resulting wound as small as possible and expanding it only where there is residual tumor. The frozen section processing results in rapid turnaround time for slides allowing multiple stages to be performed at one appointment thus eliminating the need for multiple procedures on different days to excise residual tumor. The procedures are overall low risk, generally done using only local anesthesia with very low rates of adverse events, such as infection or bleeding.[7,8]

As the incidence of skin cancers increases, so does the health care expenditure associated with treatment of these tumors.[9] The cost of Mohs surgery (which includes the surgery and surgical pathology) is comparable to standard surgical excision done in an outpatient setting with permanent section processing, when considering the additional costs associated with pathology and re-excision for inadequate margin control.[10,11] Mohs is less expensive than excisions done in an ambulatory surgical center or hospital-based operating room and is more economical than excisions done using frozen tissue section margin control.[10]

However, Mohs does not provide wide margin excision around a tumor. Thus when it is considered important, such as with a high-risk tumor with perineural invasion, wider margins may be taken with Mohs or after Mohs slides are clear. In addition, tissue analysis during Mohs focuses on margin evaluation; if there is any question about the diagnosis or other features of the tumor that may affect patient management, the central tumor can be processed separately for further diagnostic information. For example, when treating melanoma in situ, it is imperative that the central tumor be processed to evaluate for invasive disease. Finally, although the entire tumor removal and reconstruction can be done in one day, given the processing time involved, patients must be able to tolerate a procedure that can take several hours. However, since the majority of Mohs cases are done under local anesthesia in an office setting, patients can be mobile and participate in reading or other activities that make the waiting period more tolerable.

3.4.3 Variations of the Technique

Mohs surgery offers the dual benefits of 100% margin evaluation while being tissue sparing. However, it is adaptable and may need to be modified to treat tumors that have “skip areas,” difficult histology on frozen sections, deep invasion to bone or other structures not amenable to frozen sectioning, and a greater likelihood of recurrence or metastasis. These modifications may include taking a wide-margin first Mohs layer, taking an extra rim beyond the negative Mohs margins to be examined with permanent sections, and the use of rapid immunohistochemical stains.[12,13] When tumors are large and invasive, Mohs may be used to gain circumferential cutaneous margin control, and another member of the surgical team may clear the deep tissue, such as bone or other vital tissue margins. For potentially metastatic tumors, the multidisciplinary team may perform sentinel lymph node biopsy in coordination with treatment of the primary tumor with Mohs, consolidating and optimizing surgical management for the patient. Thus Mohs surgery plays a vital role in the multidisciplinary management of patients with complex tumors.

3.5 Indications for Mohs

Mohs surgery is predominantly used to treat nonmelanoma skin cancer. Nonmelanoma skin cancer is the most common cancer in the United States and European countries, and its incidence is increasing.[1,14,15] There is an array of treatment options for these tumors which ranges from destruction with electrodesiccation and curettage or cryotherapy, or topical therapies for low-risk or superficial lesions, to excision, Mohs surgery, radiation, or systemic treatments for higher risk or more invasive tumors.

Mohs surgery is recommended for skin cancers in cosmetically sensitive areas, those with high-risk features, recurrent or large tumors. The American Academy of Dermatology, in collaboration with the American College of Mohs Surgery, the American Society for Mohs Surgery, and the American Society for Dermatologic Surgery Association developed appropriate use criteria for Mohs surgery, which provides guidelines for when Mohs may be indicated.[16] Criteria include certain areas of the body (e.g., mask areas of the face), tumors with aggressive features or positive margins on recent excision, and patient characteristics (e.g., immunocompromised status). Basal cell carcinomas

(BCCs) and squamous cell carcinomas (SCCs) comprise the largest percentage of nonmelanoma skin cancers and are the most common tumors treated with Mohs. However, Mohs is also indicated for less common tumors, such as melanoma in situ, atypical fibroxanthoma, dermatofibrosarcoma protuberans, microcystic adnexal carcinoma, sebaceous carcinoma, and others. Periorbital tumors, given the high risk nature of the anatomic location, meet criteria for Mohs treatment for appropriate tumor types.

3.6 Mohs and Periorbital Tumors

Periorbital malignancies account for approximately 5 to 10% of all skin cancers.[2] These tumors can have a range of clinical presentations and may behave in an aggressive manner. In some instances, these tumors can invade vital structures, such as the orbit or sinuses and can develop regional or distant metastases. Clinicians should have a low threshold for biopsying periorbital lesions and must then select appropriate and effective treatment for malignant tumors. There are numerous types of periorbital malignancies, the most common of which are briefly discussed below.

3.6.1 Basal Cell Carcinomas

BCCs are the most common periorbital skin cancers, and occur most frequently on the lower eyelid, followed by the medial canthus, with a lower percentage occurring on the upper eyelid and lateral canthus.[2,17,18] There are a wide range of histologic subtypes of BCCs, and many tumors display mixed subtypes.[19] These subtypes vary in their clinical presentation and histologic growth pattern, and an understanding of these subtypes aids in diagnostic acumen and appropriate surgical planning. Nodular BCC is the most common periorbital subtype that classically presents as a pearly papule or nodule with branching telangiectasias. These tend to have more indolent growth patterns; however, they can result in significant tissue destruction, especially when they are large or neglected (▶ Fig. 3.3, ▶ Fig. 3.4, ▶ Fig. 3.5). Other subtypes, including micronodular, sclerosing, morpheaform, infiltrative, and basosquamous BCCs typically behave more aggressively. Some of these aggressive tumors can be subtle clinically yet have significant subclinical extension and invasion. These tumors may present with eyelid contracture, indurated plaques, or madarosis (▶ Fig. 3.6, ▶ Fig. 3.7, ▶ Fig. 3.8). In contrast, superficial BCCs often present as scaly pink patches, whereas pigmented BCCs can be clinically misdiagnosed as nevi (▶ Fig. 3.9). Given the range of clinical presentations and the ability of BCCs to mimic benign processes, clinicians should have a low threshold to biopsy periorbital lesions as needed.

BCCs are generally indolent tumors; however, they can be more aggressive and have the potential to develop deep invasion, recurrence, and rarely, metastasis. Factors that contribute to aggressive BCCs include histologic subtype as discussed above, occurrence on the central face, perineural invasion, large tumors, long-standing tumors, and those that are incompletely excised.[20] Standard surgical excision results in incomplete tumor excision in approximately 16 to 25% of periorbital BCCs.[21,22] Given the risk of extensive invasion, including invasion into the orbit and rarely intracranially and the complexity of re-excising a persistent or recurrent tumor, the goal of initial treatment for periocular BCCs should be complete tumor removal with appropriate margin evaluation. Mohs surgery provides the highest cure rate of all treatment options for periorbital BCCs, and is the treatment of choice for these tumors.[23,24] Cure rates using Mohs for primary periorbital BCCs have been reported from 98 to 100%, and 92 to 94% for recurrent tumors (▶ Table 3.1).[4,25,26] When Mohs is not available or feasible, excision with en face frozen section margin control can be an effective treatment option; however, this process can lead to gaps in tumor margin evaluation and requires close collaboration between the surgeon and the pathologist to optimize tumor mapping.[18] In contrast, as the Mohs technique evaluates margins in one plane of section, there is less risk of false-negative results with Mohs surgery.

Ultimately, obtaining true-negative surgical margins is imperative to reduce the risk of recurrence. Tumors can recur after many years, and can be extensive at time of recurrence, presenting significant challenges in management. For tumors that cannot be adequately excised via globe-sparing surgery, patients may warrant orbital exenteration or consideration of radiation or treatment with a hedgehog pathway inhibitor such as vismodegib, which has been shown to be effective for locally advanced periorbital BCCs that are not amenable to surgery or radiation, as well as metastatic BCCs.[28,29,30]

Fig. 3.3 Small superficial and nodular basal cell carcinoma of the medial canthus. **(a)** Preoperative and **(b)** after Mohs, note tumor cleared with narrow surgical margins.

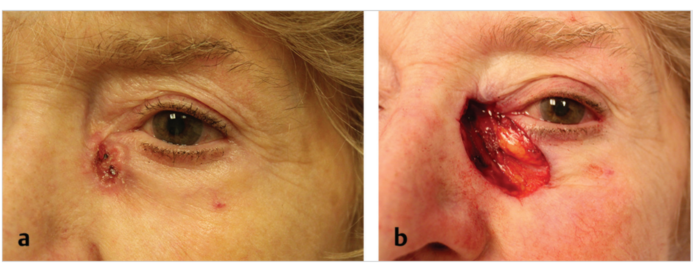

Fig. 3.4 Long-standing nodular basal cell carcinoma of the medial canthus, **(a)** preoperative and **(b)** after Mohs. Note despite appearing well-demarcated, tumor extended well beyond clinical margins.

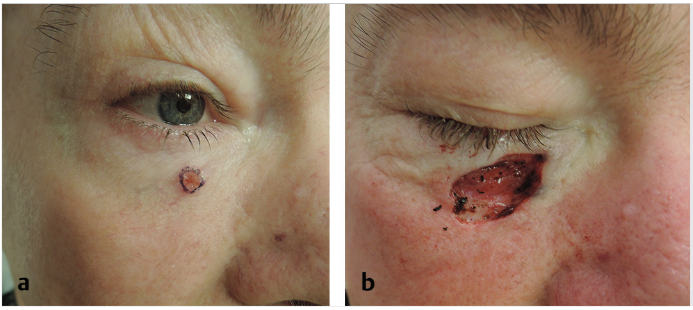

Fig. 3.5 Nodular basal cell carcinoma of the lower lid with asymmetric subclinical extension, **(a)** pre and **(b)** post Mohs.

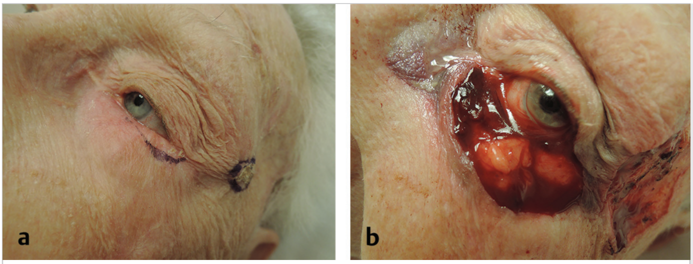

Fig. 3.6 Nodular and infiltrative basal cell carcinoma of the lower lateral eyelid margin presenting as a firm nodule along the lateral lower lid, with secondary cicatricial entropion and dislocation of the punctum to the central eyelid. **(a)** Pre and **(b)** post Mohs. Of note, there is a second sclerosing basal cell carcinoma on the left temple treated simultaneously.

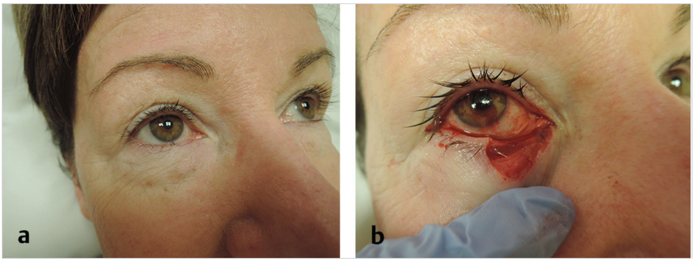

Fig. 3.7 Infiltrative basal cell carcinoma of the medial lower lid margin in a young woman presenting as focal madarosis, **(a)** preoperative and **(b)** after Mohs. Note infiltrative BCC can be clinically subtle yet extensive histologically.

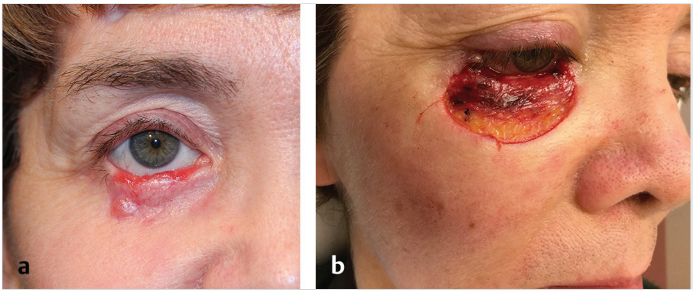

Fig. 3.8 Long-standing superficial, nodular and infiltrative basal cell carcinoma persistent following six prior incomplete excisions over 13 years. **(a)** Pre and **(b)** post Mohs. **(a)** Courtesy of Daniel Lefebvre.

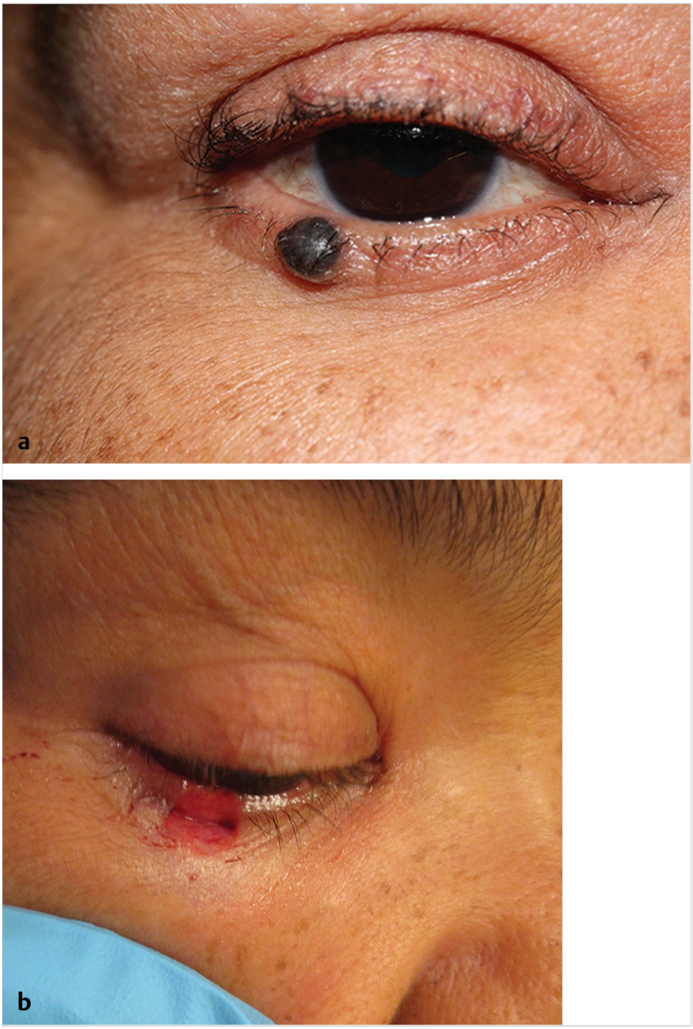

Fig. 3.9 Pigmented basal cell carcinoma of the lower lid, **(a)** pre and **(b)** post Mohs. **(a)** Courtesy of Daniel Lefebvre.

Table 3.1 Five-year cure rates with Mohs surgery for periorbital basal cell carcinoma and squamous cell carcinoma

Tumor type	Five-year cure rate with Mohs surgery
Periorbital basal cell carcinoma	
Primary	98.1–100%[4,25,26]
Recurrent	92.2–93.6%[4,25,26]
Periorbital squamous cell carcinoma	
Primary	97–98.5%[4,27]
Recurrent	95.8%[4]

3.6.2 Squamous Cell Carcinoma

SCC is the second most common form of skin cancer that accounts for 5 to 10% of periorbital malignancies.[2,31] These tumors can present in a variety of ways, including scaly thin plaques, keratotic nodules, ulcers, cyst-like lesions, and cutaneous horns, and can range from low risk in situ disease to aggressive high-risk tumors. Periorbital SCCs have been reported to occur most commonly on the lower eyelid, followed by the medial canthus, upper eyelid, and lateral canthus (▶ Fig. 3.10, ▶ Fig. 3.11, ▶ Fig. 3.12)[2,27,32].

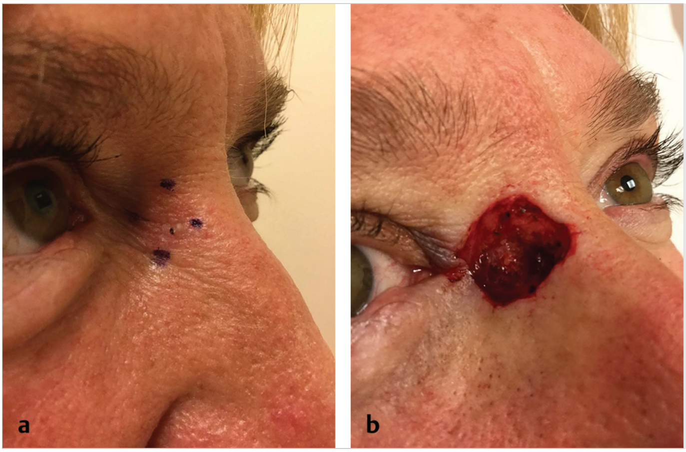

Fig. 3.10 Acantholytic squamous cell carcinoma in situ of the medial canthus, presenting as a rough pink thin plaque, **(a)** preop and **(b)** after Mohs.

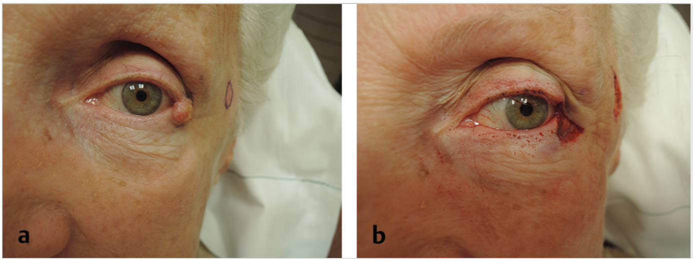

Fig. 3.11 Squamous cell carcinoma of the left lateral canthus, **(a)** preoperative and **(b)** after Mohs. Note the lesion was completely removed with narrow margins. A second squamous cell of the left temple was treated simultaneously.

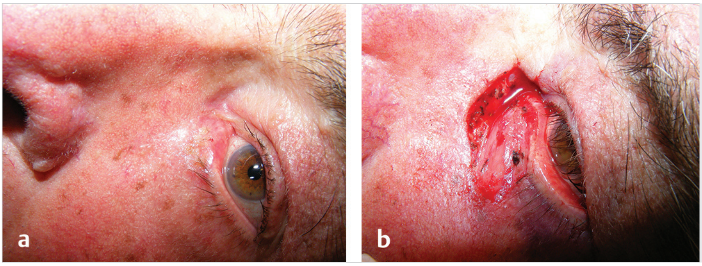

Fig. 3.12 Squamous cell carcinoma of the medial lower eyelid, which initially presented as an ectropion with excess tearing. **(a)** Preop and **(b)** after Mohs.

As with BCCs, the preferred treatment for periocular SCCs provides tumor removal with complete margin evaluation, while sparing as much unaffected tissue as possible. Standard surgical excision results in high rates of incomplete excisions, necessitating additional procedures. In contrast, Mohs surgery is an optimal treatment for periocular SCCs, as it has been shown to offer consistently high cure rates of 96.4 to 98.1%.[4,23,27]

High-risk SCCs, such as those that are large, poorly differentiated, deeply invasive, or have perineural invasion are at risk of orbital invasion, recurrence, and lymphatic spread. Orbital invasion can be evaluated with radiologic imaging, and orbital exenteration may be warranted in certain cases. Perineural invasion is present in 4 to 14% of periocular SCCs, and is associated with higher stage and recurrent tumors.[24,33] Postoperative radiation can be considered for tumors with perineural invasion or other high-risk factors for local recurrence.[34] Regional lymph node involvement has been reported to occur in 1 to 24% of periocular SCCs.[27,31,35] Lymph node evaluation can be done by palpation and radiologic imaging, and consideration should be given to sentinel lymph node biopsy for high-risk tumors. While formal guidelines do not yet exist for the use of sentinel lymph node biopsy in SCC, it is an effective way to diagnose subclinical lymph node metastases,[36] and clinical recommendations include consideration of sentinel lymph node biopsy for tumors that are large (> 2 cm), locally recurrent, or have perineural invasion.[35] For patients with extensive, unresectable locally advanced or metastatic disease, treatment has traditionally included chemotherapy and/or radiation. Novel treatments include therapies such as immune checkpoint inhibitors.[37]

3.6.3 Sebaceous Carcinoma

Sebaceous carcinoma is a rare and potentially aggressive cutaneous tumor that accounts for 1 to 6% of periocular malignancies.[38] In contrast to periocular BCCs and SCCs, these tumors occur most commonly on the upper eyelid. Sebaceous carcinomas have a varied clinical presentation, leading to frequent delay in diagnosis. These tumors can present as a yellow papule or nodule, or a thickening of the eyelid, or may resemble a recurrent chalazion, unilateral blepharoconjunctivitis or keratoconjunctivitis, or another benign or malignant neoplasm (▶ Fig. 3.13). Mohs surgery has been associated with low recurrence rates for periocular sebaceous carcinomas.[39,40] However, given the propensity of sebaceous carcinomas to have multicentric growth, skip areas and pagetoid (intraepithelial) spread, obtaining negative margins can be challenging. In certain situations, additional margin evaluation at time of Mohs may be done using rapid oil red O staining, or with an additional rim sent for permanent processing after Mohs, or doing Mohs with paraffin-embedded sections.[39,41,42] In addition, scouting conjunctival biopsies are often used to evaluate surrounding conjunctiva for pagetoid tumor involvement.[39,41] Patients diagnosed with sebaceous carcinoma should be screened for Muir–Torre syndrome, a rare, predominantly autosomal dominant genetic condition clinically characterized by sebaceous neoplasms and visceral malignancies.[43] Periorbital sebaceous carcinomas metastasize in 3 to 25% of patients,[44,45] most frequently to regional lymph nodes, thus consideration should be given to sentinel lymph node biopsy for high-risk tumors. Risk of lymph node metastasis from periocular sebaceous carcinomas correlates with large tumor size, depth of invasion, and poor differentiation.[46] Some tumors, such as those with pagetoid disease or perineural invasion, may warrant adjuvant treatment following excision, which can include topical chemotherapy, cryotherapy, and radiation.[34]

3.6.4 Melanoma

Periorbital cutaneous melanoma accounts for 1% of cutaneous melanomas and approximately 1% of eyelid tumors. Lentigo maligna melanoma is the most frequent histologic subtype of eyelid melanoma and often has ill-defined margins both clinically and histologically, resulting in a high recurrence rate after standard surgical excision.[47] Treatment of these tumors is often challenging due to poorly defined margins, proximity to vital structures, and histologic similarities between melanoma and benign melanocytes on actinically damaged skin, which can be particularly challenging to distinguish on frozen sections. Excision with 5 mm margins can result in incomplete excision in more than 50% of cases, thus surgical management is preferably done in a staged manner.[48,49] There are several such surgical approaches to treating periocular melanoma. These include Mohs surgery with additional final margins evaluated via permanent histology, Mohs surgery aided by the use of immunohistochemical stains such as MART-1, or staged excision utilizing paraffin-embedded pathology with en face processing for complete margin control (▶ Fig. 3.14, ▶ Fig. 3.15). All of these techniques emphasize the

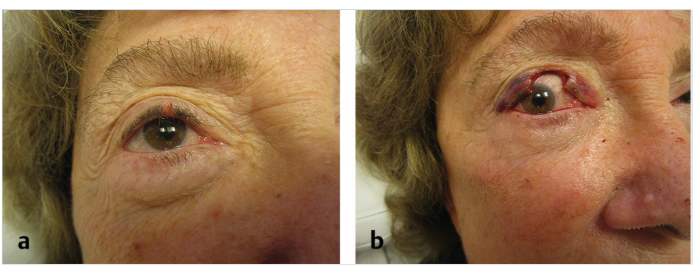

Fig. 3.13 Small sebaceous carcinoma of the right upper eyelid margin, **(a)** preoperative and **(b)** after Mohs. Additional rims sent for permanents as well as scouting conjunctival biopsies were negative for tumor.

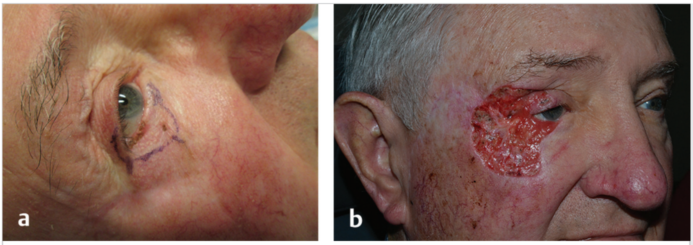

Fig. 3.14 Recurrent lentigo maligna melanoma in situ treated with staged excision with en face margin control. **(a)** Perioperative and **(b)** after excision. Note significant extension of histologic disease beyond clinically apparent margins on staged excision. Tumor cleared after 4 stages (each stage taken with 5 mm margins) and extended onto upper lid and conjunctiva. **(b)** Courtesy of Michael K. Yoon.

Fig. 3.15 Lentigo maligna melanoma in situ treated with Mohs with additional permanent histologic margin confirmation. **(a)** Preop and **(b)** after Mohs. Note tumor extended in asymmetric fashion beyond clinical margins.

importance of diligent margin evaluation, which is best performed with tangential or en face margin examination. For those procedures that take advantage of the benefits of permanent histology, it is important for surgeons to work closely with their pathology colleagues and understand how the tissue is being processed (e.g., is it cut en face/tangentially, or are sections being cut radially, in which case 100% of the margins are not evaluated histologically).[50] For complex cases utilizing permanent histologic evaluation, reconstruction is usually done in a delayed fashion. Of note, many surgeons, even when using Mohs, will remove at least a 5 mm margin of clinically tumor-free skin for melanoma in situ, and often take wider margins for invasive disease.[51,52] The aforementioned surgical techniques are also used to treat other histologic types of melanoma in certain situations, and controversy remains about optimal margin size and frozen versus formalin-fixed margin evaluation in these settings. Even with diligent margin control, periocular melanomas can recur, often in a delayed fashion, so patients require long-term monitoring.[49]

3.6.5 Microcystic Adnexal Carcinoma

Microcystic adnexal carcinomas (MACs) typically present as a slow-growing plaque, most commonly on the head and neck with particular predilection for the central face and periorbital area.[53] They classically present in young to middle-aged women. These tumors have low metastatic potential; however, they can be locally aggressive and often have perineural invasion.[54] Tumors can extend well beyond clinically appreciable margins, resulting in high rates of persistence and recurrence with standard excision (▶ Fig. 3.16).[55] For this reason, Mohs surgery is the treatment of choice for MACs, as it provides the lowest recurrence rates and spares as much normal tissue as possible.

3.6.6 Merkel Cell Carcinoma

Merkel cell carcinoma is an aggressive skin cancer that classically presents as a rapidly growing red to violaceous firm nodule on the head and neck of older adults (▶ Fig. 3.17). Risk factors include extensive sun exposure history and immunosuppression.[56] Periocular Merkel cell carcinoma most commonly presents on the upper eyelid.[57] Treatment of eyelid Merkel cell carcinoma consists of complete surgical removal of the tumor with either wide local excision or Mohs, usually done in concert with staging of the draining lymph node basins, such as with sentinel lymph node biopsy or radiologic imaging. Given the high risk of recurrence and metastatic spread, surgery may be

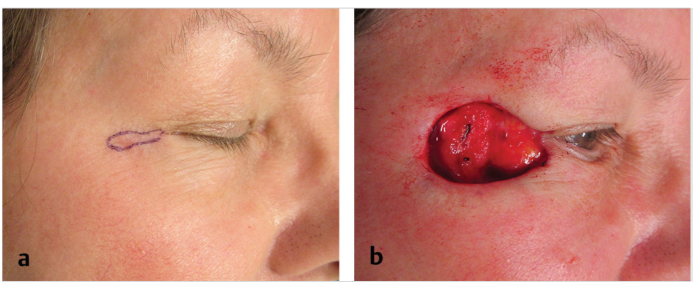

Fig. 3.16 Incompletely excised microcystic adnexal carcinoma with perineural invasion. **(a)** Preoperative, note well-healed scar without evidence of clinically apparent residual tumor; **(b)** post Mohs.

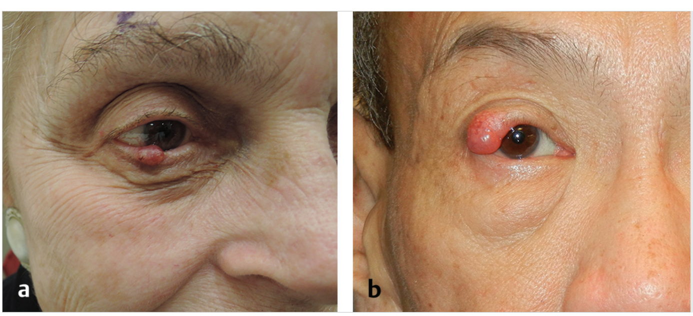

Fig. 3.17 **(a)** Merkel cell carcinoma of the lower eyelid. **(b)** Merkel cell carcinoma of the right upper eyelid, in a renal transplant patient. (Courtesy of Michael K. Yoon.)

followed by radiation to the primary site and regional lymph nodes, as well as chemotherapy in certain cases.[57,58,59] In addition, novel treatments for metastatic disease include immunotherapy.[60]

3.7 Conclusion

Periorbital skin cancers pose unique challenges for tumor extirpation and reconstruction, given the complex anatomy, functional and cosmetic roles of this area, and risk of deep tumor invasion. Early and thorough management of these tumors is essential to optimize patient outcomes and minimize risks of long-term sequelae and future recurrence. Mohs surgery provides excellent margin control and minimizes removal of surrounding normal skin and is the standard of care for periorbital tumors such as BCC and SCC. Mohs surgeons routinely work closely with oculoplastic surgeons in order to optimize reconstructive outcomes for patients with periocular tumors.

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4 Medial Canthal Eyelid Reconstruction

Suzanne K. Freitag

Summary
Reconstruction of the eyelid medial canthus requires consideration of a number of unique anatomic issues, including the concavity of the region, as well as the presence of the lacrimal outflow system, medial canthal tendon, and eyebrow cilia. Utilization of carefully planned regional flaps often provides the best reconstructive options.

Keywords: eyelid, reconstruction, medial canthus, flap, graft

4.1 Introduction to Medial Canthal Eyelid Reconstruction

Reconstruction of the medial canthal area of the eyelids provides a number of challenges because of the complex anatomy which includes the junction of the upper and lower eyelids, glabella, and upper nasal side wall. The area contains multiple contours, a variety of skin thicknesses and textures, and anatomic limitations including eyebrow cilia and the underlying lacrimal system. Consideration of these factors as well as the aesthetic importance of this region all contribute to the challenges of its reconstruction.

The lacrimal outflow system, including puncta, canaliculi, and lacrimal sac, should be carefully examined prior to beginning reconstruction as they may be minimally or significantly damaged during tumor removal. Repair with mono- or bicanalicular silicone stents should be performed as required. If the system is grossly absent or unable to be reconstructed, consideration for Jones tube placement may take place after months to years of tumor-free interval.

The medial canthal tendon (MCT) is important not only in its support of the proximal lacrimal system but also in maintaining the position of the medial commissure of the eyelids (Fig. 1.5). When the MCT is absent, the medial eyelid commissure, whether native or reconstructed, should be sutured to the periosteum of the medial orbital wall in a location that provides good eyelid to globe apposition (i.e., toward the posterior lacrimal crest). Anterior misplacement may result in damage to the lacrimal sac or a gap between lids and globe leading to focal exposure keratopathy, as demonstrated in ▶ Fig. 4.1.

When defects or flaps involve the glabellar region, consideration must be given to the brow cilia. Absent medial brow cilia can result in a significant cosmetic deformity. Flaps involving the glabellar area should be created with care to avoid medialization of the brow or shifting cilia with the flap to a discontinuous area where they would be an aesthetic concern.

An additional consideration when navigating the glabellar region is the presence of the supraorbital and supratrochlear neurovascular bundles. These provide sensory innervation to the forehead and anterior scalp as well as blood supply to many of the flaps used in medial canthal reconstruction. Hence, recognition and preservation of these structures is important when possible.

Medial canthal defects are prone to cutaneous web formation and hypertrophic healing. Webbing is a particular risk because of the concave geography of the region. This concavity can be preserved by placement of a full-thickness suture attaching the flap overlying the concavity to the underlying periosteum. Hypertrophic scarring occurs in part because the tissue filling the defect is often a thicker skin type than that native to the eyelid. It is, therefore, critical to minimize risk factors for postoperative wound hypertrophy, such as judicious use of subcutaneous polyglycolic acid sutures used to relieve wound tension, and consideration of cutaneous suture material which is least likely to promote inflammation, such as nylon or polypropylene. ▶ Fig. 4.2, ▶ Fig. 4.3, and ▶ Fig. 4.4 demonstrate medial canthal defects that healed with undesirable scars and webbing.

Periorbital skin cancers frequently involve the medial canthal region; hence, it is important to have a variety of medial canthal reconstruction techniques in one's armamentarium. A variety of flaps and grafts can be used alone or in combination to achieve a satisfactory functional and aesthetic outcome.

4.2 Secondary Intention Healing

Secondary intention healing by allowing wound granulation to occur without reconstruction is an

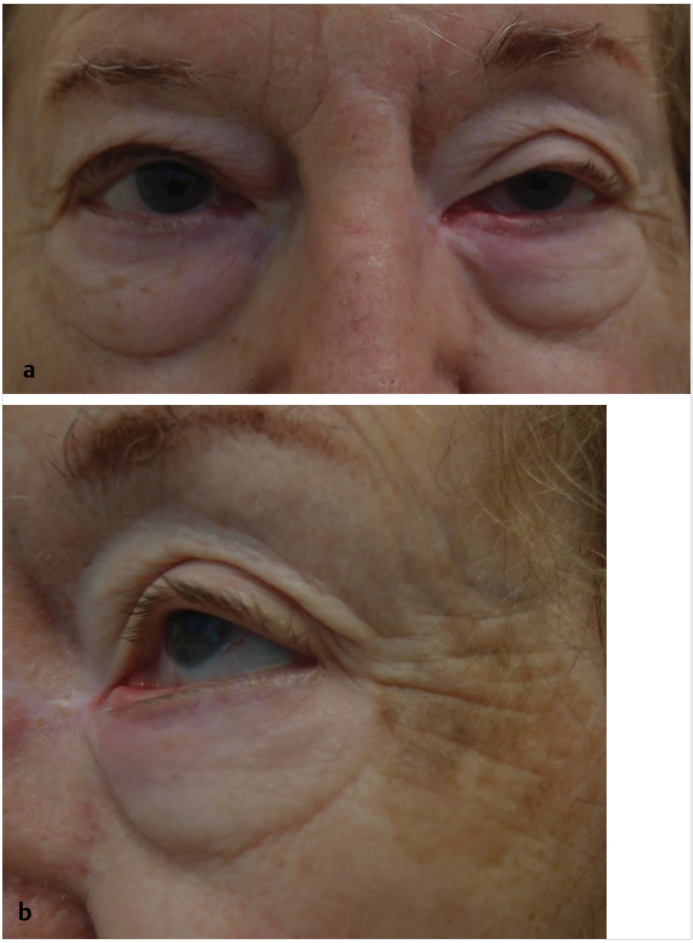

Fig. 4.1 **(a)** Patient with undesirable anterior and inferior displacement of left medial canthus following reconstruction of large medial canthal defect repaired with suture attachment of medial canthal tendon to underlying periosteum followed by myocutaneous rotational flap. **(b)** Lateral view showing gap between globe and lower eyelid medially.

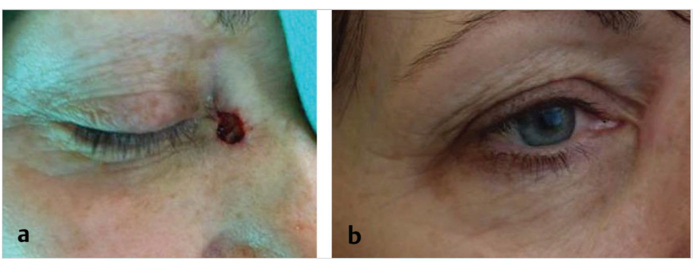

Fig. 4.2 **(a)** Defect involving skin and orbicularis muscle in the medial canthus. **(b)** Six months post-reconstruction with hypertrophic healing and multiple small webs extending from the scar posteriorly toward the medial commissure and upper eyelid.

excellent option for many small defects in the medial canthal region. Generally, defects that overlie or are just superior to the MCT are in the ideal location for this. Granulation of more inferiorly located defects may cause traction on the lower eyelid resulting in ectropion and eyelid retraction. Besides the patient avoiding an additional surgical procedure, an advantage of this passive technique is that no additional incisions are made to create flaps; hence the surface area of surgically manipulated tissue is minimized. A disadvantage is that deeper defects can take several weeks to epithelialize, which some patients find frustrating. ▶ Fig. 4.5, ▶ Fig. 4.6, ▶ Fig. 4.7, and ▶ Fig. 4.8 show examples of medial canthal defects that healed by secondary intention.

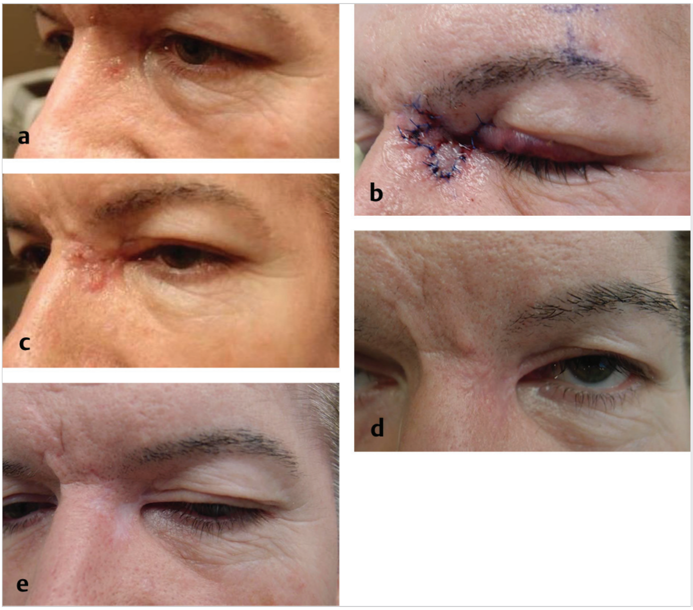

Fig. 4.3 **(a)** Preop skin malignancy left medial canthus. **(b)** Immediately post-reconstruction with small bilobed myocutaneous rotational flap from superomedial to the defect. **(c)** Four weeks post-op with early evidence of hypertrophic scarring. **(d)** 2.5 months post-op with evolution of wound healing. There is improvement and smoothing of the focal hypertrophic scar, but there is new traction and webbing to the surrounding areas. **(e)** 10 months post-op with improvement in hypertrophic healing. There is hypopigmentation in the area of the previous defect and mild residual webbing near the medial commissure.

4.3 Direct Closure

Direct closure of a small defect in the medial canthal area is sometimes possible. Care must be taken to avoid closure that would result in web formation; hence, creation of a small flap is often a better option in this risky area.

4.4 Full-Thickness Skin Graft

Full-thickness skin grafts are an option for the repair of myocutaneous defects that are of limited depth. Full-thickness skin grafts of the size needed for the periorbital area are generally easy to harvest and these survive well because of the rich vascular supply of this region. However, full-thickness skin grafts from distant sites are rarely the best option for the medial canthus due to several reasons. Skin thickness, texture, and color are usually not as good a match as that of a regional flap. Furthermore, it is not possible to control the vectors of tension on a skin graft during healing. In contrast, a flap can be created to distribute tension in a direction parallel to relaxed skin tension lines, thus increasing cosmesis and decreasing the risk of eyelid retraction and other unwanted tissue distortions. However, full-thickness skin grafts are sometimes a useful adjunct in large defects where flaps cannot completely close the defect or in patients with skin disorders or other skin cancers in the areas surrounding the defect that would prevent the use of flaps. ▶ Fig. 4.9 and ▶ Fig. 4.10 demonstrate the use of these grafts to repair medial canthal defects.

4.5 Regional Flaps

Rotational and advancement flaps are highly useful in medial canthal reconstruction. They replace missing tissue with skin of similar color and compatible texture. The thickness of the flap can be controlled to match the depth of the defect by careful dissection of the subcutaneous tissue. Flaps should be created to control skin tension vectors to maximize the aesthetic appearance and prevent undesired tension on the lid margin. In general, consideration should be given to creation of a flap originating superior to the defect, as contractile forces during healing will result in upward traction on the wound. If the flap is created inferior to the defect, there is risk of downward traction with resulting lower eyelid ectropion and retraction. The subsequent sections will discuss several flaps that are useful for medial canthal defects of various sizes and depths.

4.5.1 Rhomboid Flap

The rhomboid flap, first described by Limberg in 1946,[1,2] is a simple, versatile flap that is a workhorse in small- to medium-size medial canthal

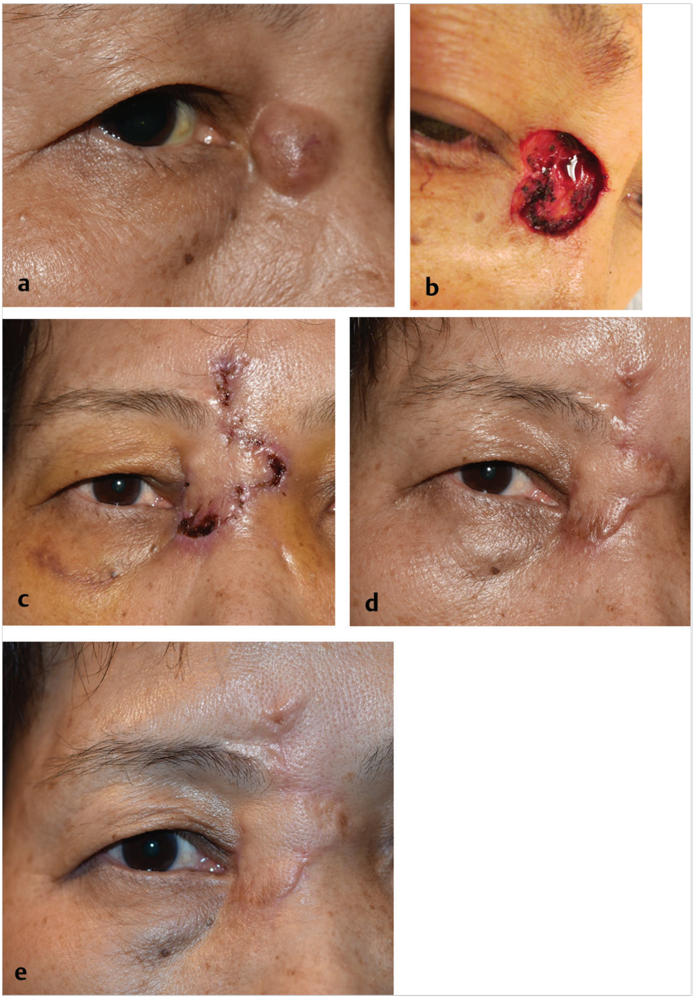

Fig. 4.4 **(a)** Preop large right medial canthal adnexal adenocarcinoma. **(b)** Defect to the depth of periosteum involving medial canthus and nasal side wall. **(c)** Two weeks after repair with bilobed rotational flap with resolving ecchymosis and edema. **(d)** Three months post-op with significant hypertrophic healing along incision lines. **(e)** 5.5 months post-op with improvement in hypertrophic healing. The patient had declined steroid or antimetabolite injections.

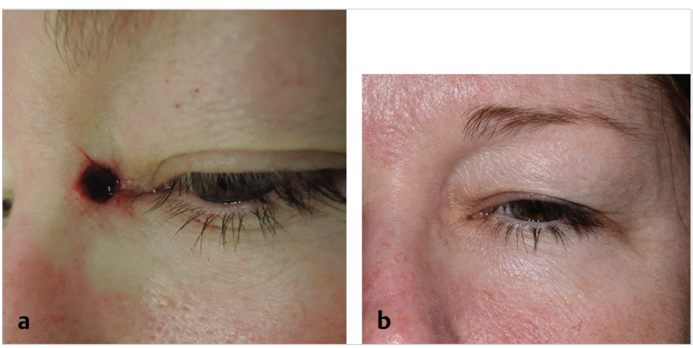

Fig. 4.5 **(a)** Defect involving a small area of skin and orbicularis muscle directly overlying the medial canthal tendon. **(b)** Six months after secondary intention healing with an excellent result.

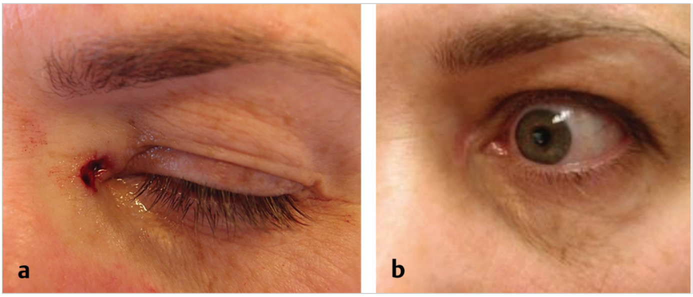

Fig. 4.6 **(a)** Defect in left medial canthus involving skin and orbicularis muscle. **(b)** 2.5 months post-op with secondary intention healing with excellent result.

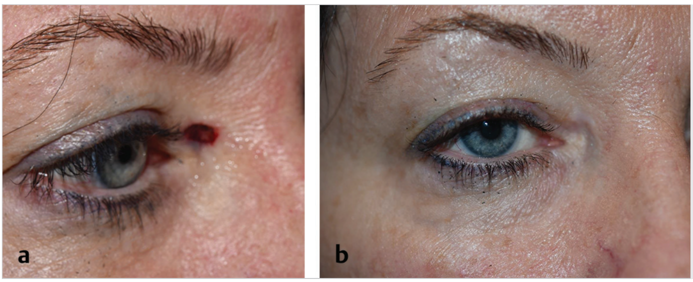

Fig. 4.7 **(a)** Defect with small myocutaneous defect just above the level of the right medial canthal tendon. **(b)** Four months post-op right medial canthus healing well via secondary intention.

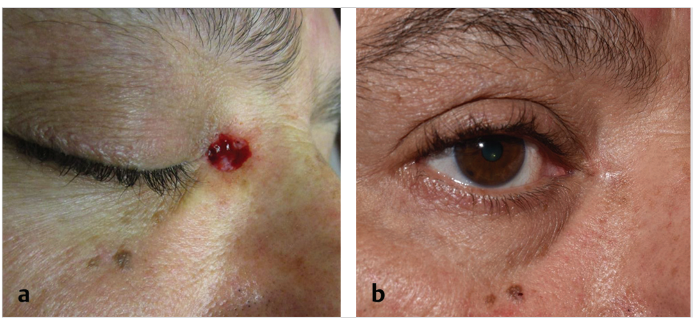

Fig. 4.8 **(a)** Defect involving skin and orbicularis muscle right medial canthus. **(b)** Six months post-op healing by secondary intention with excellent result.

defect reconstruction. The flap can be modified to accommodate variations in shape, depth, and size of the defect.

Careful planning with a surgical marking pen is recommended prior to undertaking the procedure. The defect is conceptualized as a rhomboid shape and lines are drawn as such, with all segments being of the same length. The short diagonal is extended on both sides beyond the rhomboid in same length segments. Then, four lines are drawn extending from the short diagonal extensions, lying parallel to the rhomboid sides and once again of the same length as all of the previous segments. An imaginary line is then traced back from the tip of each of the four segments to the site where the short diagonal extension touches the rhomboid. This reveals four possible rhomboid flaps. The two optimal flaps with regard to relaxed skin tension lines are those whose imaginary lines are perpendicular to the relaxed skin tension lines (parallel to the lines of maximum extensibility). Of these two possible flaps, it is usually very easy to select the one that lies farthest from a critical structure to be avoided during surgery, such as the eyebrow or eyelid margin. ▶ Fig. 4.11 and ▶ Fig. 4.12 demonstrate intraoperative drawing of rhomboid flaps.

Fig. 4.9 **(a)** Medial canthal defect immediately post-op with full-thickness skin graft in place with silk sutures in preparation for bolster placement. **(b)** 2 months post-op with well-healed left medial canthal skin graft with mild hypertrophy and webbing. Upper and lower lids are in excellent position.

Fig. 4.10 **(a)** Fairly large left medial canthal defect involving skin and superficial muscle layers. **(b)** Immediate post-reconstruction with two full-thickness skin grafts harvested from both upper eyelids and sutured into position vertically adjacent to one another. **(c)** Ten days post-op with poor viability of skin grafts after cauterization of arterial bleed at the repair site 1 day prior. **(d)** Six weeks post-op with partially sloughed skin graft with excellent wound granulation and no distortion of lid margin.

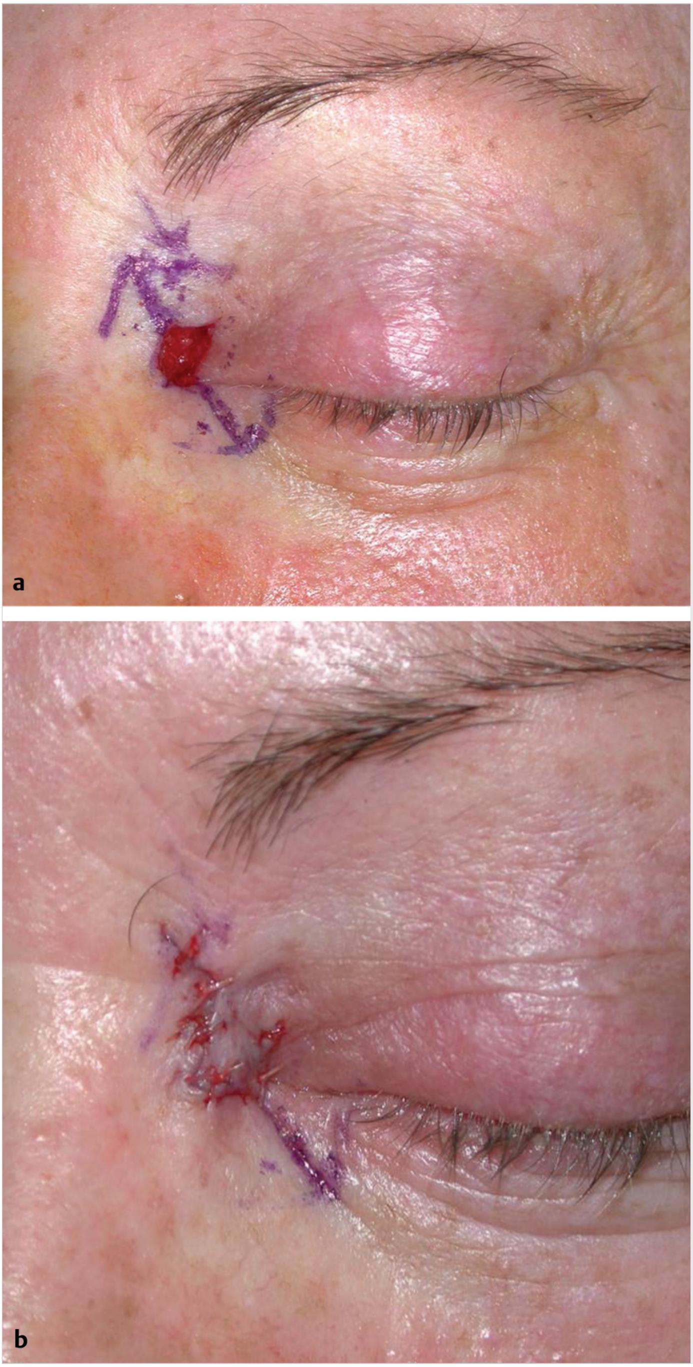

Fig. 4.11 (a) Small left medial canthal defect with delineation of possible rhombic flaps. *Arrow* indicates selection of the superolateral option as optimal choice. **(b)** The select rhombic flap has been rotated and sutured into position.

Once the flap is delineated and selected, local anesthetic containing epinephrine is injected. A scalpel is used to incise the flap and dissection is performed with scissors to create a flap of the desired thickness to match the depth of the defect. The pedicle of the flap is left intact as a blood supply. The area surrounding the defect and the flap is undermined to allow for optimal tissue motility and the flap is rotated into position within the defect. A suture may be placed through the center of

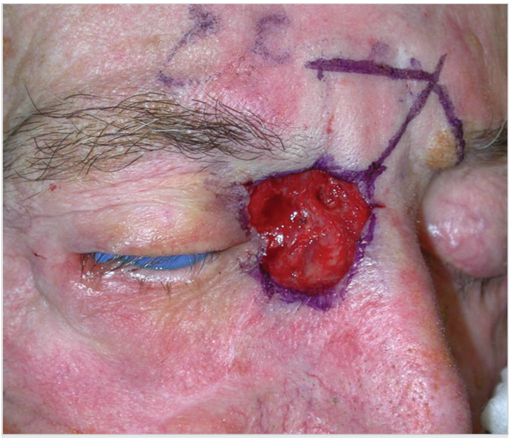

Fig. 4.12 Delineation of potential rhombic flaps in the glabellar area for reconstruction. The rhombic flap more directly above the defect is selected in order to minimize distortion of the contralateral eyebrow.

the flap to anchor it to underlying deep tissue or periosteum to re-create the concavity of the medial canthus. A variety of suture materials and techniques may be used to close the contiguous incisions of the donor and recipient sites. A light pressure dressing possibly with an additional bolster directly over the concavity is recommended for several days after surgery.

Once the surgeon becomes experienced with the design of these flaps, the methodical drawing of perfectly geometric flaps may be avoided and a more tailored flap may be created using the same principles, taking into account an irregular defect shape or other such factors. The flap need not be a perfectly proportioned rhombus, as long as the flap effectively fills the defect and the donor site can be easily closed. Additional examples of rhomboid flaps used for medial canthal reconstruction are shown in ▶ Fig. 4.13, ▶ Fig. 4.14, ▶ Fig. 4.15, and ▶ Fig. 4.16.

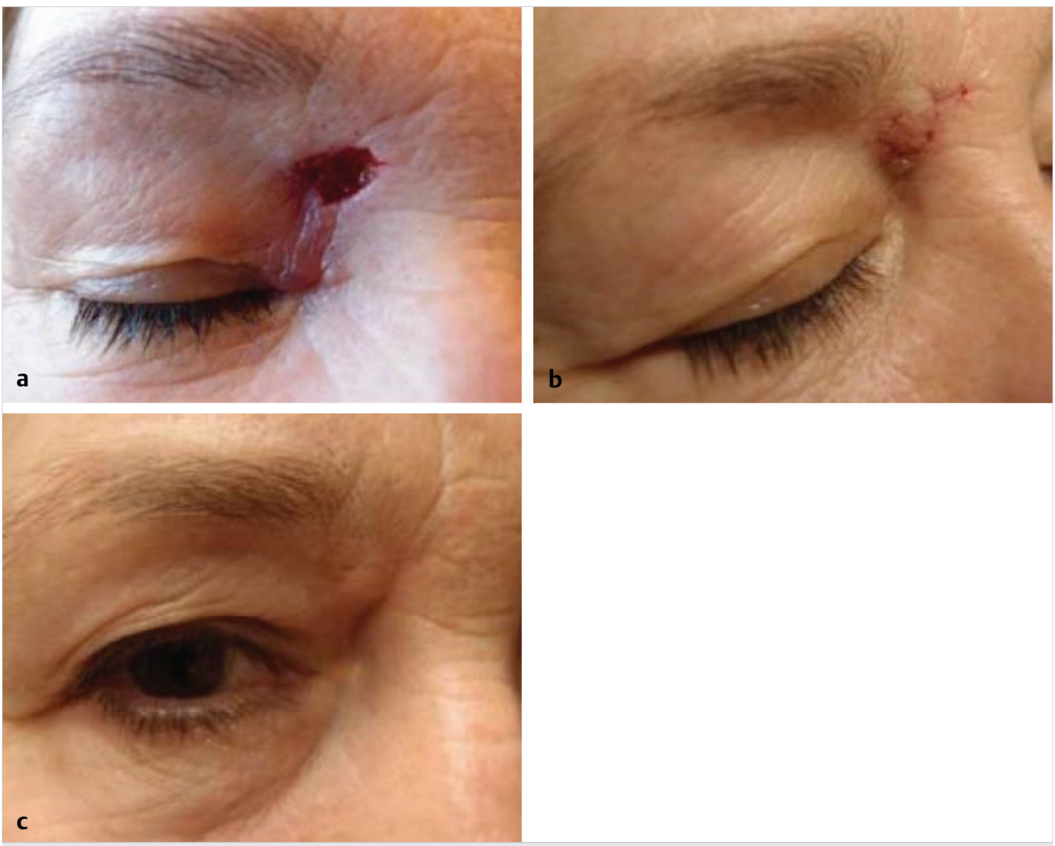

Fig. 4.13 **(a)** Defect involving skin and muscle in upper medial canthus. **(b)** One-week post-reconstruction with small rhombic flap from superomedial to the defect. **(c)** Seven months post-op with well-healed medial canthus.

Fig. 4.14 (a) Defect involving skin and underlying muscle of medial canthus and side of nasal bridge. **(b)** Immediately post-reconstruction with rhombic flap from superomedial to the defect. **(c)** Thirteen months post-op with well-healed left medial canthus.

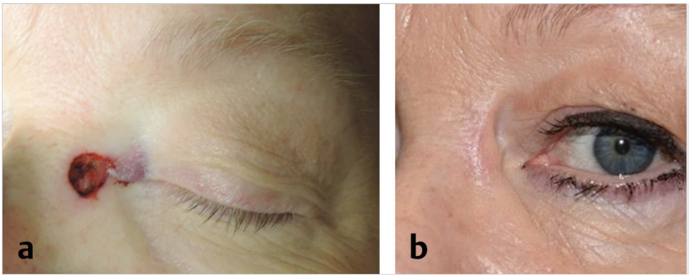

Fig. 4.15 (a) Myocutaneous defect of the left medial canthus. **(b)** Four months after reconstruction with rhombic flap from superonasal to the defect with a fair result. There is mild hypertrophic healing which is expected to improve over time.

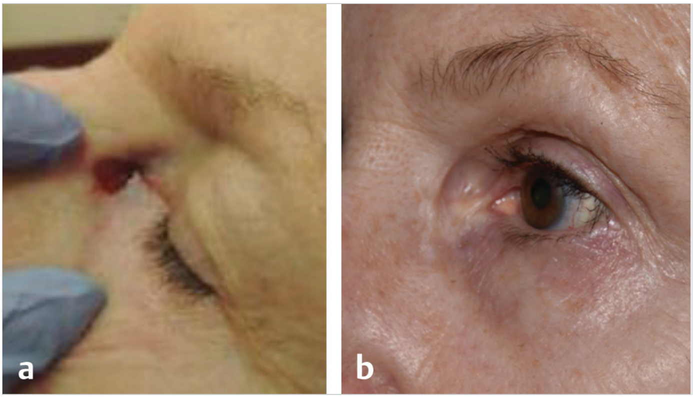

Fig. 4.16 (a) Myocutaneous defect of the medial canthus. **(b)** Four months after reconstruction with small rhombic flap rotated from superomedial to the defect yielding a good result.

Fig. 4.17 (a) Left medial canthus defect with delineation of bilobed rotational flap from glabella. **(b)** Immediately post-op with bilobed flap sutured into position with excellent wound coverage and minimal distortion of surrounding anatomy.

There is a learning curve to becoming confident with the design of this flap, but once mastered, the rhomboid flap is a quick and simple option for reconstruction that inflicts minimal damage to adjacent tissue at the donor site.

4.5.2 Bilobed Rotational Flap

Moderate- or large-sized defects of any depth may be effectively repaired with a bilobed rotational flap. The flap was first described by Esser in 1918[3] and involved the use of two same-sized flaps oriented 90 and 180 degrees from the defect. A number of modifications have been reported over the years, including making narrower angles between flaps to minimize dog ear deformities and wound tension, and decreasing the size of the second flap lobe. Often the flap is created in the glabellar area above the medial canthal defect to provide upward traction on the reconstructed area and avoid lower eyelid retraction. ▶ Fig. 4.17 demonstrates a typical bilobed rotational flap in the medial canthus. The size of the flap can be varied to extend to defects in the inferior medial canthus and medial lower eyelid.

It is important to carefully plan this flap by drawing with a surgical marking pen on the area surrounding the defect to be repaired. The base of the flap is generally superior and medial to the defect but may be varied given the proximity of critical anatomic structures. The lobes may be variably round or elliptical depending on the shape of the defect. Generally, the flap lobe to be rotated into the defect should be about 80% of the area of the defect, and the second flap about 50% of the area of the first flap. The angle of the flaps is determined by the location of the defect and the surrounding anatomy. Orienting the second flap to align with the vertical glabellar furrow results in excellent camouflage of the incision. Care should be taken to avoid moving brow cilia to an undesired location.

Local anesthetic containing epinephrine is injected into the area and incision made with a scalpel. Westcott or other small scissors are used to dissect the flaps at an appropriate thickness to match the depth of the wound. Preservation of a supraorbital or supratrochlear artery will allow for good blood supply to the flap, although ultrasound-guided vascular mapping is not necessary as long as the base of the flap is adequately wide

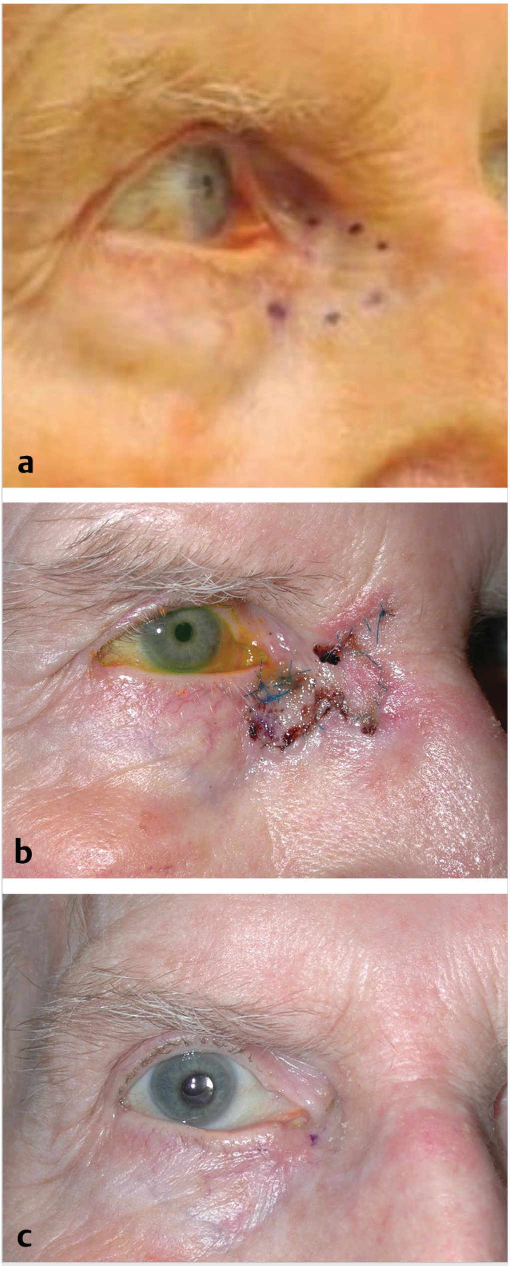

Fig. 4.18 (a) Preop squamous cell carcinoma of the right medial canthus. **(b)** One-week post-op with bilobed rotational flap from superomedial to the defect in good position. **(c)** Four months postoperative with a good cosmetic result. There is asymptomatic mild right lower lid punctal ectropion.

Fig. 4.19 **(a)** Preop basal cell carcinoma of right medial canthus and nasal bridge. **(b)** Post-Mohs defect involving skin and full-thickness muscle. **(c)** Eight months after bilobed rotational flap from glabella with very good result.

and the dermal plexus is maintained throughout the flap. After the flaps are developed, the tissue surrounding the flaps and the defect should be undermined to allow for optimal tissue transposition. Once the flaps are rotated into position, an anchor suture may be placed to attach the center of the flaps to the periosteum of the underlying bone to match the concavity of the region. Half-buried horizontal mattress sutures are used to anchor the angles of the flap to the recipient tissue corners. Judicious placement of buried subcutaneous suture is used to minimize tension along the edges of the flaps. Finally, either interrupted or running suture is used to align the skin edges along the entire perimeter of the flaps. Attention should be given to the depth of suture placement in order to line up the top surface of the flap to that of the recipient edge. A light pressure dressing applied for 5 to 7 days allows for good apposition of the flap to the defect base promoting good healing.

Examples of bilobed flaps are shown in ▶ Fig. 4.18, ▶ Fig. 4.19, and ▶ Fig. 4.20. ▶ Fig. 4.21 demonstrates a bilobed flap that is quite inferior in the medial canthal area with the flap originating inferior to the glabella. ▶ Fig. 4.22 shows a defect involving the medial canthus and nasal side wall in which the flap was created inferior and medial to the defect, as there is no risk of lower eyelid retraction in this location.

The size, depth, and angles of the bilobed flap can be tailored for maximal effectiveness. ▶ Fig. 4.23 shows a moderately large but superficial medial canthal defect repaired with a bilobed flap in which there is an unusually wide angle between two flap lobes in order to swing the flap around the eyebrow, avoiding cilia distortion. This figure also demonstrates the utility of a

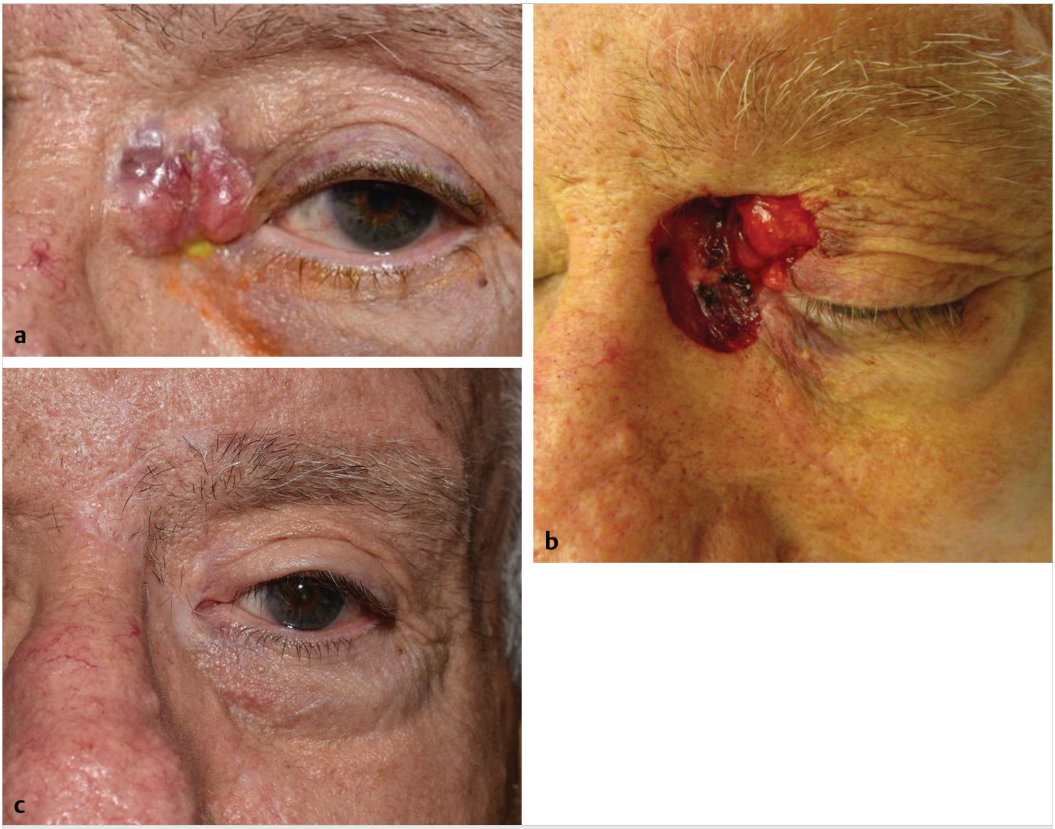

Fig. 4.20 **(a)** Preoperative photo of large basal cell carcinoma involving the left medial canthus. **(b)** Defect of the left medial canthus extending to the periosteum. **(c)** Ten months post-op after bilobed rotational flap from the glabella with an excellent result.

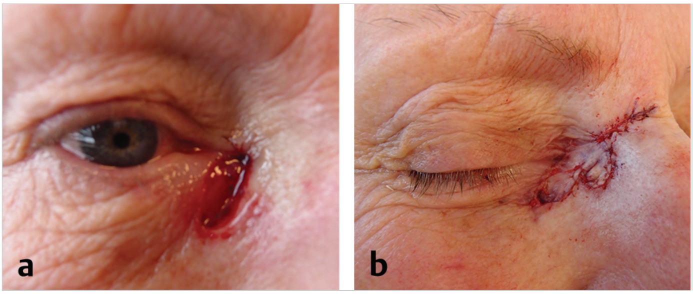

Fig. 4.21 **(a)** Defect involving the inferior aspect of the right medial canthus. **(b)** A small bilobed rotational flap from the nasal bridge has been utilized providing excellent coverage of the defect with minimal tissue distortion.

polyglycolic acid suture passing through the primary flap to attach it to the underlying periosteum to create concavity of the region.

Bilobed rotational flaps may be used in combination with other flaps when defects are large or involve multiple anatomic areas. Examples of bilobed flaps combined with horizontal advancement flaps of the lower eyelid are shown in ▶ Fig. 4.24 and ▶ Fig. 4.25.

A main advantage of the bilobed flap is that the tension is distributed over a broad region involving both flap lobes; hence, there is usually

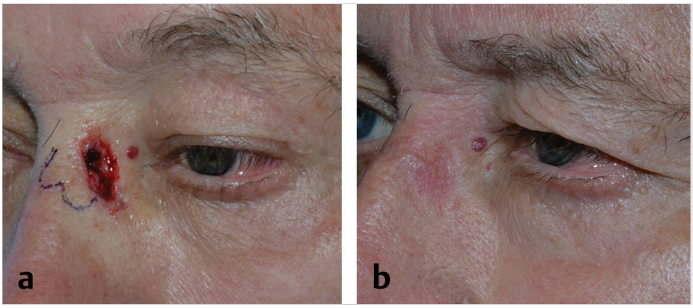

Fig. 4.22 **(a)** Medial canthal defect with delineated small bilobed rotational flap. This flap can be drawn from slightly inferior to this defect because there is no risk of lower lid retraction in this location on the nasal side wall. **(b)** Four months post-op with well-healed medial canthus.

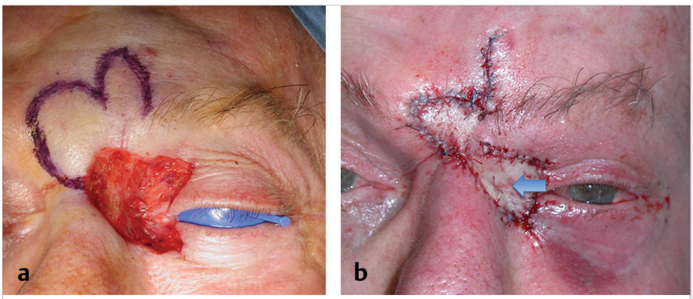

Fig. 4.23 **(a)** Delineation of planned bilobed rotational flap from glabella to medial canthus. **(b)** Immediate post-op appearance of bilobed rotational flap. The angle of the flap was modifying to wider than usual in order to fill the defect while preserving the medial eyebrow. *Blue arrow* shows Vicryl suture placed from skin full-thickness through periosteum to create flap concavity.

minimal tension on the wound edges allowing for excellent healing. This flap requires creation of curvilinear incisions in the glabellar area that do not all follow the relaxed skin tension lines. However, careful planning can result in final incision lines that respect the natural lines of the region. Generally, the contour of these flaps can nicely mimic the concavity of the medial canthal region, especially if a central deep fixation suture is placed. This flap can often obviate the need for a larger forehead flap.

4.5.3 Mid Forehead Flap

Historically, median and paramedian forehead flaps have been reported for facial reconstruction, with the median forehead flap first well-described with identification of the blood supply by Kazanjian in 1944.[4] The median forehead flap, based on bilateral supratrochlear arteries, has a wide pedicle with a consequently limited reach. The paramedian forehead flap is centered over one supratrochlear artery and hence has a narrower pedicle and more maneuverability with a better arc of rotation. The mid forehead flap is a hybrid of these flaps involving a midline forehead-centered flap utilizing the blood supply of just one supratrochlear artery plus mid forehead collaterals from the angular artery. Preservation of the supratrochlear artery allows for a richly vascular flap on a narrow pedicle which can support a long flap that is pliable and can reach distant areas. The mid forehead flap is useful for large, deep defects in the medial canthal area, especially those extending downward into the lower lid and tear trough. It may also be useful in situations where smaller regional flaps have been previously utilized, and additional surgery is required in the region.

A disadvantage of this flap is that it often bridges over an area of intact skin, resulting in a temporary unsightly “hump” of redundant skin and subcutaneous fat and the need for a secondary procedure several weeks later to return the base of the pedicle to its origin and debulk the hump. Other cosmetic disadvantages with the procedure include the forehead scar, the risk of eyebrow distortion, and flap fullness. The forehead skin is much thicker than eyelid skin and

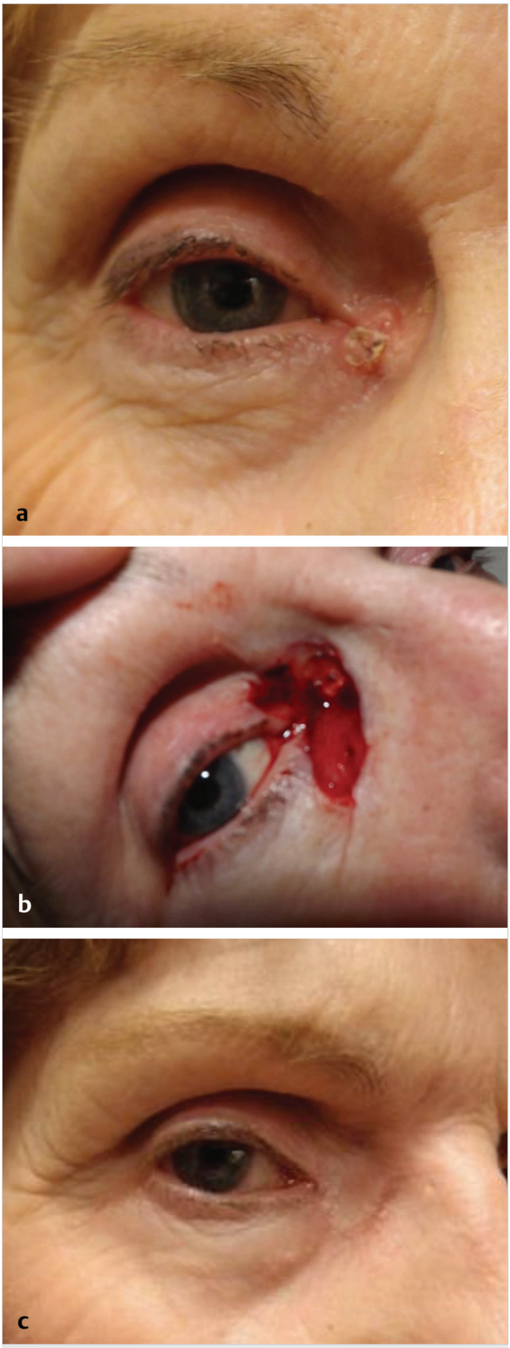

Fig. 4.24 **(a)** Preop squamous carcinoma of the medial canthus. **(b)** Post-Mohs defect of right medial canthus is larger than anticipated and extends to the periosteum of the maxilla. **(c)** Five months postrepair with bilobed rotational flap from glabella plus small horizontal advancement flap along the lower eyelid with excellent result.

contains subcutaneous fat which can distort the concavity of the medial canthus.

The procedure begins with careful mapping of the planned flap using a surgical marking pen. The flap is centered on the forehead midline and should stop below the hairline to avoid hair growing in the reconstructed region from the tip of the flap. The flap width should not exceed about 2 cm to allow for primary closure of the donor site defect. Careful measurement is important to ensure that the flap is long enough to reach the desired location. The pedicle of the flap should be based at the contralateral medial brow, allowing adequate length to bend the flap over a bridge of intact skin to reach the defect. Care should be taken to preserve the supratrochlear artery. The artery may be formally mapped with Doppler ultrasound or preserved simply by being aware of the anatomy during dissection. Local anesthetic with epinephrine is injected into the flap and area surrounding the defect. A scalpel is used to incise the flap, and the plane of dissection may be subperiosteal, preperiosteal, or subdermal, depending on the desired flap thickness and defect depth. This vertical forehead incision will later be closed in layers, with consideration of vertical mattress sutures superficially to allow for maximal wound edge eversion. The flap, once dissected, is rotated over the intact bridge of skin between the flap base and the defect to be repaired. It is anchored into position with judicious subcutaneous sutures to reduce wound tension and then cutaneous running or interrupted sutures to align the skin edges. A dressing is placed over the area for cosmesis and to apply gentle pressure to the flap. The second stage procedure to return the flap base to its origin and debulk the hump overlying the intact skin bridge can be performed after approximately 6 weeks. Surgical steps are demonstrated in ▶ Fig. 4.26. ▶ Fig. 4.27 shows a large, deep medial canthal defect extending to the lower lid and cheek that was repaired with a mid-forehead flap.

A variety of modifications to the mid forehead flap have been described including one by Mombaerts in which a single stage technique incorporates a tunneled de-epithelialized pedicle.[5]

4.5.4 V to Y flap

Conceptually, the V to Y glabellar flap combines the location and donor site closure technique of a mid-forehead flap (but does not extend as far

Fig. 4.25 **(a)** Large left medial canthal defect with depth to periosteum and extension into lower eyelid. Planned flaps are delineated: a bilobed rotational flap from the glabella combined with a horizontal advancement flap along the lower eyelid. **(b)** immediately post-op with flaps sutured into position with excellent coverage and minimal tissue distortion. **(c)** Six weeks post-op with optimal early result. The lid margins and commissure are in excellent position and the incision lines are healing well.

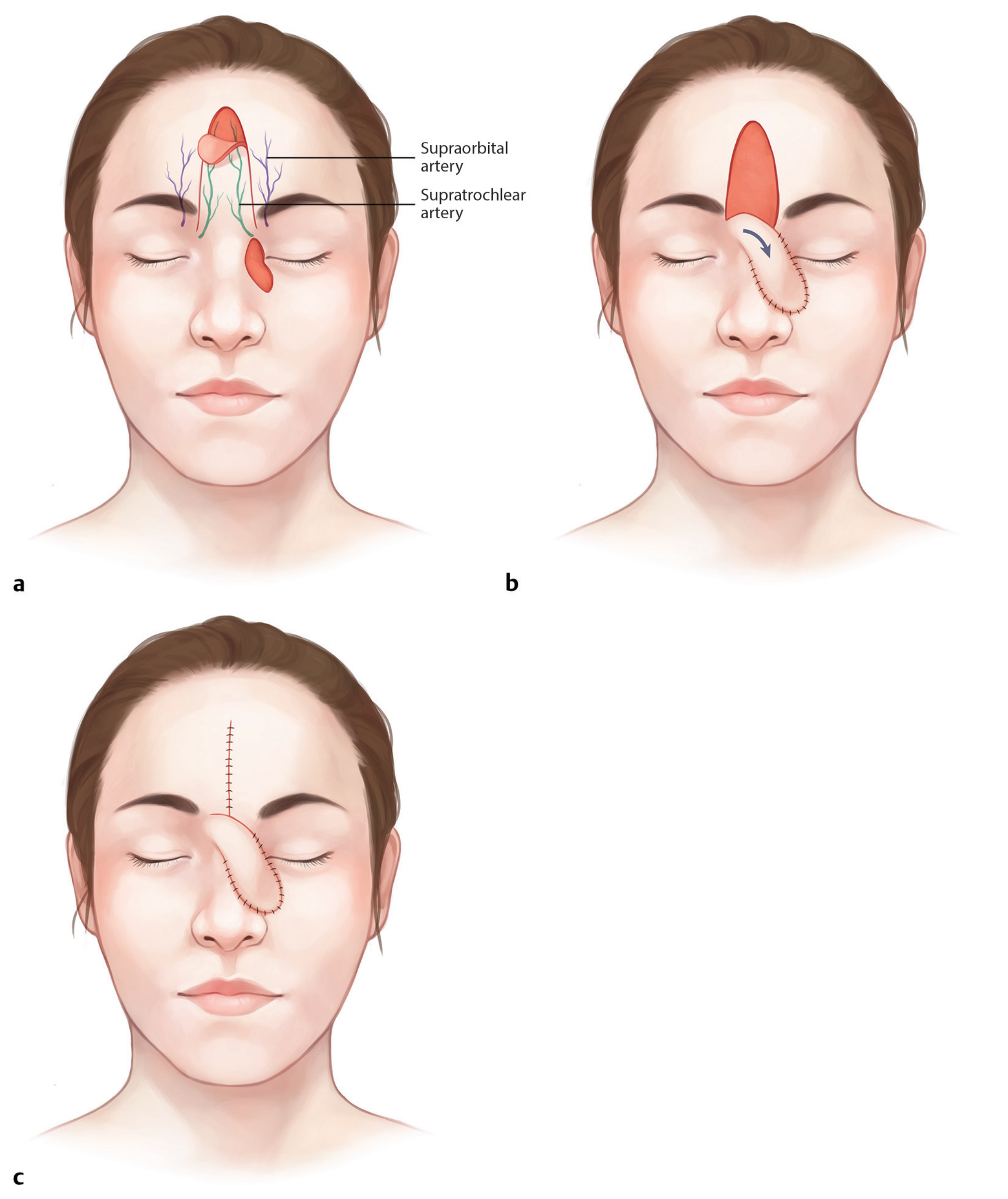

Fig. 4.26 (a) Medial canthal defect with planned mid forehead flap with identification of the supraorbital and supratrochlear arteries. **(b)** The mid forehead flap has been rotated into position, bridging over intact skin at the base of the nose, with preservation of the right supratrochlear artery for blood supply. **(c)** The mid forehead flap sutured into position at the completion of stage 1.

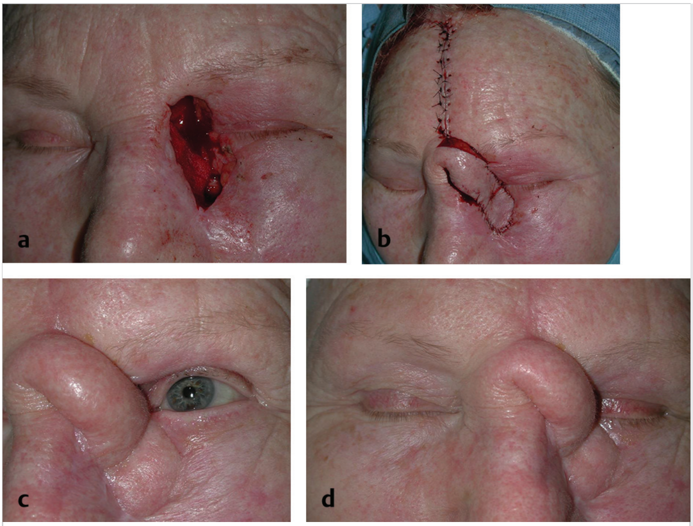

Fig. 4.27 (a) Defect involving the left medial canthus and extending inferiorly to include the tear trough and medial portion of the lower eyelid and with a depth to periosteum. **(b)** Left medial canthus immediately post-reconstruction via mid forehead flap. The pedicled flap has a blood supply from the right supraorbital and supratrochlear arteries. It bridges over intact skin superior the original defect and provides thick tissue coverage for the deep defect and adequate length to cover the full extent of the defect into the lower eyelid. The forehead donor site which extended to a subperiosteal depth has been closed with three layers of suture including cutaneous vertical mattress sutures for wound eversion. **(c,d)** Two months post-op with well-healed mid forehead flap ready for stage 2 procedure to remove the bridge of tissue overlying intact glabellar skin and debulk excess fat under the flap.

superiorly to the hairline) with the rotational technique of a rhomboid flap. An inverted V is drawn in the glabellar area, and on the side of the defect, the arm of the V is extended to meet the superonasal edge of the defect. The flap is incised, undermined, and rotated into its new position to fill the defect. The top portion of the donor site along the forehead midline is sutured into position in a vertical line until the horizontal wound tension becomes significant. The branches of the wound are then split to each side and sutured to form an inverted Y-shaped pattern. ▶ Fig. 4.28 illustrates the technique. ▶ Fig. 4.29 shows a large defect closed with a V to Y flap plus a full-thickness skin graft to the lower lid portion of the defect that could not be filled with the primary flap.

An advantage of the V to Y flap over the mid forehead flap is that it avoids a bridge of tissue being transposed over intact skin, which requires a second staged operation. In addition, the vertical forehead scar is shorter than that in the mid forehead flap. Like the mid forehead flap, this flap is often thicker than the recipient site and should be harvested at a desired depth. Like other flaps in this region, care should be taken to avoid transposing eyebrow cilia to undesired locations.

4.6 Conclusion

The repair of defects involving the medial canthus of the eyelids requires careful planning and consideration of local anatomic structures including the lacrimal system, MCT, eyebrows, and neurovascular bundles. Prevention of web formation, hypertrophic scarring, and eyelid retraction and ectropion are important concerns. The techniques described herein, either alone or in combination with techniques used in other periocular regions, provide the surgeon with an array of choices suitable for the challenges of medial canthal eyelid reconstruction.

Fig. 4.28 Planned repair with a V-Y sliding flap from the glabella plus a full-thickness supraclavicular skin graft to the circled area at the lateral aspect of the defect.

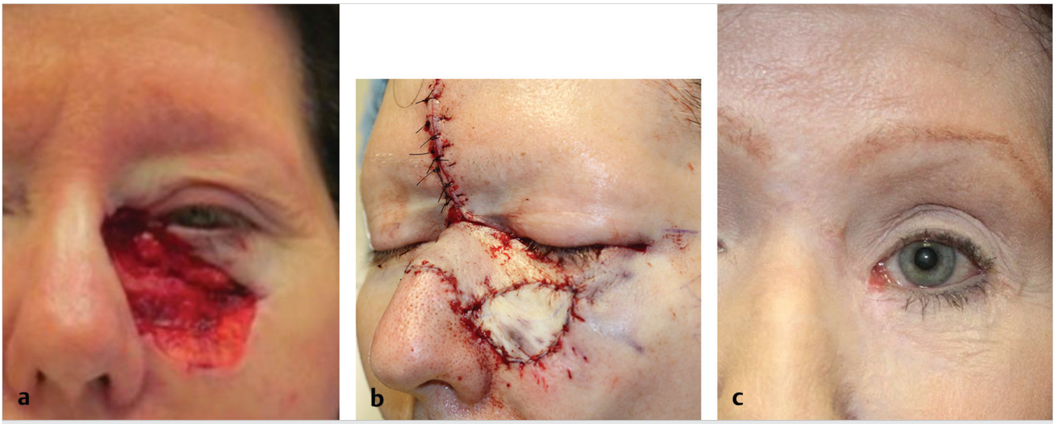

Fig. 4.29 **(a)** Large defect of left medial canthus and lower eyelid extending to the depth of periosteum. **(b)** Immediately post-op with flap and graft in place. **(c)** Nine months post-op with well-healed skin incisions and good result with very mild ectropion of the medial left lower eyelid.

4.7 References

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5 Lower Eyelid Reconstruction

N. Grace Lee

Summary
Cutaneous malignancies commonly occur on the lower eyelid. The eyelids are composed of an anterior and posterior lamella wherein one or both may be involved. It is important to be cognizant of the intricacies of the lower eyelid anatomy and reconstitute the involved layers in order to optimize the aesthetic and functional result. This chapter details the techniques that can be used for reconstruction of defects of the lower eyelid.

Keywords: lower eyelid, Mohs reconstruction, lamella, graft, flap, Hughes, Tenzel, Mustarde, advancement

5.1 Introduction to Lower Eyelid Reconstruction

Reconstruction of the lower eyelid has similar complexities as the upper eyelid. The eyelids are unique in that they are bi-layered and function to protect and lubricate the surface of the eye while being dynamic in nature. The skin and the orbicularis oculi muscle constitute the anterior lamella, while the posterior lamella is composed of the tarsal plate and conjunctiva. Therefore, in reconstructing defects of the upper and lower eyelids, both the anterior and posterior lamellae must be re-created, and the dynamic orbicularis muscle function should be preserved whenever possible.

Another complicating factor in eyelid reconstruction is the presence of the lacrimal drainage system, which is situated within the medial aspect of the eyelid (see Chapters 1 and 8, for more details). Damage to this system can result in permanent epiphora and whenever possible, the canalicular system should be restored.

As in other locations, the degree of laxity and elasticity of the eyelid determines whether primary closure is possible or if flaps or grafts are required. Lower eyelid marginal defects are characterized by the percent of eyelid margin involved, degree of non-marginal eyelid involvement, canthal involvement, lacrimal involvement, and the total size of the defect. Full-thickness eyelid defects that are large enough to require a graft of one lamella of the eyelid generally need a flap for the apposing lamella. It is not surgically viable to place a graft on a graft as neither lamella would have inherent blood supply and would likely undergo necrosis. The surgeon should also consider factors that affect healing and vascularization including cigarette smoking and previous surgery or radiation therapy to the area.

Of particular importance, the lower eyelid can become retracted after reconstruction, which can lead to lagophthalmos and exposure keratopathy. Lower eyelid defects must be closed with any tension on flap pedicles directed horizontally and, when possible, superolaterally in order to prevent lower eyelid retraction. Appropriate canthal fixation medially and laterally is critical to ensure proper position and contour.

5.2 Anterior Lamellar Defects

5.2.1 Secondary Intention

Small defects of the lower eyelid involving only skin and orbicularis muscle can be successfully managed by granulation alone. If the patient has minimal laxity of the lower eyelid and the defect is located superiorly on the lower eyelid (pretarsal), it is possible to allow secondary intention healing with minimal risk of ectropion or retraction (▶ Fig. 5.1). It is important to counsel the patient about this risk and that granulation and healing could take weeks to months.

5.2.2 Primary Closure

Small defects of the lower eyelid may be closed primarily, with undermining of the perimeter, as long as there is no vertical tension or vertical recruitment of tissue (▶ Fig. 5.2a–c). Primary closure is easiest if redundant skin exists adjacent to the defect, which is more common in the upper eyelid than the lower eyelid. In some cases, even a large defect can be closed primarily with undermining if there is enough laxity (▶ Fig. 5.2d–f). Undermining above the level of the inferior orbital rim must be done in the preseptal or subcutaneous plane whereas below the orbital rim, undermining should be done in the subcutaneous tissue plane. Significant wound tension should be avoided due to risk of dehiscence and propensity for scar formation along the incision line. Therefore, if tension remains present, additional or alternative

Fig. 5.1 Healing by secondary intention. **(a)** Right lower eyelid defect involving the lash line, margin epithelium, and orbicularis muscle. **(b)** Two months later, there is good epithelialization with some regrowth of lashes. **(c)** Infraciliary, anterior lamellar defect. **(d)** Excellent result after 3 months. **(e)** Anterior lamellar defect that is adjacent to the punctum **(f)** After 3 months, the area is well-healed without punctal ectropion.

Fig. 5.2 Anterior lamellar direct closure. **(a)** Appearance of small basal cell carcinoma at the lash line of the left lower eyelid. **(b)** After Mohs micrographic surgery, there is a pretarsal defect. **(c)** The defect was closed primarily with minimal undermining and results after 6 weeks are shown. **(d)** Concentric circles outlining the area of excision (outer circle). **(e)** Undermining and direct closure performed on a large defect involving skin and orbicularis. Note minimal vertical tension applied to the wound. **(f)** Six months postoperative result.

reconstructive techniques should be employed. In some patients, particularly with thick skin, dark pigment, or personal history of scar formation, permanent sutures should be considered and kept in place for 5 to 7 days. In the pretarsal and preseptal lower eyelid skin, 5–0 or 6–0 permanent or absorbable sutures are appropriate.

5.2.3 Cutaneous or Myocutaneous Flap

Cutaneous or myocutaneous flaps are very versatile and are often the best option to repair an anterior lamellar eyelid defect. Flaps are preferable to grafts in that there is no donor site morbidity and skin color and texture are well matched, since they are from adjacent sites. There is a high rate of successful healing due to the inherent blood supply of a flap, and there is a higher likelihood of good muscle function because of preserved innervation.

Horizontal Advancement Flap

Horizontal advancement flaps are useful in a broad range of lower eyelid defects involving the nonmarginal anterior lamella. Flaps from the medial side of lower eyelid defects may be somewhat difficult to advance due to the firm adhesion of the medial canthal tendon in the nasal region. However, laterally based advancement flaps that follow along the subciliary line and extend into the lateral canthal rhytids ("laugh lines" or "crow's feet") are particularly useful on the lower eyelid (▶ Fig. 5.3a–c). These flaps can be considered modifications of an H-plasty where bilateral flaps are raised on each side of the defect. Horizontal incisions are made through skin or skin-muscle at the superior and inferior apices of the defect. Depending on the size of the defect and the elasticity of the skin, both flaps are generally the same horizontal length as the defect and are advanced toward each other. These flaps can be elongated if tension remains. Burow triangles can also be excised on the outermost aspect of each flap to address standing cutaneous deformity formation if necessary. The edges of skin can then be approximated with either absorbable or permanent sutures. It is important to construct the flaps so that any tension on the lower eyelid is horizontal rather than vertical as to avoid lid retraction and ectropion. Another horizontally oriented advancement flap is the O-T flap (▶ Fig. 5.3d–e) where a circular defect can be closed with a subciliary incision and undermining of tissue. Much like the bilateral advancement flap above, a horizontal incision is made along the superior aspect of the defect. Then, both edges of the defect are advanced toward one another after significant undermining of the skin. A triangle is excised at the inferior aspect of the defect if a standing cutaneous deformity develops.

Rotational Flap

Rotational flaps can be very useful in their ability to control vectors and minimize vertical tension on the lower eyelid (▶ Fig. 5.3f–h). In patients who have a large anterior lamellar defect, a rotational cheek flap can be a useful option. A Mustarde cheek flap is designed as a large semicircular flap arching superiorly with an extensive dissection from the lateral canthus through the temple toward the ear.[1] The flap design begins as a subciliary incision from the lateral portion of the defect, to the lateral canthus, and then extending superiorly and laterally to the temple. Dissection on the eyelid portion is deep to the orbicularis muscle. Lateral to the orbital rim, the dissection is performed within the subcutaneous fat plane as the facial nerve courses deep to this plane (▶ Fig. 5.4). The flap is then rotated medially and can be secured into place with either 4–0 or 5–0 polyglactin sutures anchoring the flap to the periosteum of the orbital rim. Deep, interrupted 5–0 polyglactin sutures can be placed in a buried fashion at intervals along the flap to secure the position and relieve tension. Skin is approximated with a combination of interrupted and continuous running 6–0 suture (e.g., nylon and gut). There are other rotational flaps including rhombic and bilobed flaps described in Chapter 4 that can also be applied to the lower eyelid.

5.2.4 Upper-to-Lower Eyelid Transposition Flap

Transposition flaps for lower eyelid repair are harvested from the upper eyelid and are transposed down with a pivot point at the medial or lateral canthus of the eyelid. There are two particularly useful scenarios for this flap: (1) large, anterior lamellar defects where a skin graft cannot be used because of not wanting to patch a monocular patient and (2) after a tarsoconjunctival graft is placed and a vascularized flap is required. In designing and planning a flap that is laterally based, it is important to inform the patient of possible chronic lymphedema secondary to expected injury

Fig. 5.3 Anterior lamellar advancement/rotational flaps. **(a)** Moderately large nonmarginal lower eyelid defect involving skin and orbicularis. Advancement plan is outlined with dashed lines. **(b)** Immediately after advancement of flap **(c)** Postoperative month 2. **(d)** Circular defect along the right lower eyelid lash line. Planned O-T advancement in dashed lines. **(e)** Immediate postoperative result. **(f)** Large right lower eyelid lateral defect of skin and orbicularis. Plan for rotational flap. **(g)** Two weeks postoperative result. **(h)** Three months postoperative result.

of the lymphatic channels that coalesce at the lateral canthus before heading to the preauricular lymph nodes. Additionally, since skin is being removed from the upper eyelid, large flaps risk lagophthalmos and worsened dry eye due to iatrogenic anterior lamellar deficiency. The upper eyelid flap is designed after measuring the height of the lower eyelid defect. The upper eyelid crease is measured as in a blepharoplasty incision. The inferior aspect of the flap is placed in the upper eyelid crease and harvested superior to this. It is important to appropriately size the flap to minimize redundancy of the flap while avoiding tension on the edges of the wound. Please see details and accompanying figure below in the description for tarsoconjunctival graft.

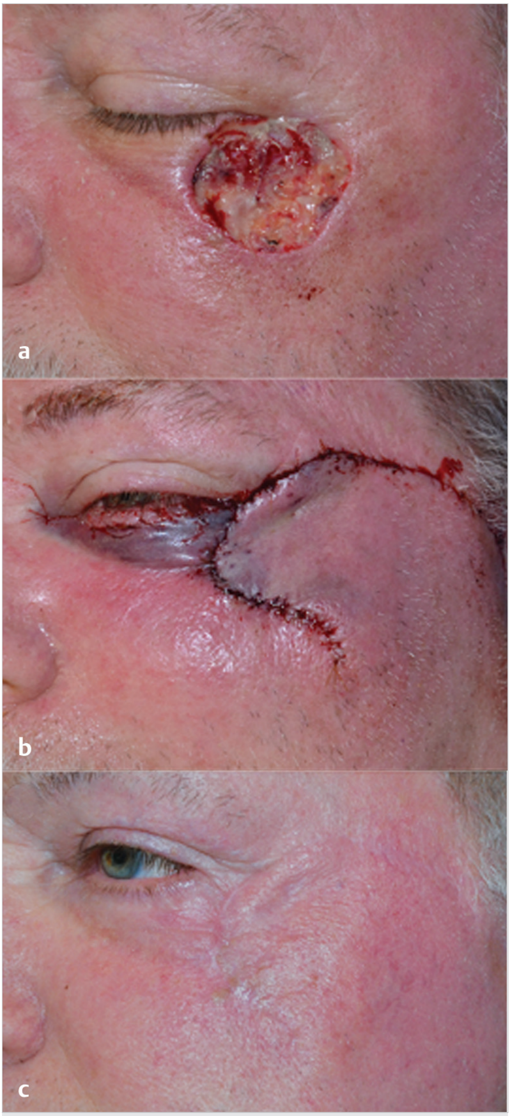

Fig. 5.4 Mustarde cheek flap. **(a)** Large, circular, non-marginal defect of the left lower eyelid. **(b)** Immediately after cheek flap with large dissection temporally toward ear. **(c)** Six month postoperative result.

5.2.5 Full-Thickness Skin Graft

Full-thickness skin grafts must be used with caution in the lower eyelid, as grafts do not allow manipulation of wound tension vectors, thus risking lower lid vertical retraction. However, these grafts are useful when other flap-based techniques are not possible. The eyelid should be immobilized from blinking for about 1 week for the skin graft to successfully integrate into the host bed (▶ Fig. 5.5); hence, this is not ideal for monocular patients when their sighted eye is affected. Placement of a Frost suture or tarsorrhaphy with a bolster and pressure patch is recommended.

Common relatively glabrous (hairless) donor sites for harvesting skin grafts include the upper eyelid, pre- and retroauricular skin, and supraclavicular skin. When possible, donor skin of the same color, texture, and thickness should be selected for grafting. The technique for full-thickness skin grafting is described in Chapter 2. It is important to meticulously remove any attached subcutaneous tissue to allow for neovascularization and oxygen supply to the graft. Occasionally, a lower lid skin graft is performed in conjunction with a posterior lamellar flap involving the eyelid margin. Please see details of this described in the subsequent section titled Hughes tarsoconjunctival flap. One should have a low threshold to address lower lid laxity, such as via a lateral canthoplasty, when placing a skin graft to the lower lid as this can combat, although not definitively prevent, lower lid ectropion and retraction.

5.3 Full-Thickness/Margin-Involving Defects

5.3.1 Defects Up to 33% of the Lower Eyelid

Pentagonal Wedge–Direct Closure

The lower eyelid tarsal plate is approximately 30 mm in horizontal length and 3 to 5 mm in vertical height. Full-thickness defects in the lower eyelid can be characterized as small (< 33%), medium (33–50%), or large (> 50%), based upon the percent of the eyelid margin involved. Wound closure technique selection in any of these size categories may vary depending on skin laxity and elasticity. In young patients with minimal eyelid laxity, up to 25% of the eyelid can be primarily closed, while in older patients with significant eyelid laxity, a defect encompassing approximately 40% of the horizontal length of the eyelid can be closed directly. However, reconstructive decisions should be made based on individual patient evaluation, rather than strictly by the above guidelines.

If there is too much tension for direct closure, a lateral internal inferior cantholysis can be performed to afford a few more millimeters of laxity

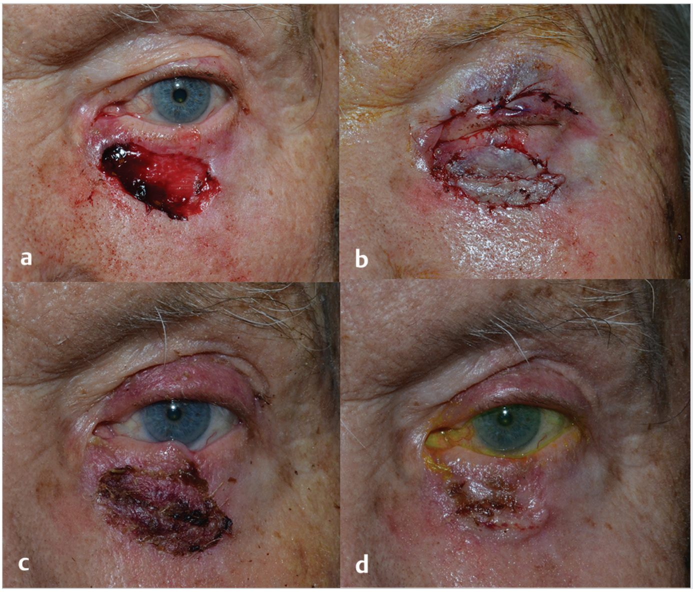

Fig. 5.5 Skin graft closure. **(a)** Large anterior lamellar defect along the nasojugal fold. **(b)** Immediate post-operative result with tarsorrhaphy placed to immobilize the lower eyelid graft. **(c)** One week after surgery, the tarsorrhaphy is released. **(d)** Four weeks after surgery, the graft is viable and is healing well.

(▶ Fig. 5.6a–c). In cases where only a portion of the tarsus is absent, additional tarsus vertically below the defect should be removed, in order to create parallel vertical edges to allow for approximation of the entire vertical height of both sides of the tarsus (Fig. 5.6d–f). The technique for closure of a full-thickness eyelid margin defect is described in detail in Chapter 2.

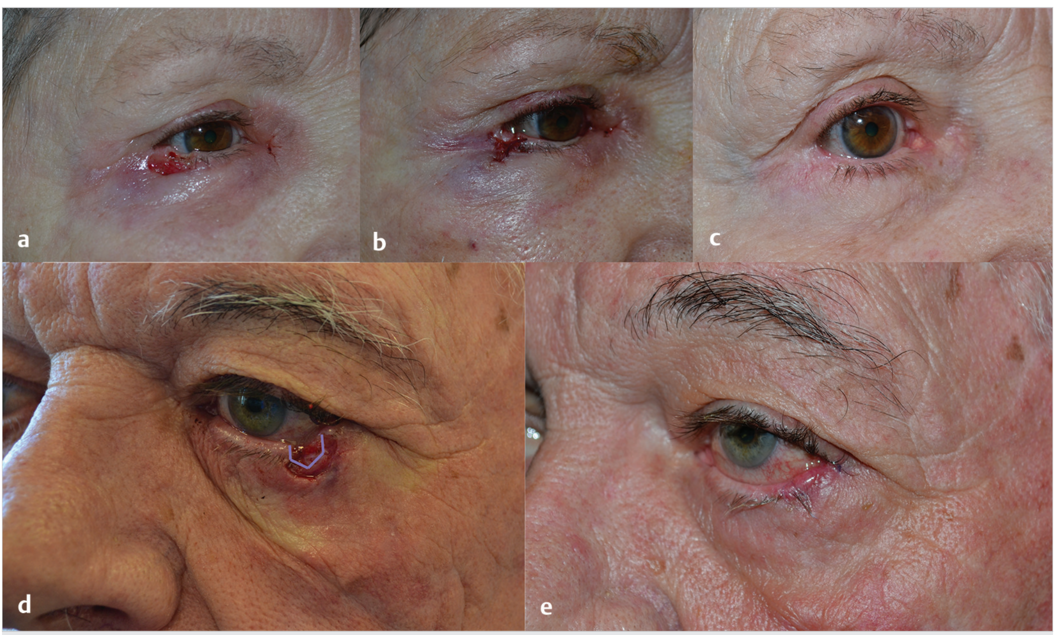

Fig. 5.6 Pentagonal wedge/direct closure. **(a)** Small defect involving the margin and tarsus along the right lateral lower eyelid. **(b)** Immediately after approximation with good eversion of the edges. **(c)** Three months after surgery, the right lower eyelid is well-healed with good contour. **(d)** Lateral lower eyelid full-thickness defect. A pentagonal wedge is excised to create parallel cut edges of tarsus prior to closure (purple lines). **(e)** Four weeks postoperative results.

5.3.2 Defects 33 to 50% of the Lower Eyelid

Lateral Internal Inferior Cantholysis

For slightly larger defects or for eyelids with a lesser degree of laxity, a lateral internal inferior cantholysis can be performed to afford several additional millimeters of eyelid length. A small cantholysis can be performed with Westcott scissors with minimal distortion of the lateral canthal skin. Following the cantholysis, placement of a single suture at the lateral commissure may help form a sharp lateral canthal angle.

Lateral Canthotomy/Periosteal Flap

For larger defects with minimal eyelid laxity, a complete lateral canthotomy and inferior cantholysis can be performed to afford additional length and aid in closure of the margin. This is performed with Westcott or Stevens scissors with a slight superior angle to the skin incision to allow the lateral eyelid to be suspended upward to decrease the risk of retraction. If the defect is too large for this to be effective, a periosteal flap can be utilized. After careful dissection down to the lateral orbital rim, a medially based rectangular flap 4 mm in height and a length sufficient to reach the lateral end of the defect is delineated with a surgical marking pen. The flap should be angled superiorly to preserve eyelid height and slightly oversized to compensate for contraction after mobilization from the bone. The flap is incised with a no. 15 blade and elevated with a periosteal elevator until it is hinged on the internal aspect of the lateral orbital rim. It is then flipped over horizontally and sutured to the lateral edge of the tarsus (or posterior lamellar substitute). This procedure allows approximately 5 to 7 mm of additional horizontal eyelid length.[2]

Lateral Advancement Flaps

Defects involving 33 to 50% of the eyelid generally require advancement or rearrangement of adjacent tissues. When either a canthotomy with cantholysis or periosteal flap is not sufficient, a Tenzel semicircular flap may be utilized. This flap was initially described by Dr Richard Tenzel in 1978 and is similar in concept to the classic Mustarde cheek rotation flap, but involves mobilization of the lateral tarsal remnant and canthus with less extensive lateral tissue disruption.[3] Results are improved if there is a periosteal flap or posterior lamellar graft to support the skin-muscle flap, but it is most often used without definitive posterior lamellar support laterally.

Beginning at the lateral commissure, a semicircle arching superiorly is delineated with a marking pen (▶ Fig. 5.7). A small lateral canthotomy with inferior cantholysis is performed and the semicircular

Fig. 5.7 Tenzel semicircular flap. **(a)** Right lower eyelid defect spans approximately 50% of the length of the eyelid. Planned incision shown in dashed lines. **(b)** Immediately after reconstruction, the lower eyelid margin is approximated and semicircular flap is closed. **(c)** Three months after surgery, there is good contour of the lower eyelid with healing lateral scar. **(d)** Second example of 40% left lower eyelid defect. **(e)** Immediately after surgery, the left lower eyelid margin is well-apposed and the semicircular flap is approximated. **(f)** One month after surgery, there is good maintained contour and height of the lower eyelid.

myocutaneous flap is incised with a blade and undermined with Westcott scissors. The flap is undermined until there is minimal tension required to approximate the tarsal edges of the defect, keeping in mind that if the dissection extends beyond the orbital rim, the frontal branch of the facial nerve passes near this area. To be safe, the dissection should be subcutaneous as it extends beyond the orbicularis territory. Two 6–0 silk sutures or 7–0 polyglactin sutures are placed through the margin in a vertical mattress fashion to approximate the tarsus and evert the margin. The tails of these margin sutures are left long so that they can be incorporated into the anterior skin sutures preventing the tails from irritating the ocular surface. The tarsus below the margin is approximated with partial thickness bites using 5–0 polyglactin suture. The lateral canthal angle is reformed with 7–0 polyglactin suture, and the skin closed.

5.3.3 Defects Greater than 50% of Lower Eyelid

Hughes Tarsoconjunctival Flap

Large eyelid defects spanning 50% or more of the total horizontal eyelid length generally require flaps or grafts for successful closure. The Hughes flap, first described in 1976, is an eyelid-sharing procedure wherein a superior tarsoconjunctival flap from the upper eyelid is mobilized into the lower eyelid defect (with a conjunctival bridge providing blood supply) as the new posterior lamella followed by a full-thickness skin graft overlying the flap to create the anterior lamella.[4] It is important to accurately measure the horizontal length of the defect with gentle central traction on both tarsal stumps prior to harvesting the flap. Creation of excess eyelid laxity with a flap that is too wide can result in lower eyelid ectropion.

A disadvantage of this flap is that the conjunctival bridge, which is left attached for 1 to 3 weeks for blood supply to the flap, occludes the visual axis.[5] If a patient is functionally monocular, a Hughes flap may not be the ideal option. In addition, the procedure requires a second stage division, although this is generally accomplished in the office with local anesthesia.

The procedure is begun with eversion of the ipsilateral upper eyelid. A transverse horizontal marking for incision is placed 4 mm superior to the eyelid margin. Retention of the inferior 4 mm of tarsus across the length of the eyelid is important to prevent upper eyelid instability and tarsal kink (▶ Fig. 5.8). The horizontal width of the flap is

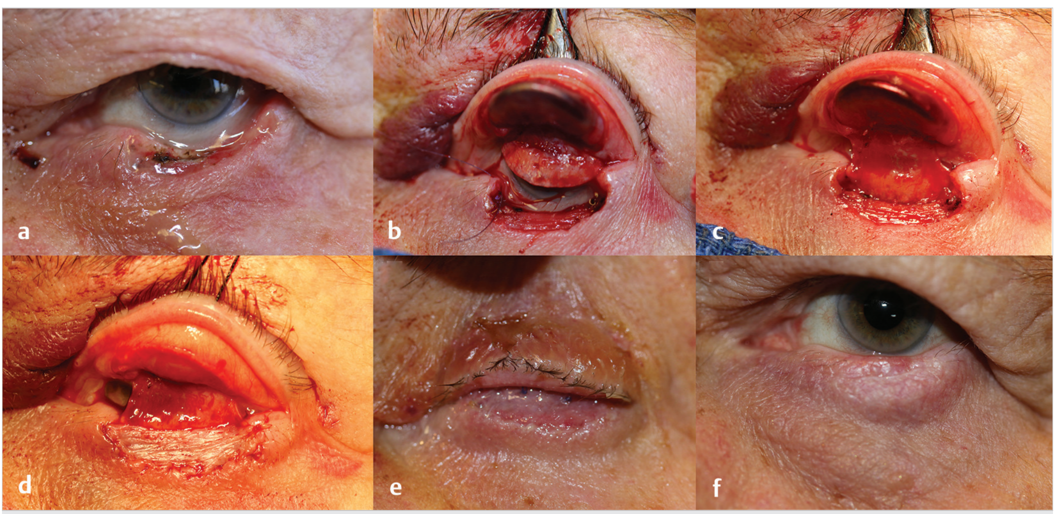

Fig. 5.8 Hughes eyelid-sharing flap. **(a)** Large lower eyelid spanning > 50% of the left lower eyelid. **(b)** Left upper eyelid is everted over a Desmarres retractor and a tarsoconjunctival flap is fashioned leaving approximately 4 mm of tarsus in the upper eyelid. **(c)** The flap is secured into place with 6–0 polyglactin sutures in the margin, 5–0 polyglactin partial thickness tarsal sutures, as well as 6–0 plain gut sutures anchoring the inferior aspect of the flap to the conjunctival fornix. **(d)** An upper eyelid skin graft is harvested from the left upper eyelid and sutured in front of the graft with 6–0 plain gut sutures. **(e)** On postoperative week 3, there is good healing of the left upper eyelid donor site, viable skin graft over the flap, and the flap is divided at this point. **(f)** Postoperative month 3 reveals acceptable contour and height of the lower eyelid.

marked with vertical marks at the medial and lateral ends. A maximum width of approximately 25 mm can be obtained. Dissection is then performed anterior to the flap to disinsert the levator aponeurosis. The incisions on the medial and lateral sides of the flap are carried vertically several millimeters past the superior border of the tarsus, into the conjunctiva, which is still attached to Müller muscle. Then, Müller muscle is hydrodissected from the conjunctiva with infiltration of local anesthetic. Müller muscle can then be sharply dissected and released 3 to 4 mm above the superior edge of the tarsal flap to prevent retraction of the upper eyelid. The tarsal flap with its bridge of conjunctiva is then advanced inferiorly and sutured to the recipient lower eyelid. The tarsal ends are sutured to the recipient tarsal ends on both sides with 5–0 or 6–0 silk or polyglactin suture. All suture ends must be secured away from the ocular surface to prevent corneal abrasions. Next, the inferior conjunctival border of the flap is sutured to the conjunctival edge in the lower eyelid fornix.

The anterior lamellar defect can be closed with a full-thickness skin graft. Full-thickness skin grafts are discussed in detail in Chapter 2. In brief, a template of the defect is transferred to the donor site and an outline is drawn. The graft should be approximately the same size as the defect it will fill. The donor site is infiltrated with local anesthetic containing epinephrine. A blade is used to incise the skin and a plane of dissection is created between the subcutaneous fat and the skin (in donor sites other than upper eyelid) with scissors. After the graft is removed, the graft is flipped over a gloved finger, and a fine scissor is used to remove any fat and subcutaneous tissue that remains. Anchor sutures of 5–0 or 6–0 plain gut or polyglactin are placed to hold the graft in position and a running suture of 6–0 plain gut is used to close the incision lines. After fixation of the skin graft is completed, the eyelid is immobilized with a bolster, Frost suture, or tarsorrhaphy followed by a pressure patch over the eye for 5–7 days. The donor site, if it is the upper eyelid, can be closed with 6–0 plain gut, nylon, or polypropylene. In preauricular, retroauricular or supraclavicular donor sites, the subcutaneous tissues should be approximated with 5–0 polydioxanone or polyglactin deep sutures followed by a cutaneous running suture.

Stage 2 Hughes flap division is performed several weeks after initial placement and as early as 1 to 2 weeks if the tissues are healing well.[5] The upper and lower eyelids are separated approximately 1 to 2 mm above the border of the lower eyelid tarsal flap as it has a tendency to retract following division. The redundant conjunctiva from the upper eyelid can be excised, or a small 2 mm strip may be left attached to the flap and sewn over the newly created eyelid margin to decrease the risk of keratinization. However, this conjunctiva on the margin has the tendency for chronic margin erythema. Bartley et al found that cutting the flap flush with the margin during the second stage rather than advancing the conjunctival flap over the margin yields better results with regard to margin hyperemia.[6] An additional technique to prevent hyperemia of the margin is to apply amniotic membrane to the mucocutaneous junction.[7]

Tarsoconjunctival Graft

This alternative to the Hughes tarsoconjunctival flap is helpful in cases where a patient's eye cannot be obstructed for a prolonged period of time and will only be successful if an anterior lamellar flap can be accessed, either from nearby lower eyelid tissue or from the upper eyelid and transposed onto the lower eyelid with a hinge on the medial or lateral canthus. This procedure is performed in a manner nearly identical to the Hughes procedure except that the flap is completely excised just above the tarsus and includes several millimeters of conjunctiva (▶ Fig. 5.9). The tarsoconjunctival graft may be harvested from the ipsilateral or contralateral upper eyelid. The advantage of an ipsilateral flap is that only one eye is affected by surgery. After securing the tarsoconjunctival graft to the lower eyelid defect as performed for the Hughes flap described above, an anterior lamellar flap is fashioned commonly from the ipsilateral upper eyelid as a transposition flap or from adjacent lower eyelid tissue. A blepharoplasty-like transposition flap is constructed based upon the length and height of the defect. With the medial or lateral aspect of the flap (or both, as in a "bucket-handle" flap) still attached to the eyelid canthus allowing for a blood supply, the flap is rotated inferiorly to cover the anterior lamellar defect anterior to the posterior lamellar graft. If there is no upper eyelid skin available and the defect is in the medial aspect of the lower eyelid, glabellar skin can also be rotated inferiorly, but may require multiple stages to achieve the desired result. These techniques are described in more detail in Chapter 4.

Other tissues and materials that may be used as a posterior lamellar graft for reconstruction of full-thickness lower eyelid defects include hard palate mucosa, auricular cartilage, autologous or donor

Fig. 5.9 Free tarsoconjunctival graft with anterior lamellar flap. **(a)** Large defect encompassing > 50% of the left lower eyelid. **(b)** Immediate postsurgical result after graft and upper eyelid laterally based myocutaneous flap transposed to the lower eyelid. **(c)** Postoperative week 2 results with sutures in place and slight retraction of the lower eyelid. **(d)** Large full-thickness defect involving the medial right lower eyelid. **(e)** Free tarsoconjunctival graft followed by a medially based transposition flap from the ipsilateral upper eyelid. **(f)** No tarsorrhaphy or frost suture is required following this procedure. **(g)** Lateral > 40% full-thickness defect. **(h)** Free tarsoconjunctival graft was harvested from the contralateral upper eyelid and anterior lamella was closed by advancing the skin superiorly and laterally. **(h)** Postoperative week 2 results. **(i)** Postoperative month 3 results.

cadaveric human dermis, or bioengineered grafts. These tissues and materials are not optimal for use in the upper eyelid because of the upper eyelid's constant contact with and motility over the cornea; however, they are useful in the lower eyelid, albeit less optimally than autologous tarsus. Further discussion of these grafts is found in Chapter 2.

5.4 Complications

Many of the complications that occur following lower eyelid repair are attributable to malposition of the lower eyelid, particularly retraction and ectropion. Patients with underlying lower eyelid laxity are particularly at risk; hence, careful intraoperative assessment of laxity is critical in prevention. The lower eyelid may be horizontally shortened via a full-thickness wedge resection or lateral tarsal strip during reconstruction if necessary. In addition, avoidance of downward vertical tension when creating flaps is critical. It is generally best to create a flap from above a defect so that the tissue will be pulled upward during healing. Wound dehiscence may occur in any periocular location while notching and madarosis are specific to the eyelid margin. A common, but undesirable outcome after total lower eyelid reconstruction is chronic erythema and keratinization of the eyelid margin.

Lower eyelid cicatricial ectropion can occur if there is insufficient anterior lamellar support and aside from being aesthetically undesirable, it can result in lagophthalmos and corneal exposure (▶ Fig. 5.10a,b).

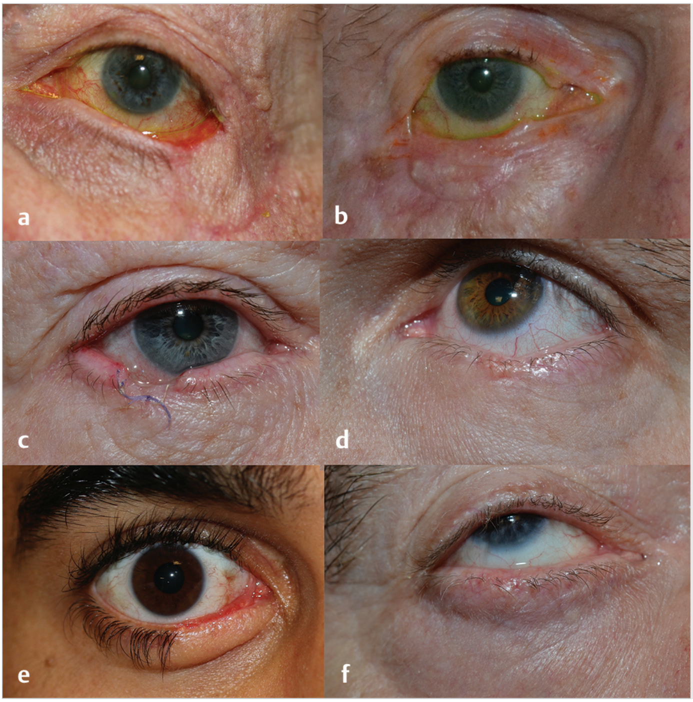

Fig. 5.10 Complications from lower eyelid reconstruction. **(a)** Cicatricial ectropion from excessive scarring following free tarsoconjunctival graft with myocutaneous flap from upper eyelid. **(b)** Eyelid retraction from skin graft contraction, anterior lamellar reconstruction only. **(c)** Dehiscence of margin vertical mattress suture. **(d)** Slight notch in the area of direct marginal closure. **(e)** Red, raw-appearing margin, madarosis, and mild myocutaneous graft hypertrophy after Hughes flap and skin graft. **(f)** Mild madarosis after direct closure of margin defect.

Dehiscence of an eyelid margin suture should be repaired in a timely fashion (▶ Fig. 5.10c). A notch in the margin may occur if there is too much tension on the wound with insufficient eversion of the margin edges initially during repair (▶ Fig. 5.10d). The margin erythema that can result from a Hughes flap or free tarsal graft is difficult to treat. Patients may also have hypertrophy of the anterior lamellar skin graft creating a visible undesirable thickening of the reconstructed area (▶ Fig. 5.10e). Madarosis in an area of graft or flap placement or even primary closure is difficult to avoid when there has been a complete removal of lash follicles in the area during tumor removal (▶ Fig. 5.10f). Epiphora can also be a complication of lower eyelid surgery due to eyelid malposition or from primary destruction of the lacrimal drainage system. Whenever possible, it is best to reconstruct and preserve the lacrimal punctum and canaliculus by placement of a stent. This is described in detail in Chapter 8.

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6 Upper Eyelid Reconstruction

Michael K. Yoon

Summary

The upper eyelid provides the majority of total eyelid movement with eyelid closure and a blink. This emphasizes key points in reconstruction—the upper eyelid must remain mobile by replacing deficient tissue and having thin tissue that does not restrict that mobility. Like the lower eyelid, both the anterior and posterior lamellae must be replaced when removed. Fortunately, the upper eyelid has more inherent redundant tissue that can be recruited for advancement, transfer, or grafting. The brow, which is in continuity with the eyelid below and forehead above, should be reconstructed respecting the orientation and presence of the cilia while avoiding damage to deeper facial nerve fibers.

Keywords: upper eyelid, eyebrow, reconstruction, skin graft, tarsus, Cutler-Beard

6.1 Introduction

The upper eyelid shares many similarities to the lower eyelid with regard to anatomic structures and principles of reconstruction. The tarsus, orbicularis oculi muscle, skin, and lacrimal drainage system are relatively analogous with the lower eyelid. However, the upper eyelid has greater excursion with eyelid blink and closure, making its ability to move more important than that of the lower eyelid. This key difference plays an important role in the reconstruction of upper eyelids after excision of cutaneous malignancies.

The tarsus of the upper eyelid is approximately 10 mm vertically at its highest point, in contrast to 4 mm in the lower eyelid. This additional upper eyelid tarsus can be utilized in the reconstruction of other eyelids. The skin of the upper eyelid is generally more plentiful compared to the lower eyelid, allowing for rearrangement, advancement, or grafting. The eyebrow, which is a continuum of the upper eyelid, has cilia that maintain a specific orientation that requires consideration during reconstruction. Preserving the innate anatomy while utilizing possible donor sites will maximize functional and cosmetic results.

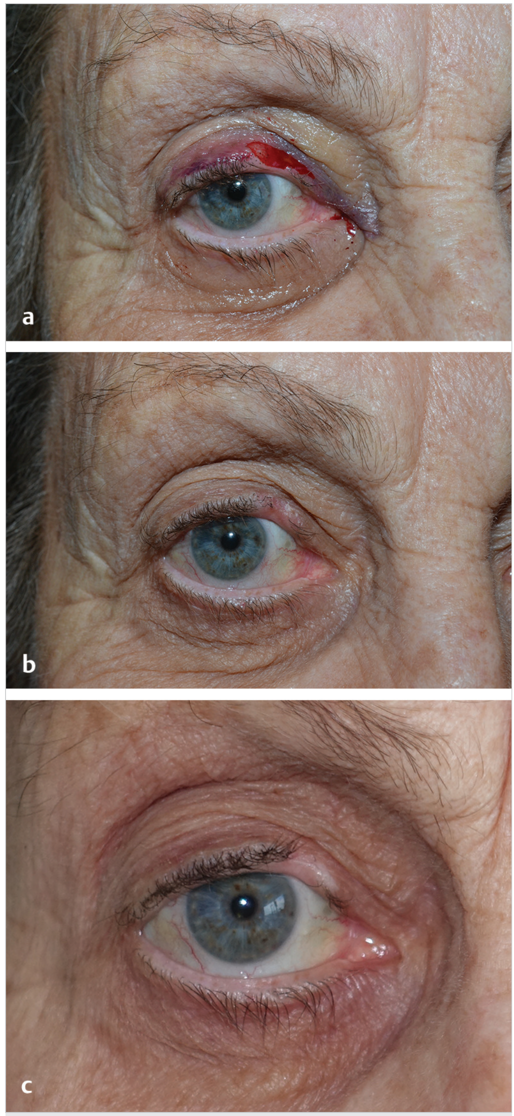

Fig. 6.1 Secondary intention granulation. **(a)** Due to a relatively small defect and patient preference, the area was left to granulate. **(b)** Although only 3 weeks after the excision, it has healed with an excellent outcome. **(c)** After 8 months, the area is well healed. There is a gap in the eyelash line. This could be repaired via a pentagonal wedge excision, although the patient declined.

6.2 Anterior Lamellar Defects

6.2.1 Secondary Intention Healing

Small defects in the upper eyelid can be allowed to heal by secondary intention. While there is no strict cutoff for size, defects less than 5 mm in size may granulate with minimal risk of eyelid retraction or unacceptable scar (▶ Fig. 6.1, ▶ Fig. 6.2). Larger areas have been allowed to heal by secondary intention with good result (▶ Fig. 6.3). Lesions near the margin but not involving the tarsus are good candidates for granulation. Contraction of these defects could result in eyelid retraction and/or lagophthalmos, resulting in a need for surgical revision.

6.2.2 Primary Closure (Not Involving Margin)

When there is anterior lamellar tissue (skin and orbicularis muscle) missing but the posterior lamella (tarsus) is present, direct closure can be attempted. With the innate redundancy and laxity of upper eyelid tissues in many patients, direct closure may be possible for small- or medium-sized defects. Although not as critical as in the lower eyelid, eliminating vertical tension is preferred to prevent retraction or ectropion resulting in ocular exposure. Therefore, any tension vectors created during reconstruction should be oriented horizontally. Skin and orbicularis oculi muscle may need to be undermined then advanced if additional tissue mobility is needed to reduce wound tension.

6.3 Cutaneous or Myocutaneous Flaps

6.3.1 Upper Eyelid Crease

Placement of incisions in the upper eyelid crease can be useful during reconstruction. In most patients, this crease is readily visible as a dominant fold in the upper eyelid skin. The advantages of incising along a preexisting anatomic landmark that

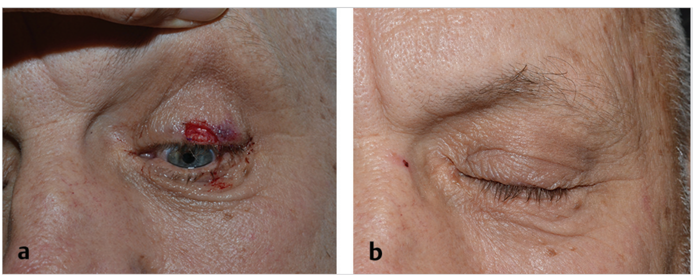

Fig. 6.2 Secondary intention granulation. **(a)** This small defect was allowed to heal by secondary intention. **(b)** One month after the excision, it has healed well with a normally positioned eyelid and margin.

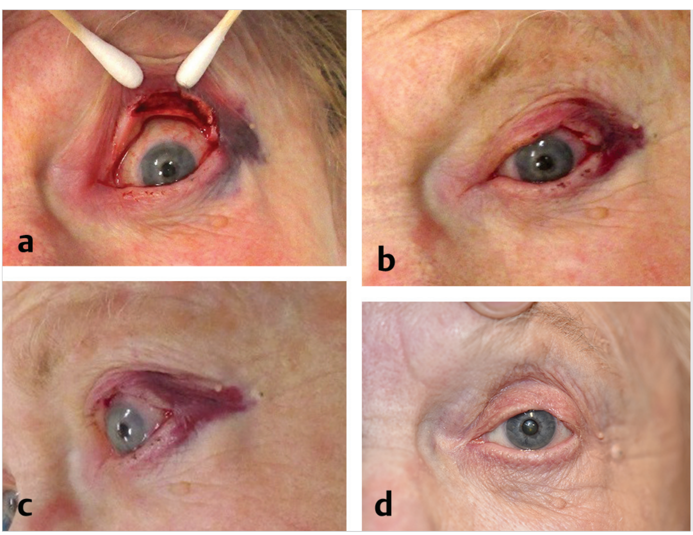

Fig. 6.3 Secondary intention granulation. **(a)** A large full thickness defect in the lateral portion of the upper eyelid. The patient declined reconstruction. **(b)** One week after Mohs excision, the wound edges have healed. **(c)** Oblique view 1 week after Mohs excision. **(d)** Three months later, the eyelid is in good position, although there is a broad notch in the eyelid margin with missing eyelashes. (Courtesy of Daniel Lefebvre, MD.)

Fig. 6.4 Sliding flaps. **(a)** Basal cell carcinoma of the medial left upper eyelid prior to biopsy. **(b)** Immediately following excision, the defect is visualized. **(c)** In planning the reconstruction, the planned incision lines are drawn in. The upper eyelid crease is incised. The skin superior to the crease is undermined and advanced medially. **(d)** One month after surgery. **(e)** Six months after surgery.

heals well in a generally hidden location are obvious. While an incision in this location does not guarantee a perfect result, it can minimize the risk of abnormally placed or multiple eyelid creases. This technique may be employed effectively for medial upper eyelid defects (▶ Fig. 6.4).

6.3.2 "O → T" Flap

When direct closure cannot be completed, advancement flaps may be necessary. One common approach to gaining laxity for closure involves making a horizontal relaxing incision at the superior or inferior end of the defect (the "O"). This flap is created by undermining in the subcutaneous plane medial and lateral to the defect until sufficient laxity is gained to advance the tips of the flaps toward each other. The flaps are sutured to each other with interrupted sutures to distribute any tension across multiple points of fixation. Then the relaxing incision (i.e., eyelid crease) is closed in a running or interrupted fashion. The final appearance of the closed incision lines looks like a "T" (or inverted "T" if the relaxing incision is at the inferior end of the defect) (▶ Fig. 6.5, ▶ Fig. 6.6).

6.3.3 Sliding Flaps

Similar to the O → T closure, sliding flaps recruit tissue from medial and lateral to the defect that are advanced toward each other. These flaps, however, consist of two parallel horizontal incisions that should be oriented parallel to the eyelid margin. Examples include an incision along the supraciliary line and eyelid crease or eyelid crease and sub-brow line (▶ Fig. 6.7, ▶ Fig. 6.4). In some cases, such as a very medial defect, a sliding flap that is limited to one side of the defect can be performed, since medial canthal skin is thicker and has less laxity than the upper eyelid (▶ Fig. 6.8).

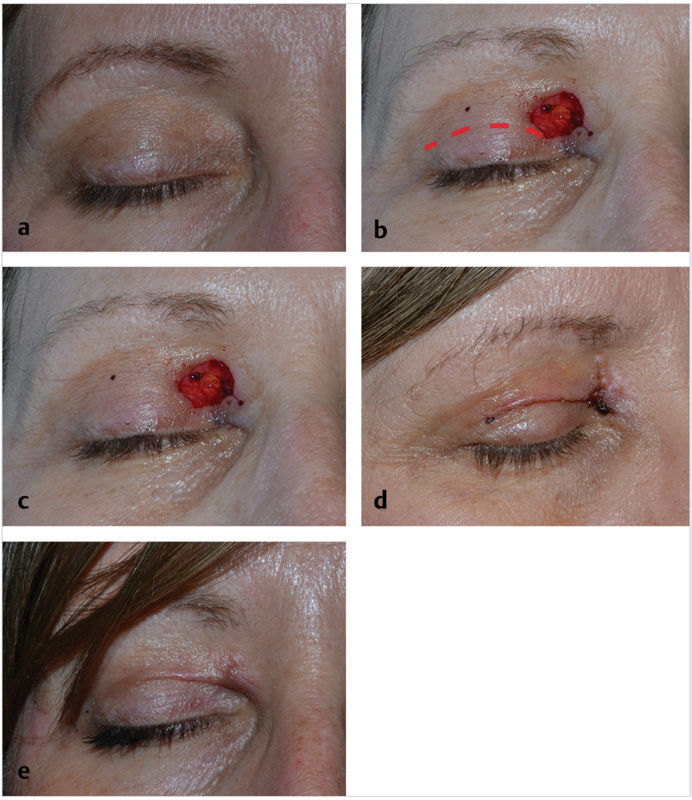

Fig. 6.5 O to T reconstruction. **(a)** Basal cell carcinoma of the medial right upper eyelid prior to biopsy. **(b)** Immediately after Mohs excision, there is a large medial upper eyelid defect. **(c)** Planning the reconstruction, the eyelid crease is immediately adjacent to the inferior edge of the defect. By incising the eyelid crease, the skin superior the crease can be undermined and advanced medially. **(d)** One week after surgery, the area is healing well with some dried blood in the incision line. **(e)** One month after surgery, there is slight edema and erythema along the incision, but is healing without a hypertrophic scar.

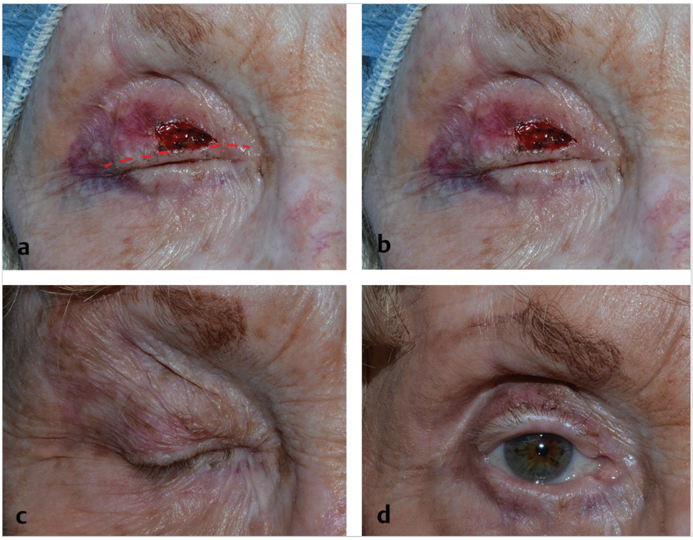

Fig. 6.6 O to T reconstruction. **(a)** After excision, there is an anterior lamellar defect sparing the eyelashes. **(b)** An O to T reconstruction with a supraciliary incision can be performed. The incision extends medial and lateral to the original defect. The skin is undermined and the two edges are advanced toward each other. They are approximated with interrupted 6–0 plain gut sutures. Then the supraciliary incision is closed with the same suture in a running fashion. **(c)** One month after surgery, there is excellent reapproximation of the skin. **(d)** With the eyelids open, mild flaking on the skin is visible.

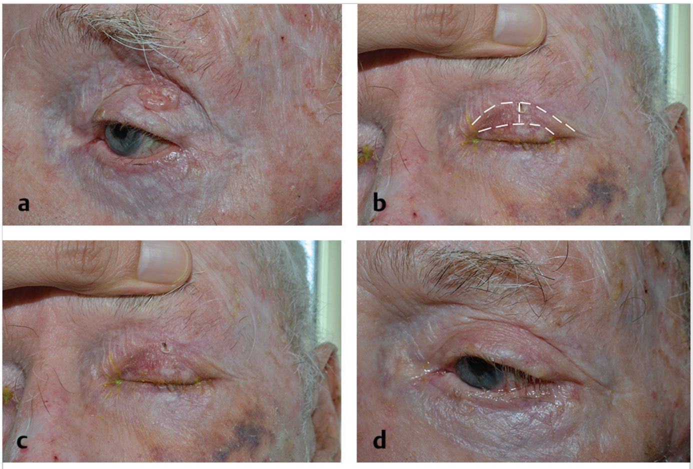

Fig. 6.7 Sliding flaps. **(a)** Squamous cell carcinoma of the left upper eyelid. **(b)** One week after reconstruction, the eyelid is healing well. At the superior and inferior ends of the defect, relatively parallel curvilinear lines were drawn and incised. The skin was undermined to allow for advancement. The medial and lateral flaps were advanced toward each other and sutured with interrupted 6–0 plain gut sutures. The horizontal incisions were closed with 6–0 plain gut running sutures. **(c)** Same image as in B without the markups. **(d)** Six weeks after surgery, the eyelid is healed well with imperceptible incision lines.

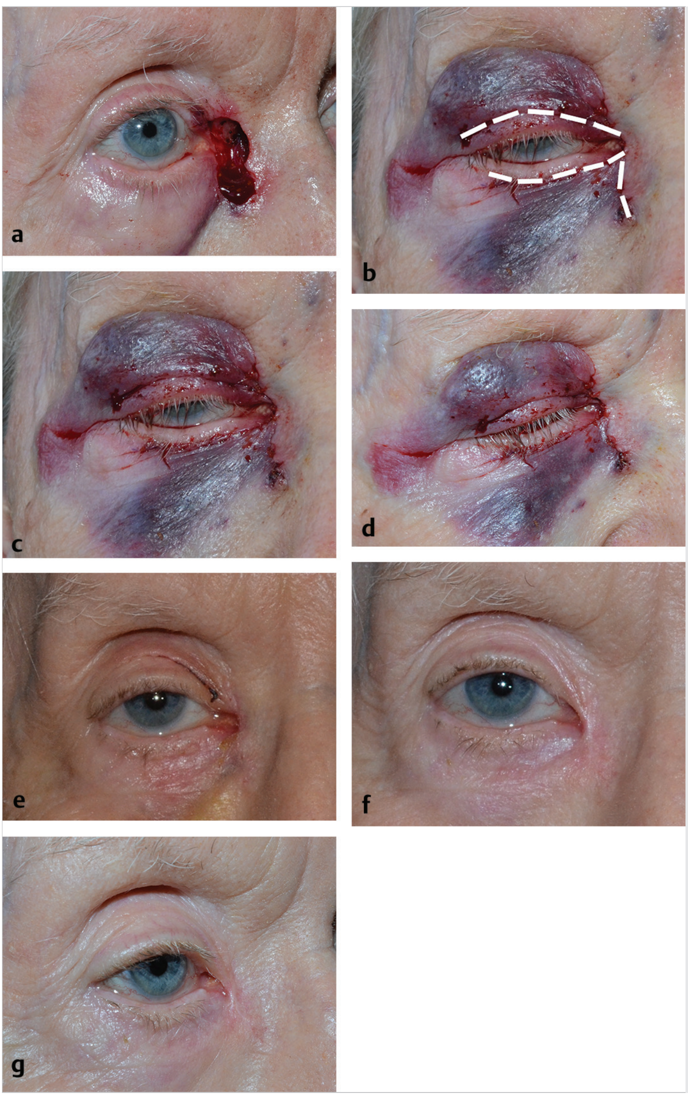

Fig. 6.8 Sliding flaps. **(a)** Following excision, there is a large defect of the medial upper and lower eyelids. **(b)** Immediately after reconstruction, the reconstruction can be visualized. The upper eyelid crease was incised and undermined. That flap was advanced medially and sutured. In the lower eyelid, a subciliary incision was made and a skin-muscle flap was advanced medially. **(c)** Same image as in B without the markups. **(d)** Oblique view immediately post-operatively gives a higher magnification view of the reconstruction. **(e)** Two weeks after surgery. There is mild ptosis, but otherwise healing well. **(f)** Three months after surgery, the eyelid and medial canthus are in excellent position. **(g)** Oblique view 3 months after surgery demonstrating the medial canthus has healed without a web or scar.

6.3.4 Semicircular Flap

For medium-size anterior lamellar defects, particularly in the lateral portion of the eyelid, a lateral semicircular advancement flap can be an excellent choice.[1] Analogous to use in the lower eyelid, this flap is drawn as a continuity of the upper eyelid like an inverted mirror image. The curvilinear incision should be continued downward toward the cheek then upward toward the temple. The length of the flap should be customized based on the laxity of skin and size of defect. Once drawn, a cutaneous or lipocutaneous flap can be elevated and undermined. After advancement into the area of the defect, it is sutured into place with a combination of interrupted sutures to anchor it into place (e.g., 5–0 nylon, polypropylene, or gut) and a running suture in the temple. In the lateral canthal region, this anterior lamellar dissection should not affect the lateral canthal tendon. During wound closure, an interrupted suture is placed at the lateral canthal periosteum to anchor the flap and prevent abnormal skin folds in this area. Precaution should be taken in the temple to remain in the subcutaneous plane to prevent injury to the facial nerve, which runs deep to the temporoparietal fascia. In the temple and cheek, unlike the eyelid, there is subcutaneous fat. Staying above or within this fat layer will maintain a safety margin away from the nerve (▶ Fig. 6.9, ▶ Fig. 6.10).

6.3.5 Glabellar Flap

Glabellar flaps are useful for defects limited to the medial aspect of the upper eyelid. See Chapter 4 on medial canthal reconstruction for further description.

6.3.6 Other Rotational Flaps

A variety of rotational flaps can be used in the upper eyelid (e.g., rhomboid and bilobed). These are generally not necessary, as the thinner eyelid skin is more easily stretched compared to the forehead or cheek. However, they can be employed successfully, particularly for the medial and lateral aspects of the upper lid, using the standard design recommendations in Chapters 4 and 7.

6.4 Full-Thickness Skin Graft

Skin grafts to the upper eyelid are not commonly needed because of the extensibility of the upper eyelid skin. However, if the defect is too large to be closed with flaps, full-thickness skin grafts can be useful alternatives. As always, it is useful to replace deficient skin with similar skin, making skin from the fellow upper eyelid the best match. This match is important for function, as the thin skin allows for rapid blinking and does not induce eyelid malposition as it may if thicker skin is used. If there is

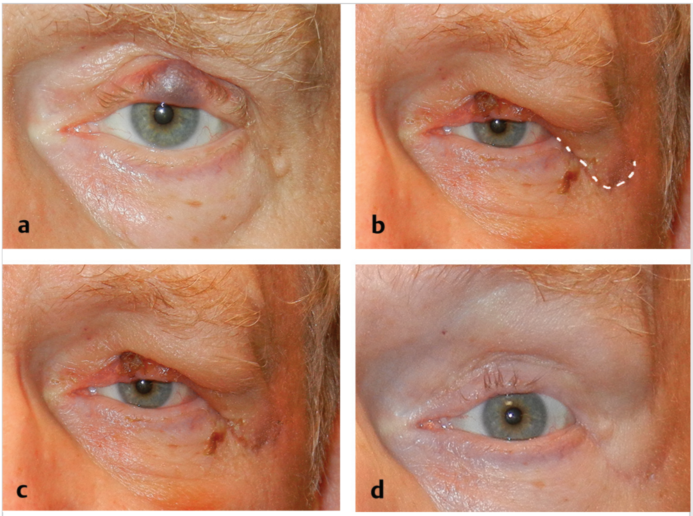

Fig. 6.9 Semicircular flap. **(a)** Melanoma metastasis to the left upper eyelid prior to biopsy. **(b)** Following Mohs excision of a melanoma metastasis, there was a large full thickness defect affecting the lateral half of the eyelid. The posterior lamella was not reconstructed. Then the anterior lamella was advanced medially via a semicircular flap. An incision starting from the lateral canthus was extended as a semicircle toward the temple. It was advanced medially and sutured to the medial end of the defect. **(c)** One week after surgery, the eyelid is already healing well. There is moderate edema, but the eyelid position and apposition are excellent. **(d)** Four months after surgery, the eyelid is healed well with excellent upper eyelid position and contour. The lateral 40% of the eyelid has post-excision madarosis.

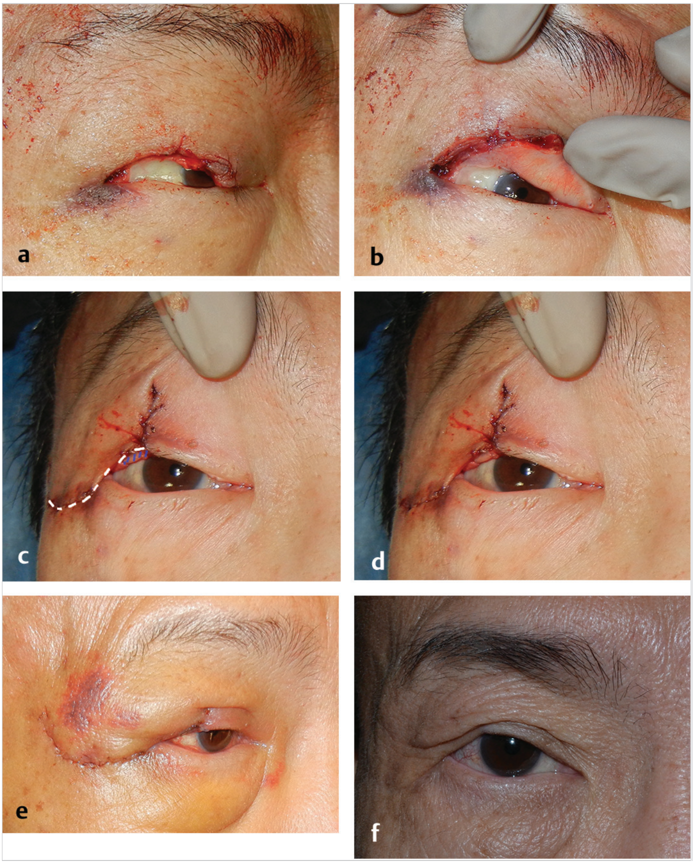

Fig. 6.10 Semicircular flap. **(a)** Following excision of a Merkel cell carcinoma of the right upper eyelid by Mohs micrographic surgery, the lateral 75% of the eyelid is missing. **(b)** Eversion of the eyelid demonstrates an oblique angled defect of the tarsus. **(c)** Immediately following completion of surgery, the steps of reconstruction are visualized. The posterior lamella was reconstructed with a tarsoconjunctival graft from the contralateral eyelid (shaded in blue). The anterior lamella was formed by a semicircular flap that was advanced medially. **(d)** Same image as C without markings. **(e)** One week after surgery, the eyelid is healing well with mild edema and resolving ecchymosis. **(f)** Seventeen months after surgery, the eyelid height is excellent. There is a small peak at the junction of the residual tarsus and tarsal graft in the lateral 1/3 of the eyelid.

insufficient fellow upper eyelid skin, other favorable donor sites include retroauricular, preauricular, and supraclavicular areas (▶ Fig. 6.11, ▶ Fig. 6.12, ▶ Fig. 6.13, ▶ Fig. 6.14).

Skin grafts are often slightly oversized compared to the size of the defect by approximately 20%. When using the upper eyelid as a donor site, the maximum size of graft that can be harvested depends on the redundancy and laxity of the skin. First, the eyelid crease is marked across the eyelid. A “pinch test” is performed to assess the amount of skin that can safely be removed, allowing for complete eyelid closure. Using fingers or Jaffe forceps, redundant upper eyelid skin is “pinched” and marked at the point when the upper eyelashes start to rotate. Although some surgeons will excise the graft with a high temperature cautery or unipolar cautery, Westcott scissors may be best to prevent thermal contraction and damage to the graft. The donor site is closed with running suture.

When inspecting the region for a retroauricular skin graft, a naturally occurring skin crease where the auricle meets the scalp is seen. This junction is marked with a curvilinear line. A crescent or spindle-shaped graft is created by drawing curvilinear lines equidistant from the central axis (e.g., 5 mm anterior and 5 mm posterior to the junction). The resultant graft can be incorporated nicely into most eyelid defects (▶ Fig. 6.15).

When harvesting preauricular skin grafts, areas of skin without visible hairs should be used to prevent the need for grooming the graft on the eyelid. This area should be carefully inspected in both men and women. In addition, dissection should not pass the subcutaneous fat layer to avoid the facial nerve branches and major vessels.

Fig. 6.11 Full thickness skin graft repair. **(a)** Following excision of a squamous cell carcinoma, there is a large defect of the lateral half of the upper eyelid affecting just the anterior lamella. **(b)** Due to the large defect and the need for thin skin to reconstruct the eyelid, a full thickness skin graft from the fellow upper eyelid was harvested. Due to the substantial dermatochalasis that was present, a large skin graft could be acquired. **(c)** An oblique view demonstrates intact eyelashes and brow hairs, and the graft does not have any tension on it. **(d)** Three months after surgery, the left upper eyelid has healed well with a natural appearance. The right upper eyelid has a typical post-blepharoplasty appearance. **(e)** With eyelid closure, the full graft and donor sites are visible with imperceptible incision lines.

6.5 Full Thickness Defects

6.5.1 Primary Closure Involving Margin (i.e., Pentagonal Wedge)

When there is an upper eyelid defect affecting the eyelid margin, including tarsus, then simple primary closure is not possible. The tarsus serves as the skeleton of the eyelid. Therefore, a partial vertical height tarsal notch cannot be repaired as a simple closure, as the rigidity of the tarsus will create substantial distortion of the eyelid. Repair of these defects requires complete excision of the affected tarsus with creation of straight vertical edges on both sides, allowing for perfect apposition of the intact remnants of tarsus.

This approach, called a “pentagonal wedge” resection, creating straight vertical margins on both sides, must be performed to remove the irregular, affected tarsus, and then repaired in the same manner in which a full-thickness laceration would be repaired. First, the medial and lateral ends of the tarsal defect are assessed. The laxity and quantity of the remaining eyelid tissue dictates the feasibility

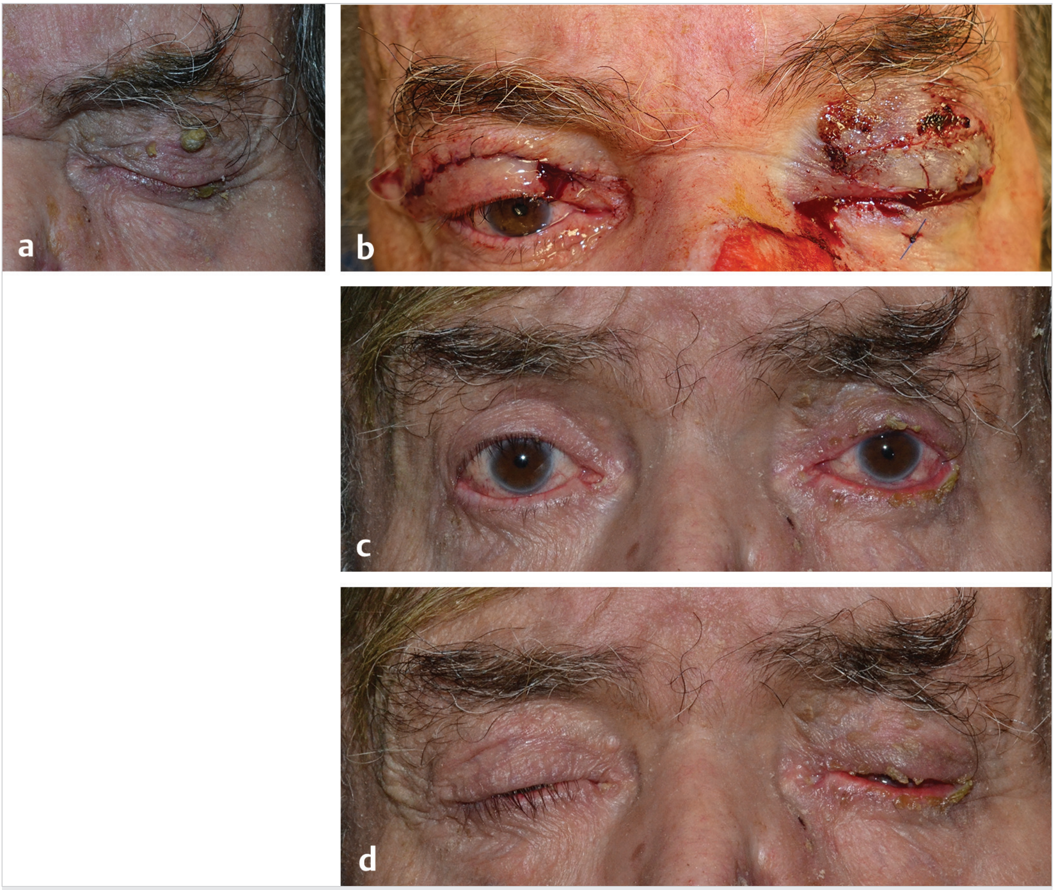

Fig. 6.12 Full thickness skin graft repair. **(a)** Large squamous cell carcinoma of the left upper eyelid prior to biopsy. **(b)** Immediately after reconstruction. A large defect was in the upper eyelid above the eyelid crease and below the brow cilia. Due to its size and involvement of only the anterior lamella, a full thickness skin graft from the fellow upper eyelid was performed. Due to the possible contraction of the graft, a temporary central tarsorrhaphy was placed. **(c)** Six weeks after reconstruction, the eyelids have healed well. The donor site is natural in appearance. **(d)** There is no lagophthalmos on either side, and the incision lines are imperceptible. There is some dried mucoid material on the surface of the skin.

of this technique. Grasping the medial and lateral ends of the marginal tarsus and pulling them together to see if these ends can appose each other without significant tension verifies sufficient tissue.

Next, the eyelid is everted. This can be assisted with a traction suture through the unaffected eyelid margin. Two parallel vertical incisions are made at the medial and lateral ends of the margin defect perpendicular to the eyelid margin. These are extended from the margin to the superior edge of the tarsus. A horizontal incision is made through the conjunctiva above the superior end of the tarsus. Of note, the presence of the peripheral vascular arcade in this area can result in brisk bleeding, which must be adequately cauterized. The remaining attachments of the tarsus are now the anterior lamella (i.e., skin and orbicularis). These should be dissected free from the anterior face of tarsus. Then the tarsus is reapproximated. Classically, a vertical mattress silk or polyglactin suture is passed to appose the two sides of the tarsus at the margin. Additional interrupted sutures are placed through the gray line or eyelash line as needed. The tarsus above the margin is then closed with partial thickness sutures. Finally, the skin is closed directly with horizontally oriented sutures, if possible, or with advancement flaps as described previously. The ends of the margin sutures are tied away from the globe into the adjacent skin sutures to prevent them from abrading the cornea (▶ Fig. 6.16, ▶ Fig. 6.17, ▶ Fig. 6.18).

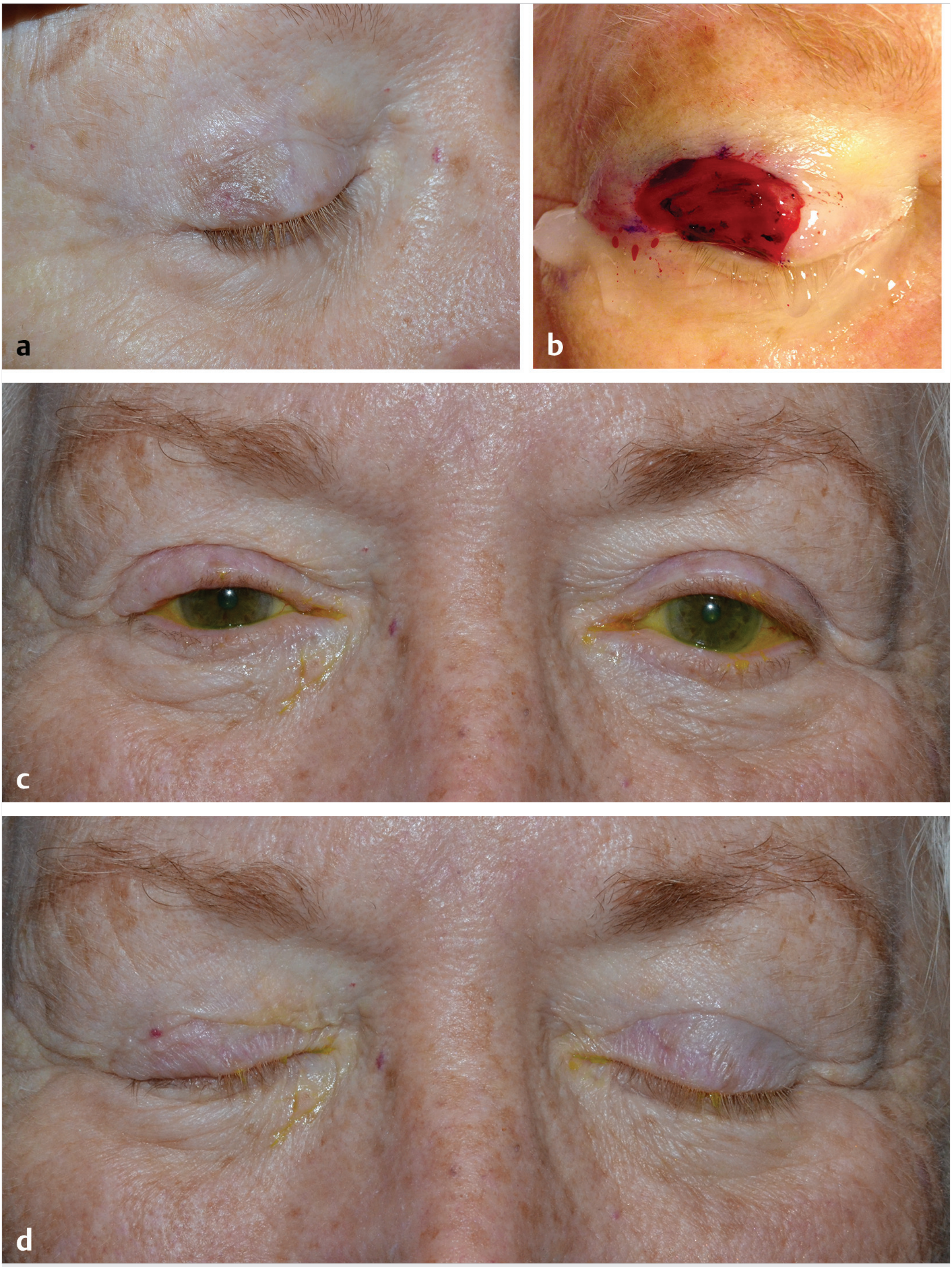

Fig. 6.13 Full thickness skin graft repair. **(a)** Lentigo maligna of the lateral right upper eyelid. **(b)** Immediately after excision, there is a skin defect with excision of the eyelashes. Copious ointment has been applied to the area. **(c)** Two months after surgery, the surgical site is inconspicuous. **(d)** With eyelid closure, the donor and recipient sites are well healed. There is a small hemangioma of the right upper eyelid.

Fig. 6.14 Full thickness skin graft repair. **(a)** A large squamous cell carcinoma of the lateral right upper eyelid measuring 1.2 × 2.0 cm. **(b)** Following six stages of Mohs excision, the defect measured 2.7 × 4.2 cm and extends from the eyelashes up to the brow. **(c)** One month after surgery, the donor and recipient sites are not visible with eyelids open. **(d)** With eyelid closure, the graft is natural in contour and position with slight hyperpigmentation. The donor site is imperceptible.

Fig. 6.15 Retroauricular full thickness skin graft harvest. **(a)** Example of the retroauricular skin graft after incision has been made. **(b)** Three months after surgery, the donor site is imperceptible.

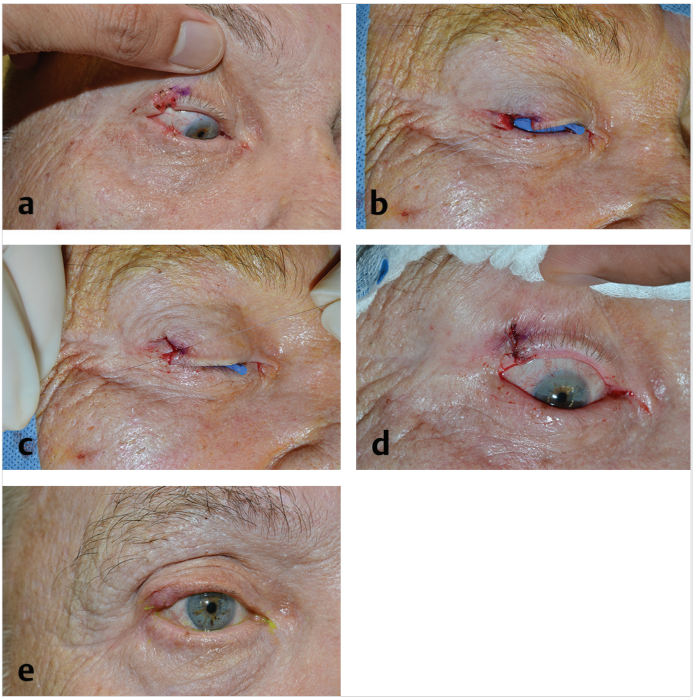

Fig. 6.16 Pentagonal wedge. **(a)** Immediately after excision of a right upper eyelid basal cell carcinoma, a small partial thickness defect of the margin including the tarsus is present. Due to the partial tarsal defect, direct closure is not possible. **(b)** A wedge-type resection must be performed. The anterior lamella can be preserved, but the tarsus must be excised with two parallel incisions through the tarsus and conjunctiva perpendicular to the margin. **(c)** There are several methods to close margin defects. However, a common technique is to place a vertical mattress through the tarsus which achieves margin wound eversion. **(d)** Immediately at the end of the procedures, the margin is reconstructed and wound eversion at the margin is well visualized. **(e)** Two weeks after surgery, sutures can be removed, and the area is healing well. Residual wound eversion will resolve over the next 2 weeks.

Defects Involving 30 to 50% of the Upper Eyelid

Lateral Internal Cantholysis

When evaluation of the eyelid laxity demonstrates that direct approximation (via the wedge-type excision and closure) is not possible, additional measures can be taken to create laxity. The simplest is to perform an internal cantholysis at the lateral canthus. This can be done without a canthotomy. Medial canthotomy is not advised, as this would cause lacrimal canalicular injury.

To perform an internal cantholysis, after infiltration with local anesthetic, scissors are placed to

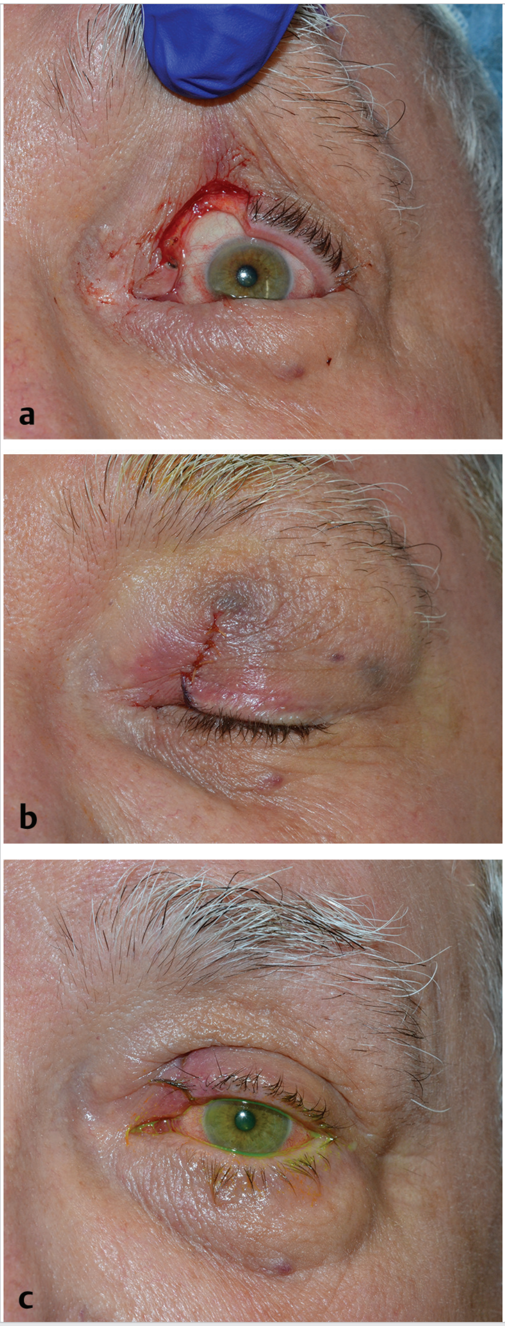

Fig. 6.17 Pentagonal wedge. **(a)** There is a large pentagon-shaped defect in the left upper eyelid. There is sufficient remaining eyelid and laxity for direct closure. **(b)** Immediately after reconstruction, the eyelid is well approximated with eversion of the margin incision. **(c)** Two weeks after surgery, the eyelid is healing well. The margin eversion will flatten to a normal contour over the next few weeks.

cut the deep surface of the lateral upper eyelid without cutting skin. Sometimes several snips are needed to completely sever the lateral canthal tendon. After closure of the primary defect, the internal cantholysis site should not require any suture closure.

Lateral Canthotomy/Periosteal Flap

When defects are even larger, and more laxity is needed, a periosteal flap can be utilized to provide additional tissue. This flap is generally utilized in lateral upper eyelid defects where direct approximation of the lateral end of tarsus to the periosteum is not possible. Using periosteum of the external aspect of the lateral orbital wall can provide up to 10 mm of additional tissue. Periosteum is durable and does not stretch, making it a firm anchoring point for the lateral eyelid. As it is a relatively smooth substance, the periosteum can contact the ocular surface directly without risk of abrasion or irritation.

The periosteal flap is initiated with a lateral canthotomy. This canthotomy incision should be approximately as long as the intended length of the flap. Blunt dissection is performed through the orbicularis oculi muscle to the periosteum of the lateral orbital rim. Additional blunt dissection is extended laterally on the periosteal surface on the lateral face of the lateral orbital rim. The flap should be designed to span the lateral orbital rim to the lateral aspect of the remaining tarsus while the eyelid is on lateral stretch. This distance should be measured with calipers. Erring on the side of making a larger flap is recommended, as small amounts of flap laxity will dissipate with time. The periosteal flap should be marked to be the same distance lateral to the rim and 4 mm in vertical height. The flap is designed with the base of the flap at the medial end. The periosteum can be incised with a scalpel or a sharp periosteal elevator. The flap is elevated and reflected medially. Then the lateral end of the tarsus is sutured to the flap using one or two interrupted sutures. Care should be taken to place suture knots on the superficial surface of the flap to minimize the risk of corneal or conjunctival abrasion. With the posterior lamella being reconstructed, the anterior lamella can be reconstructed using any of the previously described techniques (see Chapter 7, Fig. 7.6).

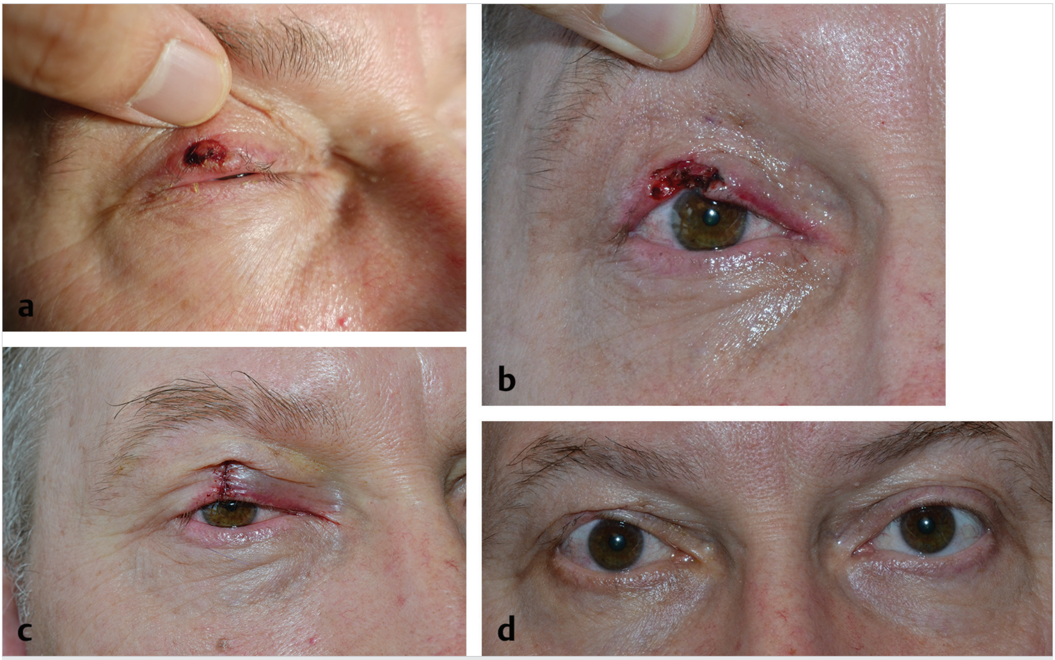

Fig. 6.18 Pentagonal wedge. **(a)** A basal cell carcinoma is present on the central right upper eyelid. There is central ulceration and madarosis. **(b)** Following Mohs micrographic surgery, there is some tarsus missing. Reconstruction would require wedge-type excision of the tarsus with two parallel incisions made through the tarsus from the margin to the superior tarsal border. **(c)** One week after reconstruction, the eyelid is well approximated with good margin eversion. Sutures are removed at 2 weeks to allow for wound integrity to strengthen. **(d)** Four months after reconstruction, the eyelid is in excellent position with minimal retraction of the upper eyelid.

Lateral Advancement Flap (Lateral Canthotomy/Cantholysis + Semicircular Skin Flap)

Another method of replacing anterior and posterior lamella is a lateral semicircular advancement flap. While described as a “Tenzel flap” for lower eyelid reconstruction, the principles for the upper eyelid are identical. This technique is useful in cases of medium to large lateral upper eyelid defects of the anterior and posterior lamellae.

This flap is designed similar to the semicircular flap described earlier. An inverted mirror image of the upper eyelid curvature is drawn in the temple region. After infiltration with local anesthetic, the skin along the marked area is incised. A myocutaneous flap (in the area overlying the eyelid) or cutaneous flap (in the area of the temple) is fashioned with careful dissection. Care should be taken to avoid dissection deep to the temporoparietal fascia where the facial nerve branches lie. Sufficient undermining is achieved when the anterior lamella can be mobilized medially to close the anterior lamellar defect. Next, the posterior lamellar closure can be initiated. A small lateral canthotomy incision is made followed by a superior cantholysis (▶ Fig. 6.19).

At this point, the posterior lamella is reapproximated. The lateral end of the defect is sutured to the lateral canthal stump, which was released with the cantholysis. If there is some tarsus remaining laterally (medial to the cantholysis), the margin and tarsus are approximated as with wedge-type closure (i.e., vertical mattress suture through the margin and interrupted partial-thickness suture through the tarsus). If there is no lateral tarsus available, direct closure with interrupted suture is performed through the lateral canthal tendon and the remaining tarsus. Care should be taken to prevent abrasion of the ocular surface with this suture.

The anterior lamella can now be sutured into place. Similar to other closures, the advanced skin/muscle is mobilized and sutures oriented

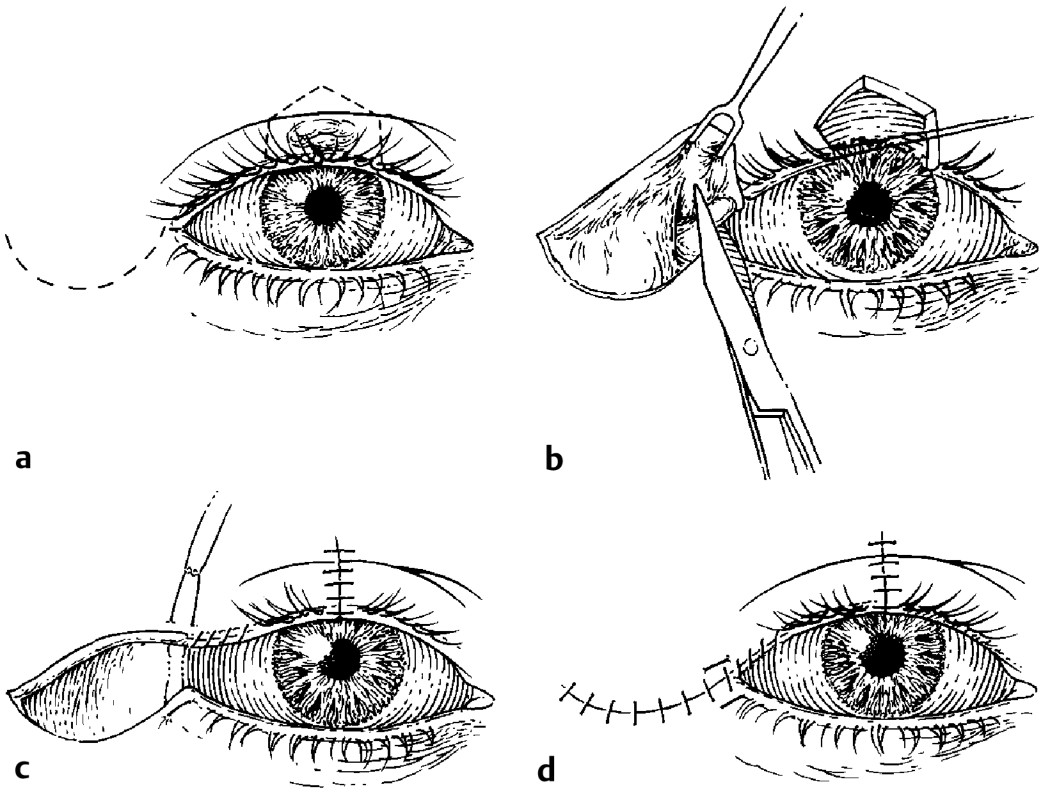

Fig. 6.19 **(a)** Reversed semicircular flap of Tenzel can be used to repair a potential upper eyelid defect. **(b)** After excision of eyelid lesion, a semicircular flap is fashioned with facilitation of a superior cantholysis. **(c)** Upper eyelid defect is closed. Lateral segment of lower lid or lateral portion of inferior tarsus is anchored to external periosteum near lateral orbital tubercle. This suture may be externalized and helps anchor lateral portion of upper lid to lateral orbital rim. **(d)** Completion of closure of semicircular flap. (From Chen W. Oculoplastic Surgery: The Essentials. 1st ed. New York: Thieme Medical Publishers; 2001.)

horizontally to limit vertical tension. Interrupted sutures help distribute tension and align the skin. Care should be taken at the lateral canthus to align the lower eyelid canthal tendon to the new upper eyelid lateral canthus. An interrupted suture can tether these together and can help create a naturally sharp lateral canthal angle.

6.5.2 Tarsoconjunctival Graft

While rarely used in isolation, the tarsoconjunctival graft is a key reconstructive tool that is an ideal posterior lamellar replacement. It is most often harvested from the contralateral upper eyelid, and provides conjunctiva-covered material that incorporates perfectly into the newly reconstructed eyelid. As an autologous graft, it undergoes minimal contraction after placement. If absent, the anterior lamella must be replaced using a vascularized flap (random, vessel-based, or free) to provide blood supply to the tarsoconjunctival graft.

To harvest the graft, the donor eyelid is selected. A 4–0 silk traction suture is placed through the eyelid margin and the lid is everted over a Desmarres retractor. Calipers are used to mark at least 4 mm from the eyelid margin. This leaves up to a vertical height of 6 mm of tarsus that can be harvested. The horizontal length of tarsus to be harvested is determined by measuring the width of the deficient posterior lamella in the eyelid to be reconstructed. However, this measurement should be made with mild tension holding the medial and lateral ends of the defect together to prevent too large a graft causing excessive laxity. The horizontal width of tarsus to be harvested is marked on the donor tarsus using calipers, and the tarsus is incised with an 11 or 15 blade scalpel. Westcott scissors are then used to dissect the levator aponeurosis from the anterior face of tarsus. Once the superior edge of tarsus is reached, the conjunctiva in this area is dissected free from the overlying Muller muscle. A 2-mm "skirt" of additional conjunctiva superior to the tarsus is left attached and harvested with the tarsal graft. The donor site does not need closure, although meticulous hemostasis is essential, particularly along the peripheral vascular arcade (▶ Fig. 6.20).

The recipient eyelid should be prepared. The medial and lateral ends of the defect should be trimmed, if necessary, so the tarsal edges are perpendicular to the eyelid margin. The graft is oriented so the "skirt" of conjunctiva is at the newly constructed eyelid margin. The graft is sutured into place with vertical mattress sutures at the margin and partial thickness sutures medially and laterally through the tarsus. The anterior lamella can then be reconstructed with a vascularized flap of the surgeon's choice. The "skirt" of conjunctiva is draped over the margin and is sutured to the skin flap to prevent keratinized skin growing posteriorly and abrading the ocular surface.

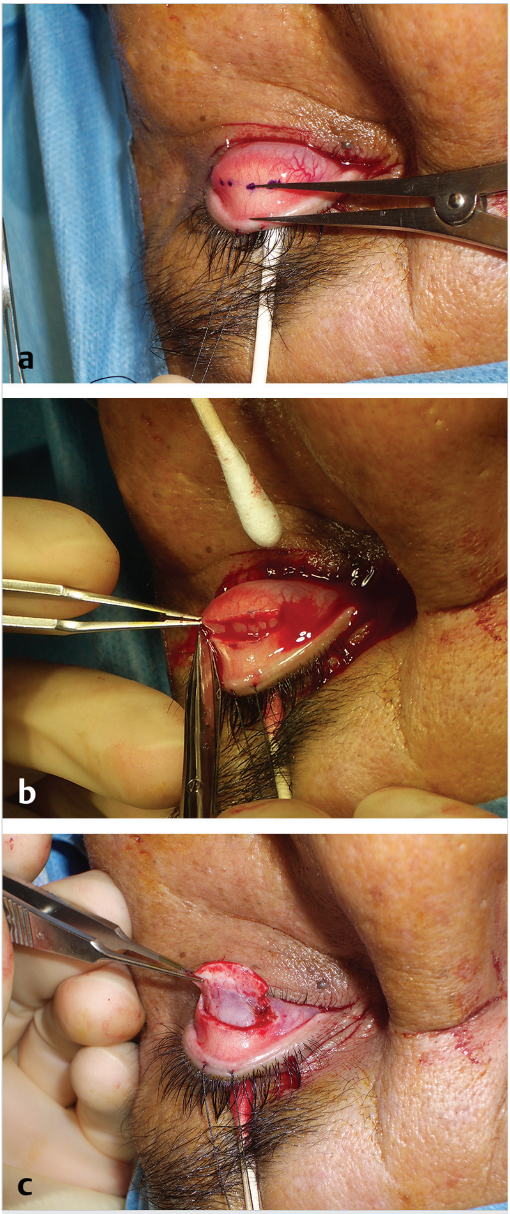

Fig. 6.20 Tarsoconjunctival graft harvest. **(a)** The eyelid is everted over a cotton-tipped applicator. A 4–0 silk suture was passed through the eyelid margin to aid in handling the eyelid. A line is marked 4 mm from the margin with calipers. **(b)** After the line is incised with a blade, the incision is extended with Westcott scissors. At the medial and lateral ends of the graft, a perpendicular incision is made superiorly toward the superior edge of tarsus. **(c)** Then the anterior face of tarsus is dissected free of overlying tissue with Westcott scissors.

6.5.3 Flipped Tarsal Bridge Graft

In some cases, the excision of tumor will sacrifice the eyelid margin producing a defect that includes a focal portion of the tarsus. Given its vertical height in the upper eyelid, there is often some superior tarsus remaining. In cases where the horizontal length of absent margin is small or there is sufficient laxity, direct approximation of the tarsus after pentagonal wedge excision should be employed. However, in large defects of the upper eyelid where this is not possible, and there is remaining superior tarsus, the "flipped tarsal bridge" technique can be employed.

There are several benefits to this technique. First, the residual strip of superior tarsus would be removed and discarded if the lid margin was to be primarily repaired. Second, the horizontal width of this potential tarsal graft exactly matches the width of the defect, making it a perfect fit. Third, use of this adjacent tarsal bridge obviates the creation of a secondary surgical donor site.

To start, the defect is inspected. If superior tarsus is present (approximately, the superior 4–6 mm), there is sufficient tissue for closure using this technique. Vertical incisions are made through the conjunctiva and tarsus at the medial and

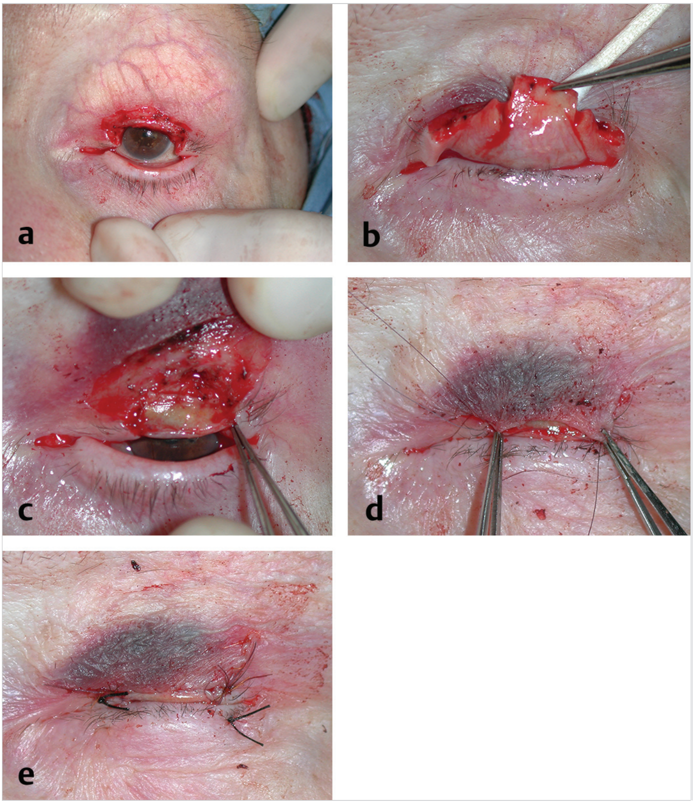

Fig. 6.21 Flipped tarsal bridge flap. **(a)** After excision of the margin carcinoma, there is a broad full thickness defect of the upper eyelid margin, but only affecting the inferior 2 mm. (Photo credit Timothy J. McCulley, MD) **(b)** Eversion of the upper eyelid reveals remnant tarsus superior to the margin. **(c)** The tarsus is harvested by placing two parallel incisions at the medial and lateral ends of the defect from the cut edge of tarsus to the superior edge of tarsus (like a wedge-excision). Just as with tarsoconjunctival graft harvest, a 2-mm "skirt" of conjunctiva attached at the superior edge of the graft is harvested together. This graft is then "flipped" so the "skirt" is now inferior and will form the new eyelid margin. The rolled edge of the conjunctiva is seen at the neo margin. **(d)** To close the anterior lamella, a flap of skin is advanced over the graft. In this case, with redundant upper eyelid, a skin-muscle flap is elevated and advanced inferiorly to the margin. **(e)** At the conclusion of the case, a temporary tarsorrhaphy is placed to keep the anterior lamellar flap on stretch.

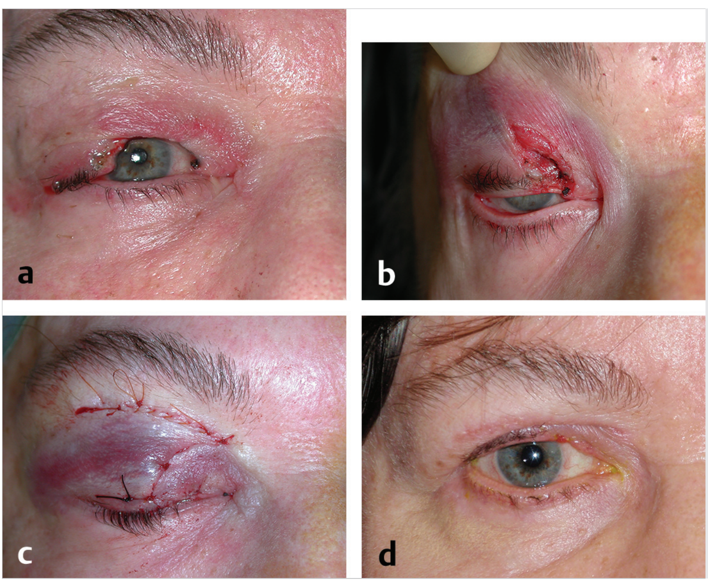

Fig. 6.22 Flipped tarsal bridge graft. **(a)** There is a medial upper eyelid margin and full thickness defect after resection of a basal cell carcinoma. With her relative young age, there was insufficient laxity for direct closure. **(b)** As in the previous case, there was tarsus suitable for a graft more superior in the eyelid. With it "flipped" and sutured into place, the posterior lamella is reconstructed. **(c)** The anterior lamella is closed with an advancement flap. **(d)** One month after surgery, the eyelid has mild residual edema. There is a well-constructed eyelid with slight notch and minuscule granuloma at the margin.

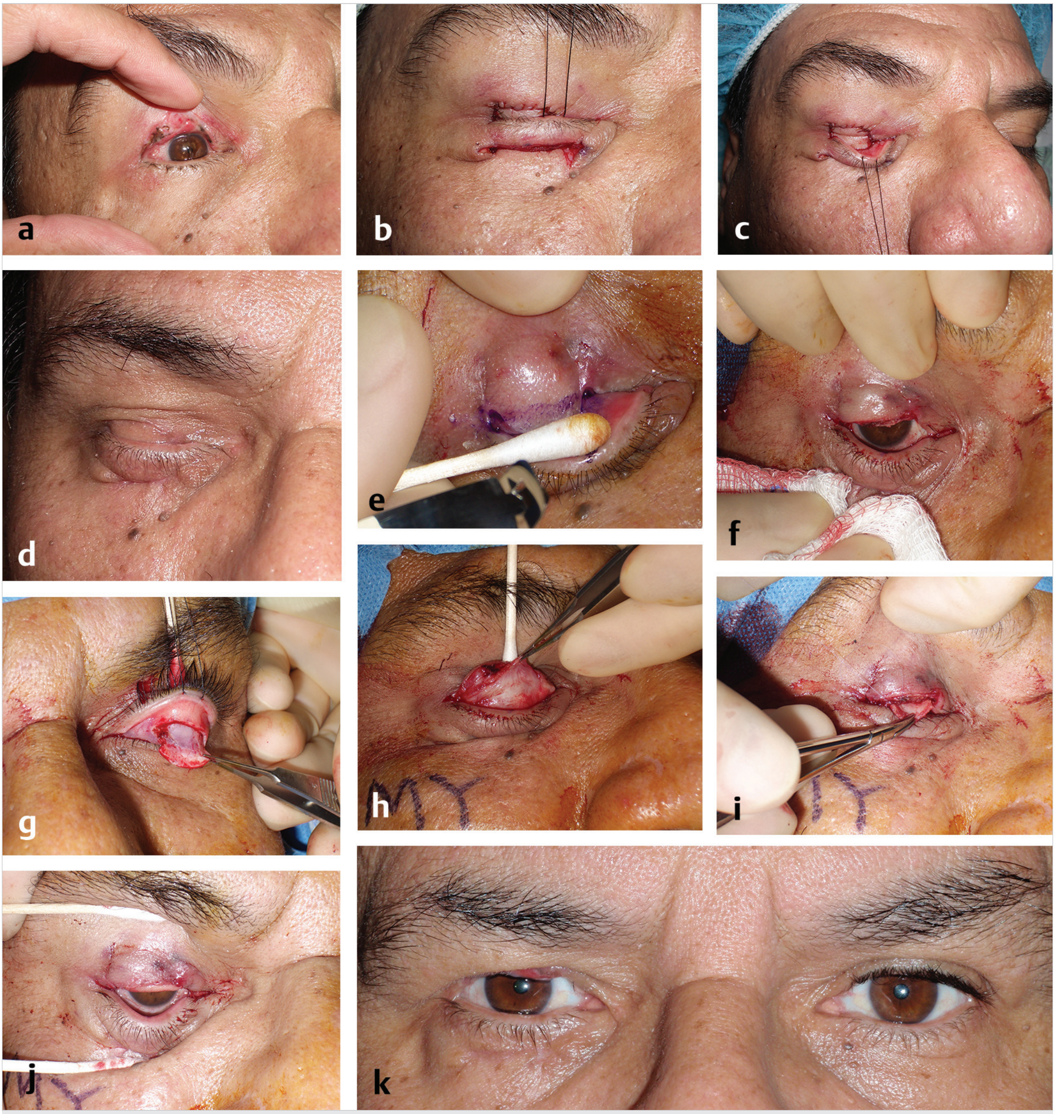

Fig. 6.23 Cutler-Beard flap. **(a)** A large defect of the right upper eyelid is present. The lateral 80% of the tarsus is missing in its entirety. **(b)** Following the first stage of surgery, the lower eyelid/cheek flap has been advanced deep to the lower eyelid margin bridge and sutured into place. **(c)** The lower eyelid margin bridge is reflected down to more fully visualize the lower eyelid flap. **(d)** Six weeks later, the flap is well vascularized in its new location and ready for division. **(e)** The flap is marked with a horizontal line where the new upper eyelid margin will be. **(f)** Intraoperative photograph shows the eyelid is now divided. **(g)** A tarsoconjunctival graft is now harvested from the left upper eyelid. There is 2 mm extension of conjunctiva superior to the tarsus that is harvested attached to the graft. **(h)** To create a recipient bed for the tarsoconjunctival graft, the anterior and posterior lamellae are separated. When this is done, the conjunctiva retracts superiorly, creating a space for the graft. **(i)** The tarsoconjunctival graft is oriented with the conjunctival surface facing the globe, and the “skirt” of conjunctival toward the new upper eyelid margin. **(j)** The “skirt” of conjunctiva becomes the new upper eyelid margin. **(k)** One month after the second stage of surgery, there is a functional and cosmetically acceptable right upper eyelid.

lateral ends of the defect. From the superior end of tarsus, an additional 2 mm of conjunctiva is harvested that will serve as the new eyelid margin. The graft is flipped from superior to inferior and then sutured into place. The medial and lateral ends of the graft are sutured to residual native tarsus with 7–0 polyglactin in a vertical mattress fashion as previously described. The anterior lamella is reconstructed according to the surgeon's preference, although a flap must be employed to provide blood supply to the tarsoconjunctival graft. If there is ample redundant tissue, the upper eyelid skin and orbicularis can be advanced inferiorly. If not, tissue can be advanced medially and laterally. Quilting sutures to appose the graft to the flap may be placed with 6–0 polyglactin suture. Alternatively, a pressure patch and temporary tarsorrhaphy can be placed for a week (▶ Fig. 6.21, ▶ Fig. 6.22).

6.5.4 Cutler-Beard Flap

For particularly large full thickness defects of the upper eyelid, generally 70 to 100%, replacement of both the anterior and posterior lamella requires a local or regional flap. The Cutler-Beard procedure is an excellent traditional option for this scenario.[2] This procedure has been plagued by various inadequacies including the risk of cicatricial entropion, a poor cosmetic outcome, and a long temporal gap between stages. In its original description, the two-staged procedure is separated by 3 months. This is no longer the case, although occlusion of the involved eye for 2 to 4 weeks is typical.

When direct closure or advancement flaps are not possible, the Cutler-Beard reconstruction may be employed. The first stage involves a horizontal full-thickness incision made horizontally just inferior to the lower tarsal border of the ipsilateral lower eyelid. It is important to protect the globe with a Jaffe retractor, which is more effective for this procedure than a scleral shell, as it provides a greater protective area. Then full-thickness relaxing vertical incisions are made at the medial and lateral ends of the horizontal incision. These can be of variable length, depending on the amount of lower eyelid and cheek laxity, as well as the vertical height of the upper eyelid defect. The horizontal width of the flap is determined by measuring the width of the upper lid defect with

Fig. 6.24 Cutler-Beard flap complication. A patient underwent left upper Cutler-Beard flap reconstruction 7 years prior. Without a posterior lamellar spacer, the patient had entropion with secondary keratopathy and conjunctival abrasion. The contour is also irregular.

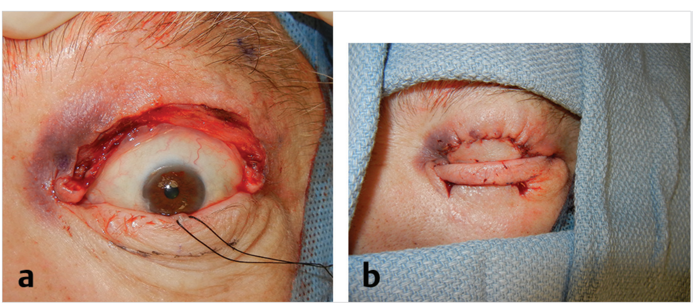

Fig. 6.25 Cutler-Beard flap. **(a)** Following resection of carcinoma, the entire upper eyelid is missing. **(b)** Stage 1 of the Cutler-Beard procedure completed. There are no other photographs, as the patient expired due to complications of carcinoma.

gentle traction pulling the two ends together. Once sufficiently mobilized, the flap is passed deep to the lower eyelid margin bridge (untouched lower eyelid margin, tarsus, orbicularis oculi muscle, and skin) and advanced superiorly. The conjunctiva of the advanced flap is sutured to the conjunctiva of the remaining upper eyelid with 7–0 polyglactin suture in an interrupted fashion. Any remaining levator aponeurosis or muscle should be identified and sutured to the orbicularis oculi muscle of the flap. Then the skin of the flap is sutured to the upper eyelid skin with 6–0 chromic gut suture in an interrupted fashion. The lower eyelid defect at the base of the bridge is left to heal by secondary intention (▶ Fig. 6.23d).

After 2 to 4 weeks, the second stage division can be performed. The Cutler-Beard flap is divided at a height where the newly constructed upper eyelid margin will be. The remaining flap is inset into the lower eyelid. It is important to remove granulation tissue from the inferior border of the lower eyelid bridge with a no. 15 blade. Then the inferior portion of the newly divided flap is sutured back to the lower eyelid. The skin alone can be reapproximated with 6–0 chromic gut suture in an interrupted fashion (▶ Fig. 6.23k).

To prevent cicatricial entropion of the upper eyelid, a tarsoconjunctival graft may be harvested from the contralateral upper eyelid (▶ Fig. 6.24).[3] This rigid posterior eyelid tissue helps to counteract the natural contractile forces of healing tissue. Please refer to the previous section on tarsal graft harvest for details of this procedure. Importantly, for maximal stability of the reconstructed upper eyelid, the widest possible graft should be harvested. The newly constructed upper eyelid is then prepared for the tarsoconjunctival graft. The conjunctiva is separated from the overlying skin and orbicularis oculi muscle. The tarsoconjunctival graft is placed into this bed. The conjunctival edge of the graft (the "skirt") is sutured to the skin with 7–0 polyglactin suture. The superior edge of the graft is sutured to the upper eyelid conjunctiva using 6–0 fast absorbing plain gut in a running fashion. Vertical mattress sutures are then used at the margin to approximate the graft to the remaining medial and lateral stumps of tarsus or tendon in a fashion similar to eyelid margin laceration repair (▶ Fig. 6.25).

Bucket Handle Flap

The Cutler-Beard procedure involves a composite posterior and anterior lamellar flap. An alternative

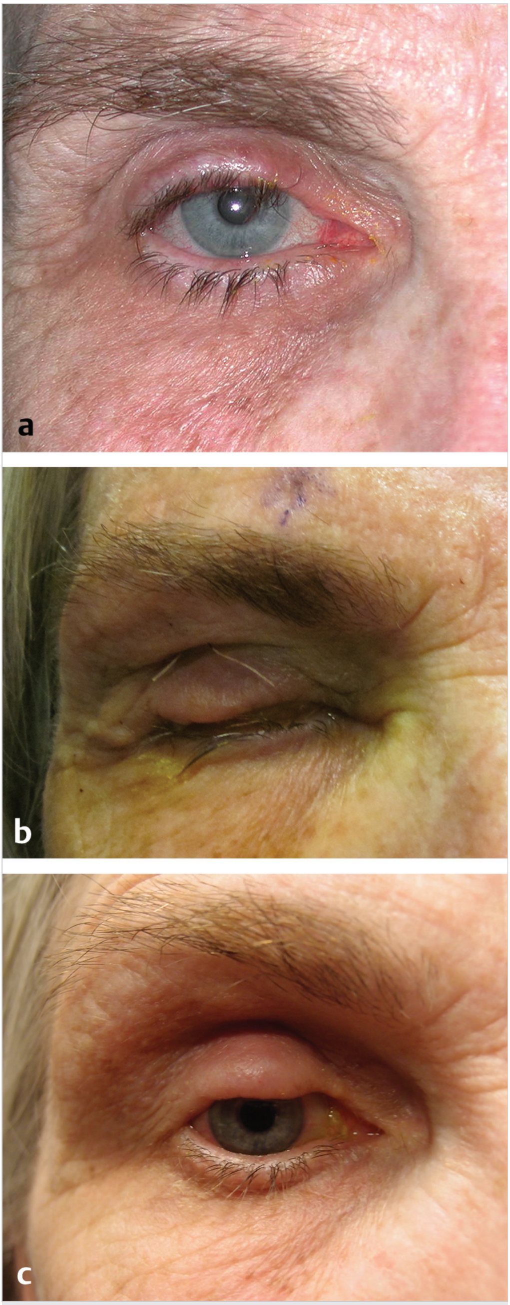

Fig. 6.26 Bucket handle flap. **(a)** Pre-operative photo showing central upper eyelid thickening found to be sebaceous cell carcinoma. **(b)** Four days after surgery, the flap is in good position with expected edema. A suture superiorly secures the tarsoconjunctival graft to the skin-muscle flap. **(c)** Thirteen months after surgery, the eyelid is reconstructed, although with thickening of the flap and secondary ptosis. **(b,c;** Courtesy of Suzanne Freitag, MD.)

to this is a posterior lamellar graft and an anterior lamellar flap. This offers the advantage of avoiding occlusion of the visual axis, and thus may be considered especially in monocular patients where the sighted eye has the eyelid defect. One potential limiting factor is the quantity of available upper eyelid skin and orbicularis oculi muscle. In a younger patient without redundant skin, an adequate anterior lamellar flap may not be achievable. A skin or skin-muscle flap from the lower eyelid is also generally not possible as there is less redundant tissue available to donate.

The recipient site is evaluated. If there is remaining tarsus above the margin, this can be excised (as in wedge-type excision discussed earlier) or harvested as the flipped tarsal bridge (also discussed earlier). If there is minimal or no remaining tarsus, a tarsoconjunctival graft is harvested (see earlier). It is oriented and sutured into place. Then the skin-muscle flap is created. Generally, it can be designed with an incision at the eyelid crease. Once it is marked, the skin-muscle flap is incised and undermined leaving both the medial and lateral ends attached. The flap is then positioned over

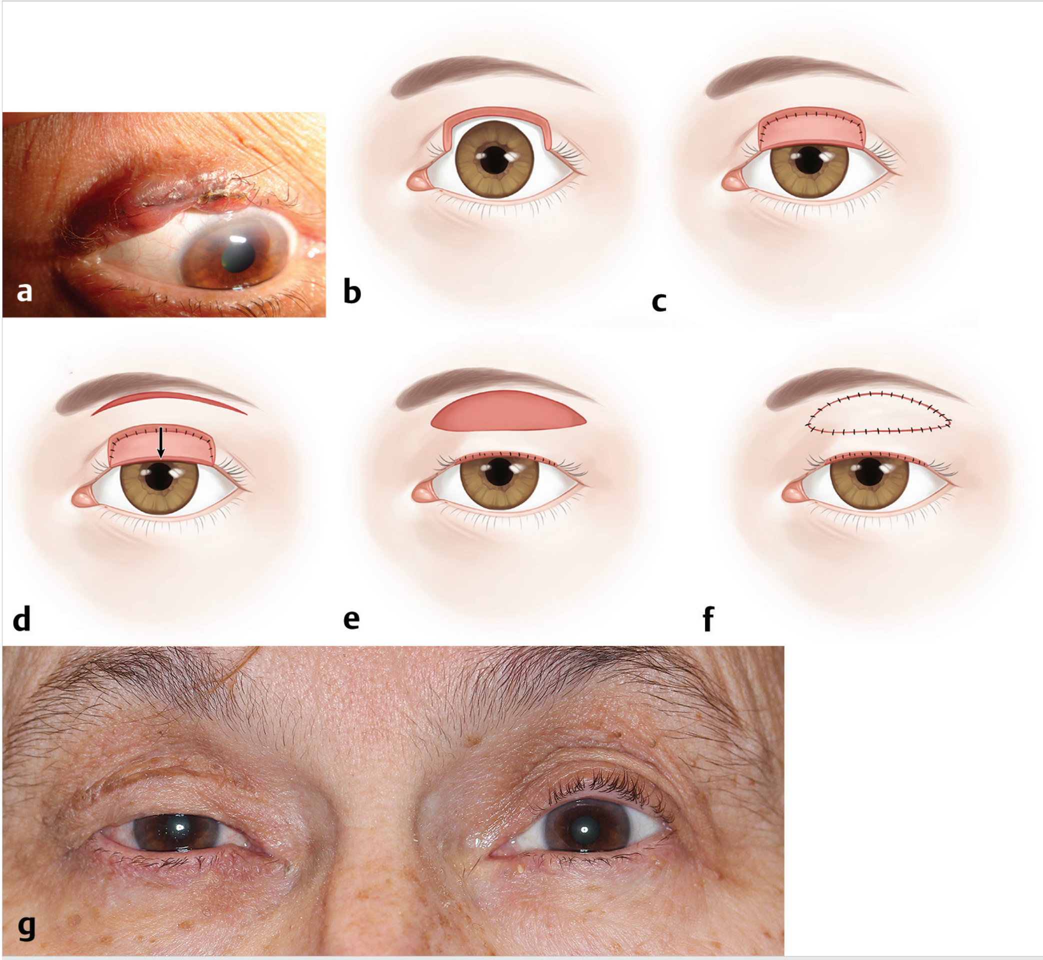

Fig. 6.27 Bucket handle flap. **(a)** Melanoma of the central right upper eyelid prior to excision. **(b)** Central full thickness excision of the upper eyelid. **(c)** A matching tarso-conjunctival graft is harvested from the fellow eyelid and sutured into place. This completes posterior lamellar reconstruction. **(d)** A sub-brow incision is made slightly longer than the margin defect. This skin is then undermined and elevated. It is then inset inferiorly at the margin. **(e)** There is now a defect more superior to the margin representing the donor site of the skin flap. (i.e. the “bucket handle”). **(f)** A full thickness skin graft is placed to cover the flap donor site. **(g)** Four months after surgery, the eyelid has an excellent contour and thickness. The donor site of the bucket handle is seen above the neo eyelid crease and the full thickness skin graft covering the donor site is seen as slightly hyperpigmented. There is mild ptosis. (Courtesy of Suzanne Freitag, MD.)

Fig. 6.28 Brow repair. **(a)** Melanoma in situ in the right mid-eyebrow with visible pigment. **(b)** Immediately after excision, there is a large defect down to the subcutaneous fat layer. **(c)** In non-hair-bearing skin, an O to T type reconstruction is often performed. However, to align the eyebrow cilia perfectly, the medial and lateral ends of the defect were advanced toward each other. The skin was undermined in the subcutaneous fat plane taking care not to damage the hair follicles. Polypropylene sutures were used to reduce the risk of scarring. **(d)** Four months after surgery, the incision lines are barely visible and the brow cilia are uninterrupted. **(e)** Eleven months after surgery, the site is not visible in the frontal view.

the tarsoconjunctival graft and sutured into place (▶ Fig. 6.26, ▶ Fig. 6.27). It provides vascularized coverage of the posterior lamellar graft and the presence of the orbicularis oculi muscle in the flap may provide better eyelid closure than skin alone. If there is inadequate skin for closure of the upper eyelid defect, a full-thickness skin graft may be placed superior to the flap once the flap has been

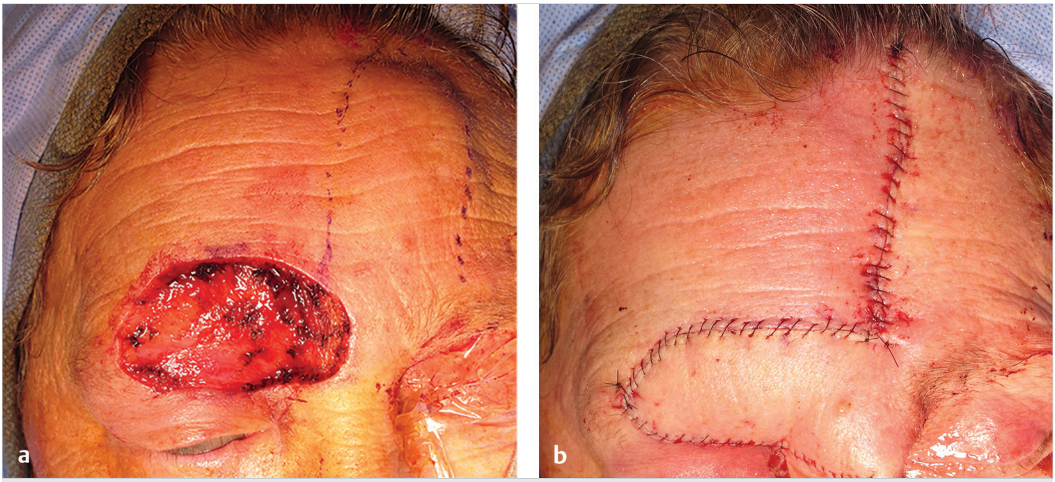

Fig. 6.29 Brow repair by rotational pedicled flap. **(a)** A large right brow defect is seen after tumor removal. No brow cilia are present. A median forehead flap is designed. Anesthesia has already been infiltrated into the brow. Although there is no named vascular supply to this flap, it will get blood supply via skin vessels and the flap bed. **(b)** Following elevation of the flap and rotation of flap into the brow defect, it is sutured into place with 5–0 polypropylene suture in a running fashion. There is a dog-ear inferiorly which can be treated with flap revision in the office. The secondary defect where the flap was harvested is closed with subcutaneous dissection and direct closure. (Courtesy of Michael Migliori, MD.)

sutured into position. This graft may be harvested from the contralateral upper eyelid or any of the sites previously discussed. The graft is placed on a vascular bed of orbicularis muscle, making the risk of graft failure quite low.

6.5.5 Brow Repair

The hair-bearing eyebrow is less frequently affected by cutaneous malignancies than the eyelid due to the protection from the hairs themselves. However, cutaneous malignancies can occur on this area as well.

The cilia in this area are an important consideration in reconstruction. They have a consistent orientation, so rotation of the hair-bearing skin should be done with caution. In addition, the hairs can be sensitive to trauma, with a relatively high rate of alopecia in areas of surgery or trauma.

Direct closure, with undermining deep to the hair follicles, often results in a good cosmetic outcome (▶ Fig. 6.28). Although the brow may be horizontally shorter, it may not be noticeable to the casual observer. Absence of cilia in the medial portion of the eyebrow is more cosmetically obvious than loss of cilia temporally. Hence, in this case, the remaining lateral cilia may be mobilized medially as an island pedicle.

In rare cases of complete brow loss, rotational flaps are useful (▶ Fig. 6.29). Similar to a paramedian forehead flap, a vascularized pedicle can be used from the contralateral side. Once elevated in the subcutaneous plane, it can be rotated and inset into place.

6.6 References

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7 Lateral Canthal Eyelid Reconstruction

Daniel R. Lefebvre

Summary

The lateral canthus is not as anatomically complex as the medial canthus; nonetheless, this region is of major importance to facial cosmesis and ocular health. Incorrect reconstruction at the lateral canthus can lead to postoperative ectropion, tearing, and eye pain. The techniques presented in this chapter will offer reconstructive options to enable the surgeon to achieve the goal of reconstructing the outer eyelid area for optimal functional and cosmetic result.

Keywords: lateral canthus, Mohs reconstruction, Tenzel, Mustarde, advancement, periosteal flap, Fricke, Tripier

7.1 Introduction

While the lateral canthus is not as anatomically complex as the three-dimensional concavities of the medial canthus, and does not contain critical structures such as the lacrimal canaliculi, it does have an important role functionally and cosmetically. From a cosmetic standpoint, the lateral canthal angle is an important visual landmark and should have symmetry to the contralateral side. Generally, the lateral canthus is positioned several millimeters superior to the medial canthus. Additionally, the lateral canthal angle should be sharp, not rounded. These are principles that are wisely heeded during cosmetic eyelid surgery, and play no less of a role in reconstructive surgery.

The adage "form follows function" rings true. An inferiorly displaced lateral canthus, while unsightly, may also contribute to epiphora and lateral ocular exposure as well as upper eyelid malposition from downward traction. A rounded lateral canthal angle or lateral canthal web is unnatural and can shorten the horizontal palpebral aperture, potentially causing trichiasis and discomfort, as adjacent lashes are pulled inward by the web. The reconstructive surgeon must take measures to avoid these problems as they can be challenging to satisfactorily remedy via secondary revision surgery.

The conceptual approach to lateral canthal reconstruction follows the standard hierarchy of healing by secondary intention, direct closure, adjacent tissue transfer, and tissue grafting.

7.2 Secondary Intention Healing

The lateral canthal area and lateral commissure can heal quite satisfactorily via secondary intention healing. For example, when a lateral canthotomy and cantholysis are performed in the emergency setting for orbital compartment syndrome, the wound often heals acceptably without subsequent surgical revision (▶ Fig. 7.1). However, unlike reconstruction after skin cancer removal, lateral canthotomy, and cantholysis requires no removal of tissue.

The ideal lateral canthal defect for secondary intention healing is small and superficial and does not involve the lateral commissure. There are no strict rules regarding this, however, and a larger defect certainly could be allowed to granulate in a patient who is not a good operative candidate (e.g., due to medical comorbidities) for formal reconstruction. One must pay attention to the possibility of resultant lateral canthal dystopia, the risk of which is proportional to the size and location of the defect. Defects at highest risk are those inferior to the horizontal raphe and those in close proximity to the lateral canthus. Additionally, if the lower eyelid has significant horizontal laxity, a lateral canthoplasty (in the form of a lateral tarsal strip, etc.) is advised to stabilize the lid and reduce the likelihood of canthal dystopia or ectropion. However, if surgical eyelid tightening is performed, it is reasonable to proceed with complete reconstruction rather than secondary intention healing.

There are a variety of wound care protocols regarding secondary intention healing, ranging from wet-to-dry dressing changes, petrolatum gauze packing and redressing, and ointment applications. For most small to moderately sized defects undergoing secondary intention healing, the author prefers to keep it simple and apply ophthalmic antibiotic ointment (such as erythromycin) to the wound several times daily until fully granulated.

7.3 Primary Closure

In most cases, particularly in older patients, the lateral canthal area generally has ample excess skin with prominent relaxed skin tension lines

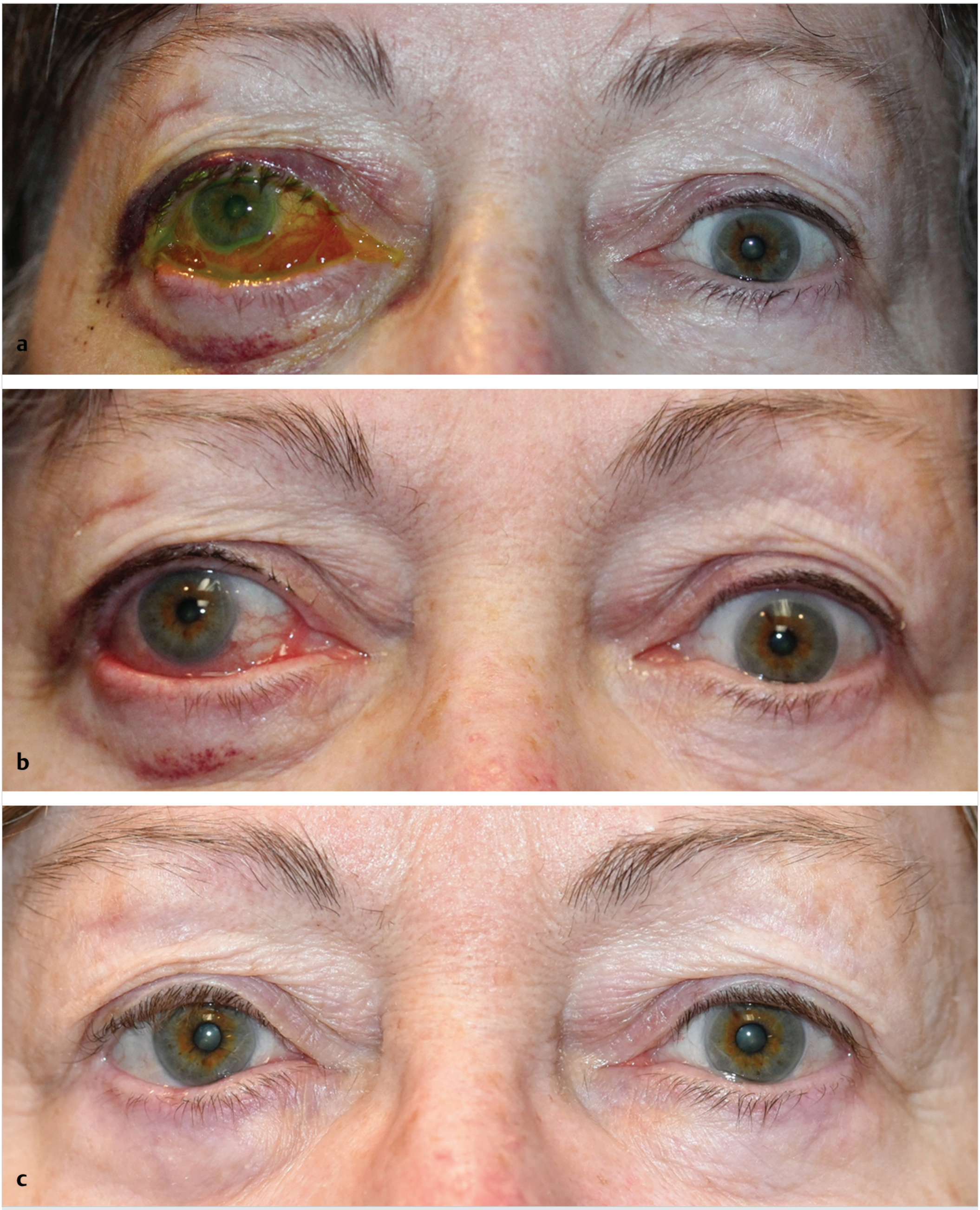


Fig. 7.1 **(a)** A 68-year-old female status-post right emergency right lateral canthotomy and inferior cantholysis for orbital compartment syndrome due to hemorrhage. **(b)** One month after the procedure, the eyelid is healing well without surgical intervention. **(c)** Three months-post, without any secondary revision procedures. The eyelid and lateral canthus have healed to quite normal and satisfactory position and cosmesis.

Fig. 7.2 **(a)** A 50-year-old male with post-Mohs defect of right lower lid/lateral canthal area following the removal of basal cell carcinoma. **(b)** Hiding the reconstruction was of paramount importance to this patient, and thus the repair was performed as a complex linear closure within a lateral canthal rhytid combined with lower lid stabilization performed as a lateral canthoplasty to deter formation of lower lid ectropion. **(c)** Postoperative month 6 following reconstruction.

("laugh lines" or "crow's feet"), which can be used to recruit skin and hide scars. If possible, defects for primary closure should be oriented within the relaxed skin tension lines, unless doing so would impart downward vertical traction on the eyelid, particularly the lower eyelid, as this area is at high risk for the development of ectropion or eyelid retraction. As mentioned, lateral canthopexy or lateral tarsal strip horizontal eyelid tightening should be considered when necessary to stabilize the lateral canthus and lower eyelid (▶ Fig. 7.2).

Direct linear closure often best involves undermining of surrounding tissue in the subcutaneous plane. Small or superficial wounds may be closed with a single layer, such as 6–0 plain gut or 6–0 nylon, if nonabsorbable suture is preferred. In cases with deeper wounds or with wound tension, a layered closure should be employed, such as 5–0 or 6–0 poliglecaprone or polyglactin inverted interrupted deep sutures and 6–0 fast absorbing plain gut simple interrupted or simple running sutures for the epidermis. Surgical tissue adhesive or bandage strips may be applied to further stabilize the skin to minimize tension, movement, and scarring.

7.4 Adjacent Tissue Transfer

As the defect increases in size beyond the scope of primary closure, adjacent tissue transfer or flap reconstruction may be appropriate. The surgeon must consider the area from which the flap is based, both in terms of skin mobility to enable acceptable wound-edge tension, and the resultant force vector applied to the eyelids and lateral canthus proper. In general, the skin of the cheek area is mobile and amenable to recruitment for flap construction and has the risk of pulling the lower eyelid inferiorly. The skin of the temple and lateral forehead is relatively less mobile.

7.4.1 Bilobed Rotational Flap

Adjacent tissue transfers such as bilobed flaps are possible in the lateral canthal region; however, the surgeon must be prepared for wide undermining, robust layered closure, and possible wound tension forces above what is acceptable, which could lead to scar widening and even frank wound dehiscence (▶ Fig. 7.3). Whether in the temple, forehead, or cheek, the dissection plane is in the subcutaneous layer to avoid injury to underlying facial nerve branches. A description of creation of this flap can be found in Chapter 4.

7.4.2 Heterotopic Eyelid Flap

A heterotopic or transposition eyelid flap, such as a modified Tripier flap, can be used as a cutaneous or myocutaneous flap for the lateral canthal area.[1] This is a flap with a relatively narrow pedicle, and is prone to prolonged postoperative edema, sometimes requiring flap revision (▶ Fig. 7.4). This is likely due to damage to the lymphatic system confluence draining the lateral canthus and lower eyelid to the preauricular basin.

The author most commonly employs this flap with a laterally based pedicle; however, a lateral

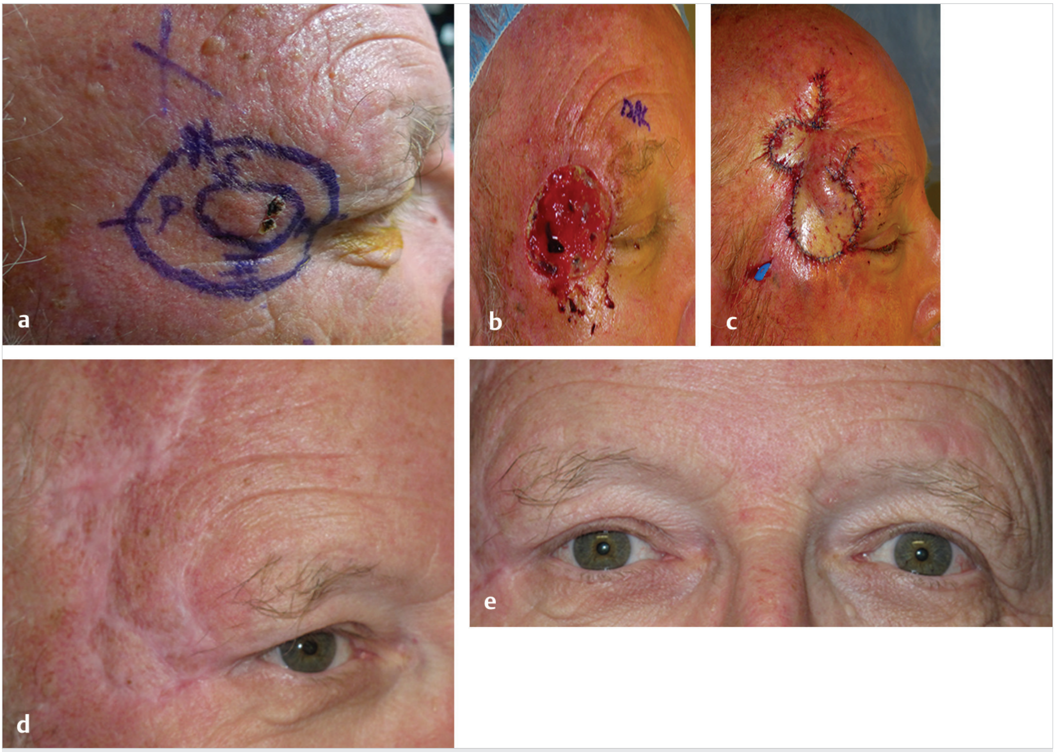


Fig. 7.3 **(a)** A 71-year-old male with amelanotic malignant melanoma of the right temple and lateral canthus marked for wide local excision. **(b)** Postexcision defect showing abutment to the lateral commissure. **(c)** Decision was made to close via an adjacent tissue transfer as opposed to a skin graft. A bilobed flap was selected. **(d)** Postoperative month 6 following reconstruction; there is satisfactory cosmesis and lower lid anatomy; there is evidence of scar widening owing to wound tension at time of reconstruction as the forehead and temple region is not an area of great skin distensibility or mobility. **(e)** Head-on view post-reconstruction.

and medial pedicle can be used to create a "bucket-handle" flap. The procedure begins with marking the upper lid as in a blepharoplasty, that is, marking the eyelid crease and determining the upper extent of the incision based on a pinch technique. An elliptical marking is made; however, the lateral aspect of the ellipse serves as the pedicle. The incision is made with a no. 15 blade, and then Westcott scissors are used to elevate a skin-muscle flap. It is important to keep the orbicularis layer intact across the flap, and particularly important to keep the pedicle intact at the lateral base. The flap is transposed into the area to be reconstructed and secured with skin sutures of choice. The donor site is closed as in a blepharoplasty. This flap has the advantage of providing an upward vector to the lateral lower eyelid and lateral canthal area to combat ectropion or dystopia. Edema postoperatively can be significant and may take months to resolve; occasionally, a revision in which the skin is elevated as a flap and the underlying edematous tissue and orbicularis oculi muscle is debulked if the edema has not resolved by 6 to 12 months postoperatively.

7.4.3 Supra-Brow Flap

A supra-brow Fricke flap is also an option in the lateral canthal region.[2] This flap provides thicker skin that may be useful in filling a deeper post-Mohs defect, but at the expense of often inducing some degree of brow elevation. It is possible to make the distal aspect of this flap bilobed to allow simultaneous reconstruction of the lateral upper and lower eyelid anterior lamella (▶ Fig. 7.5).

The supra-brow flap is constructed by marking the incision above the brow as in a direct brow lift; however, the lateral base of the flap is left open to

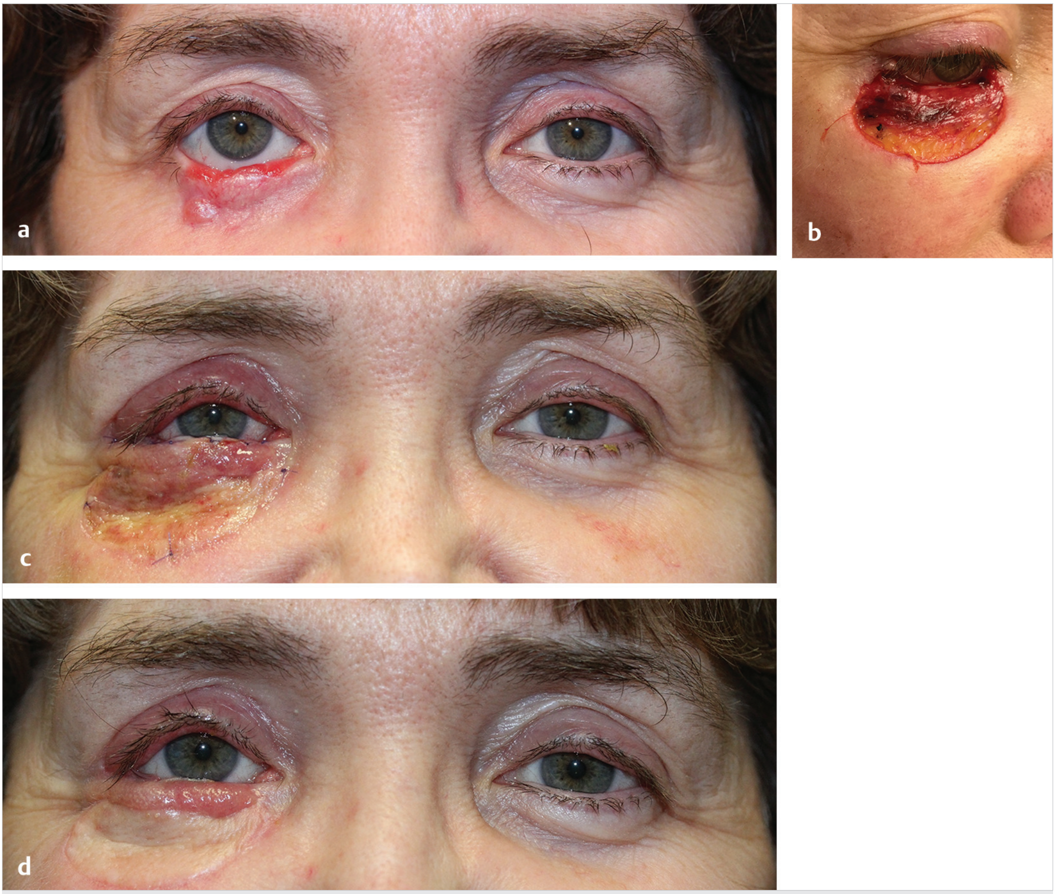


Fig. 7.4 **(a)** A 51-year-old female with a recurrence of nodular basal cell carcinoma of right lower lid. She had previously undergone a local excision and reconstruction via a Hughes tarsoconjunctival flap and skin graft at an outside institution approximately 4 years earlier. **(b)** Post-Mohs defect showing complete loss of the full thickness reconstructed lower lid as well as significant loss of preseptal and preorbital skin. **(c)** Reconstruction performed with a free tarsal graft from contralateral upper eyelid nourished by a laterally based Tripier heterotopic eyelid flap of right upper lid to right lower lid, along with a postauricular skin graft to preseptal/preorbital region. **(d)** Post-reconstruction month 2. There is evidence of distal heterotopic eyelid flap edema and erythema but satisfactory eyelid position overall.

serve as a pedicle. It is preferable to keep the length of the flap no more than three times the width of the flap pedicle to avoid tip necrosis. A no. 15 blade is used to incise the skin along the marking. A curved Stevens scissors can be used to elevate the flap in the subcutaneous plane. This is a lipodermal flap; the underlying muscle is left in place. The flap is then rotated inferiorly to fill the defect and is secured with sutures of the surgeon's choosing. The donor site is closed in layers. Brow elevation can be minimized by not undermining the area under the brow itself.

7.4.4 Semicircular Flap

Skin can be recruited via a Tenzel semicircular flap for either the upper or lower lateral eyelid. Often, this flap is utilized to enable medialization of the lateral eyelid structure; however, it remains a useful tool for bringing in tissue for anterior lamellar reconstruction of the lateral canthus. The convexity of the flap curve is opposite to the eyelid being reconstructed, that is, for a lower eyelid the convexity is superior, for the upper eyelid the convexity is inferior (see Chapters 5 and 6).

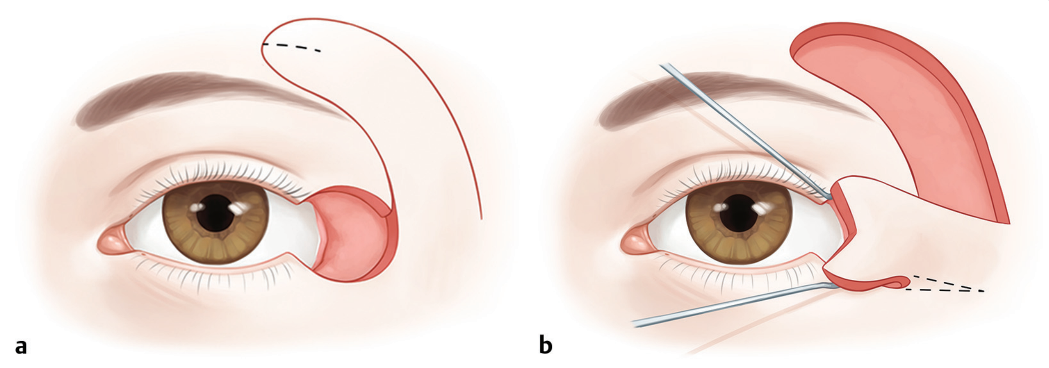


Fig. 7.5 **(a)** A supra-brow flap is marked and incised and elevated in the subcutaneous plane to avoid injury to underlying neuromuscular structures. The vascular supply of this flap is the dermal plexus provided that the flap is of limited length. **(b)** The flap is rotated into position; in this example, the distal end of the flap has been divided to re-create the upper and lower lateral eyelids/lateral canthus.

The skin is marked as a semicircular flap with the diameter of the curve proportional to the size of the defect being filled, which on average is 1.5 to 2 cm, with the lateral extent blending into a natural rhytid. The skin is incised with a no. 15 blade and elevated in the subcutaneous plane to avoid injury to underlying facial nerve motor branches. The skin is then advanced medially toward the defect area, and the wound is closed with dermal sutures of 6–0 polyglactin and 6–0 plain gut or equivalent running suture for the skin surface. When desired, the central aspect of the flap internally can be pexied (e.g., with 6–0 polyglactin) to the periosteum of the lateral orbital rim to provide additional stabilization.

7.4.5 Cheek Advancement Flap

When the defect of the lateral canthal area also involves a large area of the lower eyelid and cheek, a cheek advancement or Mustarde flap (with or without an additional skin graft to the lower lid and lateral canthus) can be a good option to avoid a large skin graft.[3] With wide undermining, this flap can cover a surprisingly large area with excellent skin texture, color, and depth match. Depending on how medially the advancement needs to be taken, thickened scarring by the nasal sidewall and possible medial canthal webbing (from inferior descent of nasal or medial canthal tissue during healing) and lower eyelid ectropion (from the inferior descent of flap during healing) may occur and require secondary revision surgery, either in the form of scar revision, Z-plasty, or even addition of a small skin graft and lateral canthoplasty to the lower eyelid. In cases of a Mustarde flap, the author routinely performs a lateral canthopexy or canthoplasty (often overcorrected) in an attempt to combat lower eyelid descent and ectropion; however, even this maneuver does not guarantee that the eyelid will not pull away as the flap matures and heals. Patients should be counseled preoperatively of the real possibility for needing revision surgery (▶ Fig. 7.6).

The flap is drawn with a marking pen, extending out of the defect zone curving superiorly and then inferiorly. If a temporal tuft of the hairline is prominent, the incision should pass anteriorly to this if possible to avoid translocation of conspicuous hair onto the face. The incision is then directed to the pretragal area as in a facelift incision. For the purposes of most cheek and lateral canthal reconstructions, the incision generally does not need to proceed to the retro-auricular area. The incision is created with a no. 15 blade and a lipocutaneous flap is elevated with facelift scissors in the subcutaneous plane. The author prefers to infiltrate the subcutaneous fat plane with injectable saline to inflate the fat and make dissection safer and easier. Bridging vessels to the dermis may be kept intact by blunt dissection around these areas. Once the flap is well developed, it is rotated into the defect zone and fixated with cardinal sutures of 6–0 polyglactin. Often, the flap is suspended centrally from its undersurface with a 5–0 poliglecaprone suture to the periosteum of the lateral orbital rim area. Dermis is closed at key locations with inverted interrupted 5–0 poliglecaprone suture and the skin can be closed with

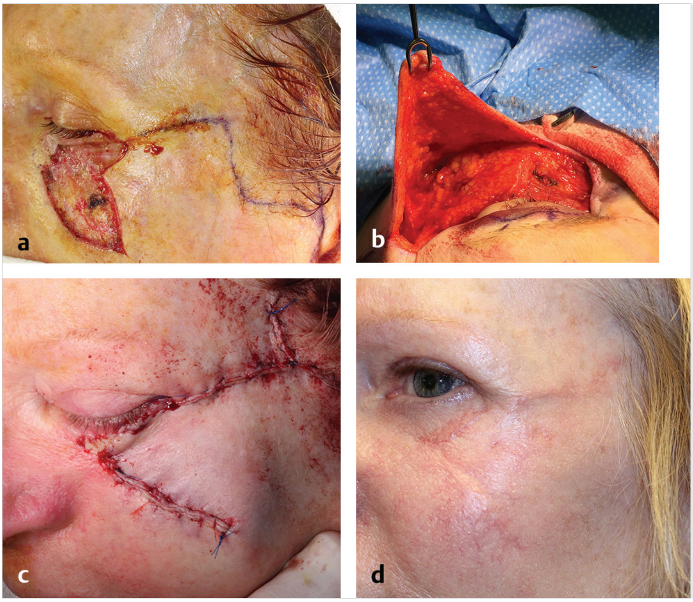


Fig. 7.6 **(a)** A 63-year-old female facial defect following the excision of lentigo malignant melanoma. A facial advancement flap plan has been drawn. **(b)** Lipocutaneous flap elevation is seen. **(c)** Flap is advanced and secured. Key to this repair is a formal lateral canthoplasty/lateral tarsal strip to deter lower lid ectropion development. **(d)** Postoperative month 3 with resolving incisional erythema and normal eyelid position.

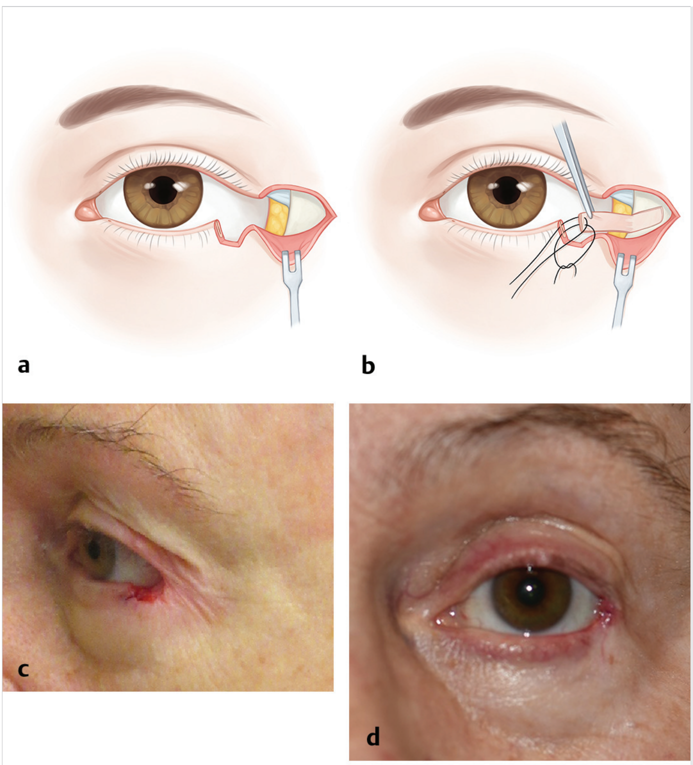


Fig. 7.7 **(a)** Defect of lateral right lower lid/lateral canthus. Illustration shows periosteum of the lateral orbital rim has been incised to create a tab of periosteum that is elevated and flipped over to function as a tendon to which the lid can then be fixated. **(b)** The lid is fixated to the periosteal strip in a standard fashion with horizontal mattress suture to reestablish strong fixation to the lateral orbital rim. **(c)** A 72-year-old female with following Mohs micrographic surgical excision of basal cell carcinoma from lateral left lower eyelid. **(d)** The eyelid did not have adequate laxity to enable simple lateral advancement and directly closure; thus, a periosteal strip was fashioned to reestablish direct connection to the lateral orbital rim; adjacent skin was then advanced over the periosteal strip. Postoperative month 2 photograph.

the surgeon's choice; the author generally closes with 5–0 polypropylene running horizontal mattress suture and 6–0 fast gut, in very close proximity to the eyelids. Sutures are removed on approximately postoperative day 7. Some cases may exhibit hypertrophic scarring, particularly at the medial area of the reconstruction where tension forces may exceed ideal limits. In such cases, triamcinolone injection may be tried in the earlier postoperative period, while scar excision and revision closure is an option after a period of months.

7.5 Periosteal Strip

When there is a loss of the lateral canthal band, a periosteal strip may be used to substitute as a pseudotendon to the orbital rim. This provides an autologous lateral canthal band reconstruction that is secure to the orbital rim bone to provide excellent eyelid stabilization as well as appropriate vectoring. Creation of the periosteal flap is described in detail in Chapters 5 and 6.

In cases of lateral canthal defects in which both the lateral upper and lower eyelids require periosteal strip support, a double-wide strip may be fashioned and then split longitudinally and "crossed" to maintain the appropriate upper and lower eyelid vectors. The periosteal strip is a vascular structure, and as such, it is possible for a periosteal strip to support a skin graft, but not ideal. It is preferable to recruit adjacent skin to cover the strip, either through adjacent tissue undermining and advancement, or via a formal flap construction (▶ Fig. 7.7).

7.6 Instrumented Canthal Fixation

At times, there is inadequate tissue at the lateral canthus to enable appropriate canthal fixation (i.e., loss of lateral canthal band tissue and periosteum). In these cases, techniques to fixate tissue directly to bare bone may be utilized.

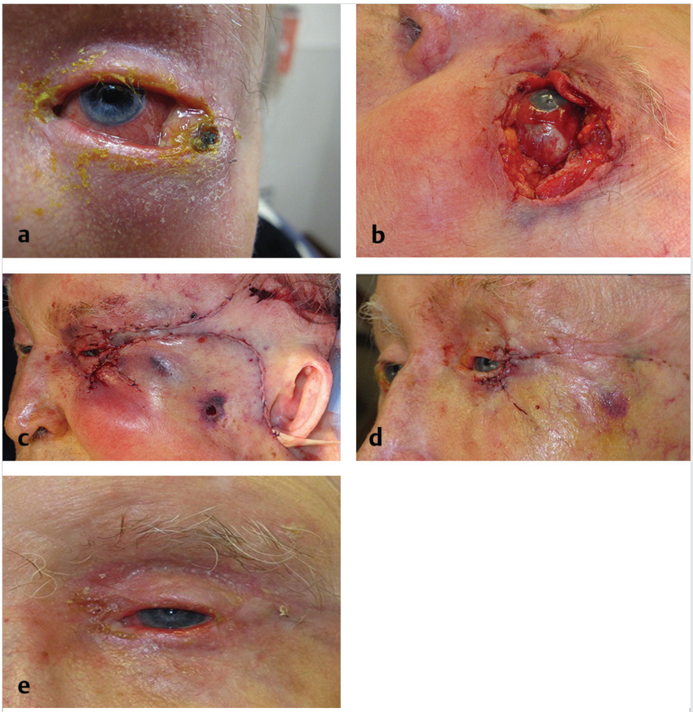
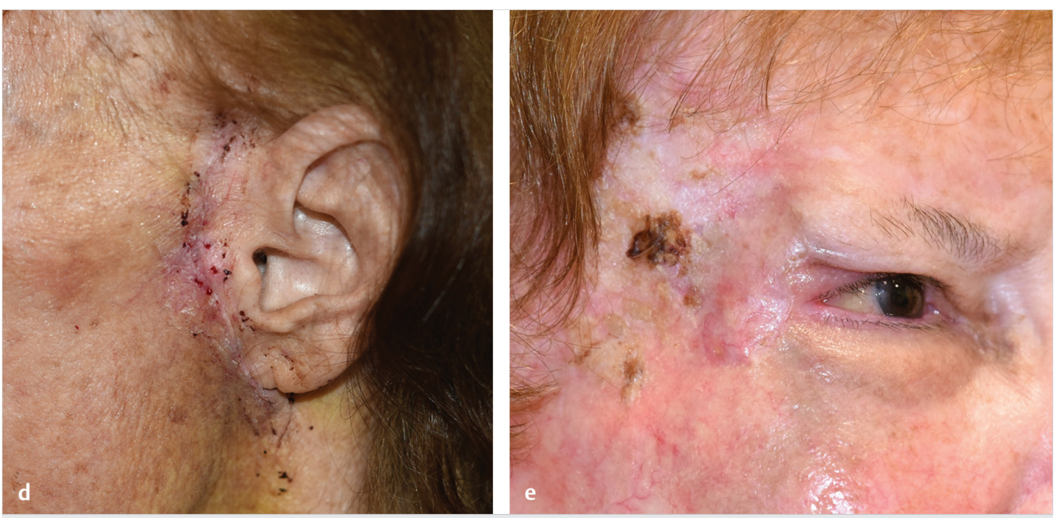


Fig. 7.8 **(a)** A 79-year-old male with the history of renal transplantation and multiple skin cancers presented with a rapidly growing squamous cell carcinoma of the left lateral canthal region with extension to the anterior lateral orbit. He declined any type of globe removing treatment, and thus underwent extended Mohs micrographic excision. **(b)** Post-Mohs defect showing significant loss of full thickness upper and lower eyelid, lateral bulbar conjunctiva, and soft tissue of the periorbital area. **(c)** Reconstruction was performed via a combination of flaps and grafts. The upper lid was able to be lateralized adequately to maintain proper blink and corneal coverage. The lower lid was reconstructed with a free tarsal graft from the contralateral upper eyelid, and additional internal lid structure was built with acellular cadaveric dermis (Alloderm; Allergan, Dublin, Ireland) and porcine serosa (tarSys; Katena, Denville, NJ). Amniotic membrane (Ambio2; IOP Ophthalmics, Costa Mesa, CA) was used to cover the exposed sclera. A cheek advancement flap was employed to rebuild the lateral periorbital soft tissue and skin. **(d)** Post-reconstruction week 2. **(e)** Postoperative month 2.

Fig. 7.9 **(a)** A 77-year-old female s/p Mohs micrographic excision of squamous cell carcinoma right temple and lateral canthus. **(b)** Decision was made to close with skin graft. Left preauricular donor site. **(c)** Skin graft in place.



(d) Left preauricular donor site healing well. **(e)** Postoperative month 2 following reconstruction. There has been some tightening of the graft that has led to some lateral pulling of the lateral eyelid commissure.

A traditional bony canthopexy involves placing two drill-holes of full thickness through the lateral orbital rim through which a permanent suture (such as 4–0 polypropylene) is passed and used to secure the eyelid soft tissues to the orbital rim. The drill holes should be positioned such that the eyelid has an internal attachment to the rim to attain good eyelid-globe apposition, and located superiorly (for a lower eyelid) or inferiorly (for an upper eyelid) to the lateral raphe to maintain proper eyelid vectors.

An alternative to a full thickness drill-hole can involve the use of an implant. A titanium microplate and screw can be used to provide a secure attachment site for suture with which to pexy the eyelid tissues to the lateral orbital rim. Alternatively, a less bulky method involves the use of an anchored suture, such as the Mitek Micro Quickanchor (DePuy Synthes/Johnson & Johnson, Raynham, MA).[4] This device is an alloy bone anchor attached to a braided polyester suture. A drill-hole is placed using a high-speed drill and the drill bit included with the kit followed by deployment of the anchor device into the drill-hole, which releases barbs once deployed that secure the device within the bone. The anchor should be placed such that there is a vector pulling the eyelid tissues inward and upward (for lower eyelid stabilization) to maintain appropriate position and cosmesis.

Violating bone in the setting of cancer surgery has the potential to lead to intraosseous seeding should there be recurrence. The decision to perform the aforementioned procedures must be made with this oncologic consideration on an individual basis.

7.7 Autologous Grafts, Allografts, and Xenografts

Grafting techniques are reviewed in detail in Chapter 2. The use of a variety of grafting techniques for reconstruction of a large lateral canthal defect is shown in ▶ Fig. 7.8.

7.7.1 Skin Graft

The author, over the course of his practice, has, with rare exception, only employed full thickness skin grafts, avoiding split thickness skin grafts, for oculofacial reconstruction. The use of full thickness skin grafts offers better thickness and lowers graft

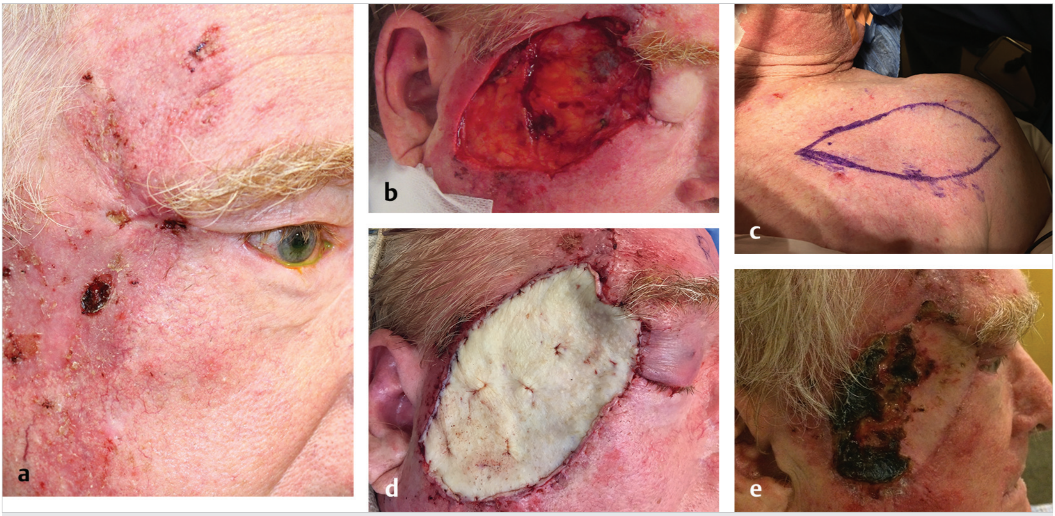


Fig. 7.10 **(a)** A 76-year-old male with recurrent squamous cell carcinoma of right temple and facial area. **(b)** Following Mohs micrographic excision. A large defect is present including the lateral commissure. **(c)** Decision made to cover the defect with a large full thickness skin graft. Deltopectoral groove selected as relatively hairless donor site. This is not an optimal color or texture match but options are quite limited for this size of facial defect. **(d)** Skin graft secured, lateral canthus repaired via a simple lateral canthal angle cerclage and canthopexy to the lateral orbital rim. **(e)** Postoperative week 2. Unfortunately, the posterior half of the graft demonstrates epidermal necrosis. This area was allowed to continue healing secondarily.

contracture ratio, which in proximity to the eyelids (especially, the lower eyelid) can lead to ectropion and retraction requiring revision surgery.

A graft is appropriate particularly in very large defects where available flap options may be insufficiently sized or if there is concern that the flap donor site cosmetic morbidity would be worse than primary reconstruction of the defect with a graft, or in the presence of tumor or pathology in the adjacent donor tissue.

Smaller defects can be well-covered with upper eyelid skin grafts if there is associated dermatochalasis. For more inferior and posterior temple defects in which thicker skin may be needed, a preauricular graft offers excellent color and texture match. The preauricular zone is also an excellent donor site for an older patient who may have static preauricular rhytids and skin laxity. Dissection in the subcutaneous plane avoids injury to facial nerve branches (▶ Fig. 7.9). If the preauricular region is not appropriate as a donor site, either because of tight skin or patient preference, a postauricular graft may be used.

Larger defects can be repaired with multiple grafts combined or single larger grafts. The supraclavicular area can offer grafts much larger than an upper eyelid donor site. This skin may be thinner than postauricular skin, and often is more darkly pigmented. In some men, this area can have significant hair coverage that should be taken into consideration.

Very large defects of the lateral canthus, temple, and lateral face can be covered by a skin graft from the deltopectoral fossa of the chest. This can leave a sizeable donor scar and in men can often be hair-bearing. Often the cosmetic outcome is marginal; however, this is the result of the size and extent of the defect that necessitates this type of reconstruction (▶ Fig. 7.10).

7.8 References

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8 Eyelid Reconstruction following Trauma

Nailyn Rasool and Lora R. Dagi Glass

Summary
Eyelid trauma repair can be complex and should be approached in a thorough and systematic manner, beginning with a complete clinical history and examination. The trauma-inducing impact may be blunt or penetrating and involve damage to the globe and surrounding facial or orbital tissue. In any case of eyelid trauma, the extent of damage to structures such as canthal tendons and the canalicular system should be determined, as specialized repair techniques are required. This chapter will provide an overview of the repair of non-marginal periocular, margin-involving eyelid, medial and lateral canthal tendon, and canalicular trauma.

Keywords: eyelid trauma, eyebrow laceration, eyelid margin laceration, canalicular laceration, medial and lateral canthal tendon trauma, reconstruction

8.1 Introduction

Eyelid trauma ranges in complexity, but its inherently unexpected nature demands clinically meticulous examination and repair. A thorough history, if the patient is able to comply, is important to understand the etiology and associated risks of the trauma, as well as the underlying conditions that may complicate wound repair and healing. In the trauma setting, acquiring social history is imperative. Is the trauma due to suspected abuse or gang-related danger? Certain domestic and peer-related situations may require urgent security or police-related intervention. Was a foreign body involved? Metal, glass, organic matter, or other material may remain deeply or superficially embedded within the wound. If the patient is not up-to-date with vaccinations, tetanus vaccine is required in cases involving metallic penetration. Consideration of rabies status should be given when there is concern for animal exposure. Was the source of trauma blunt or sharp? Blunt or sharp trauma may fracture orbital bones, in some cases despite minimal overt signs of skin trauma. Imaging is frequently necessary. A sharp source may result in missing tissue or may have penetrated deeper than initial examination reveals. In such cases, thorough wound exploration at the time of repair is critical to rule out an occult foreign body. Does the patient believe vision was affected? A thorough globe examination is imperative in all cases, including a careful anterior and posterior segment examination to rule out occult ocular injuries or intraocular hemorrhage. Does the patient report double vision? Orbital fracture is a likely possibility, but orbital foreign body and other etiologies must be considered and orbital computed tomography imaging is mandatory. Conditions that could compromise wound-healing such as smoking, diabetes, or chemotherapy, may push the clinician toward extra antibacterial coverage and more frequent wound checks. Medical history of poor coagulation or anticoagulants should warn the clinician that wound repair may require additional hemostatic maneuvers. Throughout the course of discussion with the patient, the clinician should be alert for signs of trauma to the brain or other sustaining organs; has the patient been properly examined for systemic injury?

After ruling out life-threatening injuries, ruptured globe and sight-threatening retrobulbar hemorrhage, examination of the periocular trauma patient begins with an external survey of the face; single or multiple lacerations may be present unilaterally or bilaterally, including the eyelid and eyebrow. Facial nerve injury may be present. Vision and intraocular pressure should be assessed, as should the anterior and posterior segments. Extraocular muscle movement should be carefully examined. As the patient's pupils are dilating, the superficial trauma can be more closely detailed. In the case of eyelid lacerations, integrity of the eyelid margin, medial and lateral canthal tendons, nasolacrimal system, and orbital septum should be noted. Coordination with other specialties for repair of all injuries should be attempted whenever possible. Even if eyelid injuries could be repaired at the bedside, if the patient is going to the operating room for other procedures, eyelid repair under the planned anesthesia may be preferable.

Pearls

- Is the patient currently safe, socially and medically?
- Was the source of trauma sharp or blunt, dirty, or relatively clean?

- Is the patient being covered for possible infection, including tetanus and rabies?
- Is there an underlying condition that may predispose toward bleeding, poor wound healing, or infection?
- Always remember to evaluate for retrobulbar hemorrhage (possible orbital compartment syndrome), ruptured globe, and orbital wall fracture.

8.2 General Rules of Laceration Repair

Consent is the first step toward repair. The patient or appropriate representative should be consented with the discussion of risks including hemorrhage, infection, scarring, nerve injury, ptosis, brow ptosis, brow cilia or eyelash loss, the potential need for additional surgery, and the risk of visual loss or ocular penetration.

Prior to repairing periocular lacerations, arrange a sterile, organized procedure space. Betadine solution (diluted to 5% so as not to irritate the ocular surface tissues) should be used for cleansing the periocular area and sterile towels for isolation of the field. Anesthetic eye drops and local anesthetic injection should be present both preprocedurally and on the field. A mixture of long and short acting injectable anesthetic is recommended, such as 0.75% bupivacaine mixed 1:1 with 2% lidocaine with 1:100,000 epinephrine. In addition to the instruments for repair, which include fine toothed forceps, needle holder, suture scissor, and corneal protective shield, the tray should include sterile cotton tipped applicators, sterile gauze, and lacrimal irrigation cannula, punctal dilator, and Bowman lacrimal probe. A fine, curved mosquito hemostatic forceps and a Desmarres retractor may be useful when gently exploring a shelved or unexpectedly deep wound. Each laceration should be thoroughly explored, irrigated, and cleaned with sterile saline or dilute betadine solution prior to wound closure. Tissue that appears loosely attached or poorly perfused in the periorbital area should generally not be debrided, as this tissue may be critical for the repair and is highly likely to reperfuse given the vascularity of the eyelid region. Wound repair should align natural anatomic planes without distorting the eyelid margins, causing eyelid retraction or lagophthalmos. Running sutures are generally avoided, allowing for the removal of individual sutures in case of infection.

Antibiotic ophthalmic ointment is applied to the wound at the end of the procedure, with topical and oral antibiotic generally recommended for 1 week after repair. A patch is avoided if possible, as the patient's ability to see their wound may allow for early identification of wound infection.

Pearls

- A thoughtfully organized setup allows for faster, safer wound repair.
- Wounds should be well-cleansed prior to repair.

8.3 Non-Marginal Periocular Lacerations

8.3.1 Eyelid

Lacerations of the eyelid that do not involve the eyelid margin, the medial or lateral canthal tendons, or the lacrimal drainage system are considered simple lacerations. A deep layer of closure is usually unnecessary and may cause inadvertent secondary eyelid retraction or tethering if the orbital septum is mistakenly sutured. Eyelid skin should be unfurled, and tissue reoriented for best anatomic approximation to help minimize scarring and prevent eyelid retraction (▶ Fig. 8.1). In blunt trauma, actual tissue loss almost never occurs, though it may require gentle manipulation if contracted. There is a higher risk of missing tissue in sharp or bite mechanism injuries. If orbital fat is observed in the wound, the orbital septum has been violated and the wound should be explored with particular attention to the possibility of deeper injury and orbital foreign body.[1] Once adequate evaluation of the wound has been completed, the orbital fat can be repositioned into the orbit and the skin closed. The orbital septum should not be sutured. Repairing lacerations of the levator aponeurosis is controversial and its function can often be restored without direct repair.

Classically, eyelid skin closure with simple interrupted 6–0 nylon or polypropylene sutures is adequate. These unbraided sutures minimize scarring and infection but need to be removed in approximately 7 days. Plain gut suture should be avoided in trauma repair because of the high risk

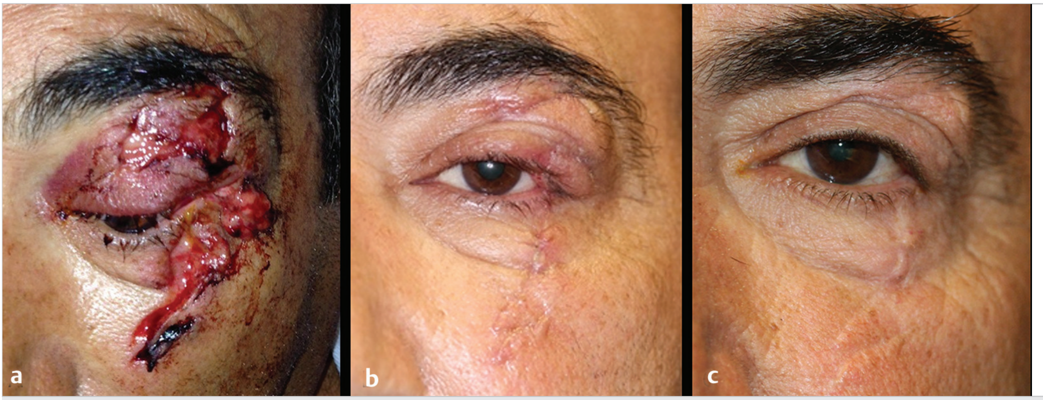

Fig. 8.1 Eyelid lacerations including margin lacerations. This patient presented with left upper eyelid, eyebrow, and lateral canthal lacerations, as well as margin-involving lacerations of both the left upper and left lower eyelids. Interrupted sutures of the skin were used to repair the non-marginal upper eyelid and eyebrow sites. The margin was repaired using a combination of vertical mattress and interrupted partial-tarsal sutures. **(a)** Initial laceration. **(b)** Ten days following repair. **(c)** One year following repair.

of early suture loss and wound dehiscence, except perhaps in pediatric cases which might require repeat anesthesia for suture removal. If there is concern that the patient may not follow up for suture removal, absorbable suture may also be considered. Good wound approximation with slight eversion of the wound edges helps prevent later scarring. Dried or devitalized appearing skin may serve as a helpful scaffolding during wound repair and will often reperfuse. Sutures should be uniformly spaced and with everted wound edges for best aesthetic results. The depth of suture should include only skin and not deeper underlying tissues. Use of cyanoacrylate tissue adhesive may be considered in simple periorbital lacerations that do not involve the lid margin and are under minimal tension. Care must be taken to avoid leaving sharp glue edges near the ocular surface. This is an excellent option in children, as it avoids the need for injection of anesthetic, which would be required prior to suture placement.

Pearls

- Clean, unfurl, and examine all tissue; it is likely present in its entirety.
- Trauma repair is like a puzzle; gently move tissue within its plane such that the pieces fit together without distorting the eyelid anatomy.
- Suture choice is important and should be individualized to the patient.
- Suture depth should be equivalent throughout the repair with wound eversion during suture placement.

8.3.2 Eyebrow

Eyebrow lacerations are of particular importance in that they are often obliquely angled, the skin is thicker than that of the eyelid, and permanently displaced or missing brow cilia can be cosmetically disfiguring.[2] As with the eyelid, tissue should be thoroughly cleansed and gently maneuvered until the tissue “reveals itself” to be anatomically appropriately positioned. In this setting, eyebrow cilia position and orientation can be helpful in determining appropriate realignment (▶ Fig. 8.2). As the dermis in the region of the eyebrow is thicker, deep subcutaneous closure with subsequent superficial closure may be necessary; in this setting, superficial wound margin eversion is ideal. Brow hair follicles may be visually obvious along the lacerated edge; if deeper sutures are necessary, it is best to avoid suturing near these follicles. However, the presence of brow cilia should not prevent superficial skin closure of a consistent suture depth. Deep closure can be performed using deep interrupted 5–0 or 6–0 polyglactin suture, whereas the superficial skin may be reapproximated using 5–0 nylon or polypropylene sutures

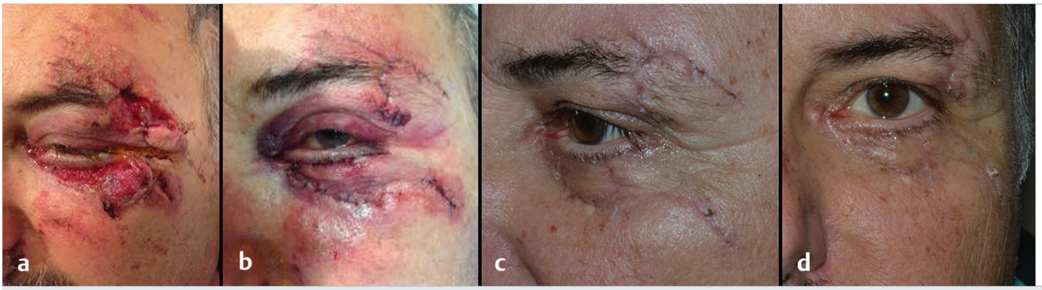

Fig. 8.2 Eyebrow and eyelid lacerations including canalicular laceration. This patient suffered superficial lacerations of the left eyebrow and left lower eyelid, as well as a medial canthal laceration involving the canalicular system. Repair involved interrupted sutures of the superficial skin lacerations, and mini-Monoka (FCI Ophthalmics Inc. USA) monocanalicular intubation with sutured reanastomosis of the transected lower canaliculus. **(a)** Initial presentation. **(b)** Immediately postrepair. **(c–d)** Two weeks following repair. Note good brow cilia realignment; however, better eversion of the left brow laceration at the time of repair might have helped prevent scar depth along the left brow.

in an interrupted or vertical mattress fashion. Should there be a risk of poor patient follow-up, 5–0 polyglactin suture will suffice.

Pearls

- Eyebrow wounds are often deep and obliquely angled; suturing should maintain anatomic planes of depth.
- Manage expectations; warn patients that brow hair loss is possible.

8.4 Marginal Eyelid Lacerations

8.4.1 Eyelid Margin Repair

Meticulous repair of the eyelid margin in the region of the tarsal plate is crucial to maintain margin anatomy and avoid notching or misalignment at the traumatized site. In this endeavor, an understanding of eyelid margin anatomy is the key, with ultimate success dependent in large part upon exact reapproximation of the tarsus and eyelash line, and eversion of the epithelium at the wound site.[3] In longer marginal lacerations, alignment of the margin assists in the alignment of traumatized tissue more distally.

Defects involving the epithelium of the margin alone may benefit from one or two interrupted 7–0 polyglactin sutures just posterior to the gray line and at the lash line. The tails on these sutures should be left long, as incorporating the tails into an interrupted suture away from the eyelashes prevents corneal-suture rub. Sutures can be removed in 10 to 14 days.

Defects involving the tarsus require meticulous repair (▶ Fig. 8.3). Classically, two or three 6–0 silk sutures are used in a vertical mattress fashion to realign the tarsus and the gray line; these tails are left loose as the tarsus is explored further. Depending upon the vertical height of the tarsal laceration, up to three partial-thickness tarsal sutures using 6–0 polyglactin are used to realign the anterior surface of the tarsus in an interrupted manner, tied and cut short (▶ Fig. 8.4). The vertical mattress sutures at the eyelid margin are then tied with an emphasis on eversion of the wound, and the tails are left long. It is optimal to position knots so that they are farthest from the central cornea. An additional 6–0 silk suture is placed at the eyelash line to perfectly realign the eyelashes; this tail is also left long. If eyelid skin is lacerated, it is closed with interrupted 6–0 polypropylene, nylon, or polyglactin sutures. Ultimately, the long tails of the eyelid margin sutures are incorporated into the interrupted cutaneous sutures away from the eyelash line, and then trimmed (▶ Fig. 8.5). Many surgeons prefer using 7–0 polyglactin suture in place of 6–0 silk in the eyelid margin with excellent results and anecdotally less tissue inflammation. Palpebral conjunctival lacerations typically heal well without the need for sutured closure. In all cases, the eyelid margin sutures should be removed in approximately 14 days. Oblique eyelid margin lacerations are repaired in the same manner with attention paid to oblique realignment in anatomically equivalent planes.

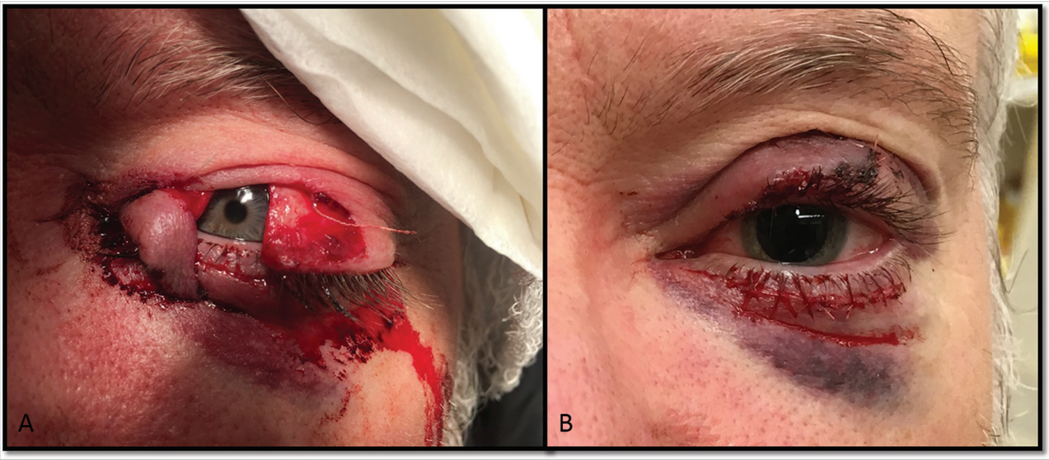

Fig. 8.3 Eyelid margin laceration. This patient presented with a large, margin-involving laceration of the left upper eyelid and a horizontal superficial laceration of the left lower lid. **(a)** Initial presentation. **(b)** Immediately post-reconstruction. The left upper eyelid laceration was repaired using vertical mattress sutures at the margin and interrupted partial-thickness tarsal sutures along the more superior tarsus. Left upper and lower eyelid skin was sutured in an interrupted manner.

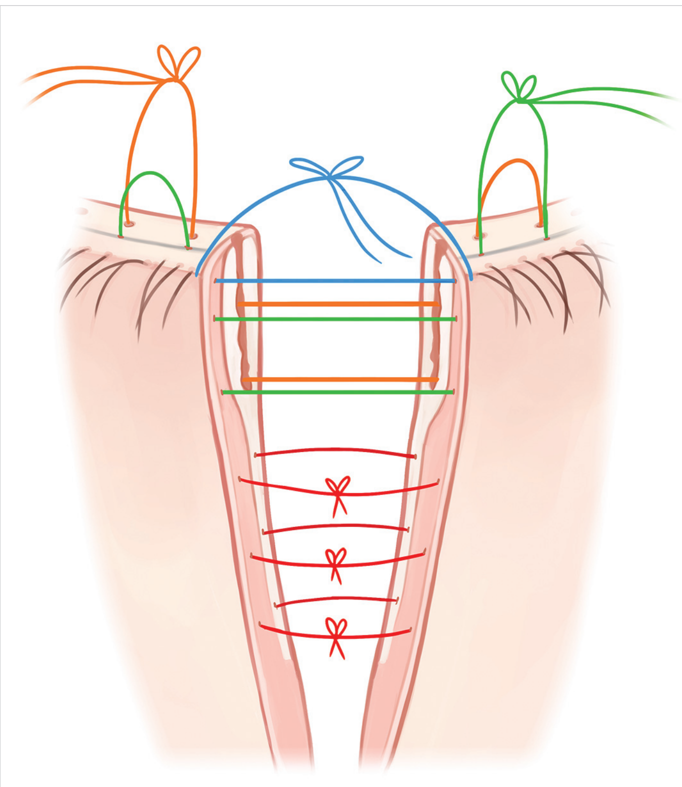

Fig. 8.4 Laceration repair of the eyelid margin. This figure illustrates the placement of sutures in a repair of the eyelid margin. Two vertical mattress sutures are placed through the tarsus (orange) and gray line (*green*), respectively; they are initially left untied. Initiating these two sutures on opposite sides helps control tail visibility later in the procedure. Interrupted partial-depth tarsal sutures (*red*) are then placed further along the tarsus, preventing corneal-suture rub. The number of interrupted tarsal sutures is titrated to the individual case. These are tied and cut short, after which the vertical mattress sutures are tied and left with long tails. Another interrupted is placed at the lash line (*blue*). Ultimately, the tails of the vertical mattress and eyelash sutures will be incorporated into a skin suture, as seen in ▶ Fig. 8.5.

Pearls

- If using an absorbable suture, using the same suture material on the vertical mattress sutures and on the interrupted suture in which their tails are held, allows all sutures to absorb concurrently.
- Wound eversion of the eyelid margin should be noticeable to the naked eye; patients may be warned that they will notice a bump on the eyelid margin initially.

8.4.2 Medial Eyelid Laceration with Canalicular Involvement

Canalicular trauma must be considered whenever there is a laceration near the medial canthus of the eyelids, especially when a laceration is noted medial to the punctum. While some have debated the merits of superior canalicular repair, it is a common practice to repair both upper and lower eyelid canalicular lacerations. Furthermore, it is best to repair these lacerations within 72 hours of injury, as it becomes more difficult or impossible to find the cut ends of the canaliculi with passing time.

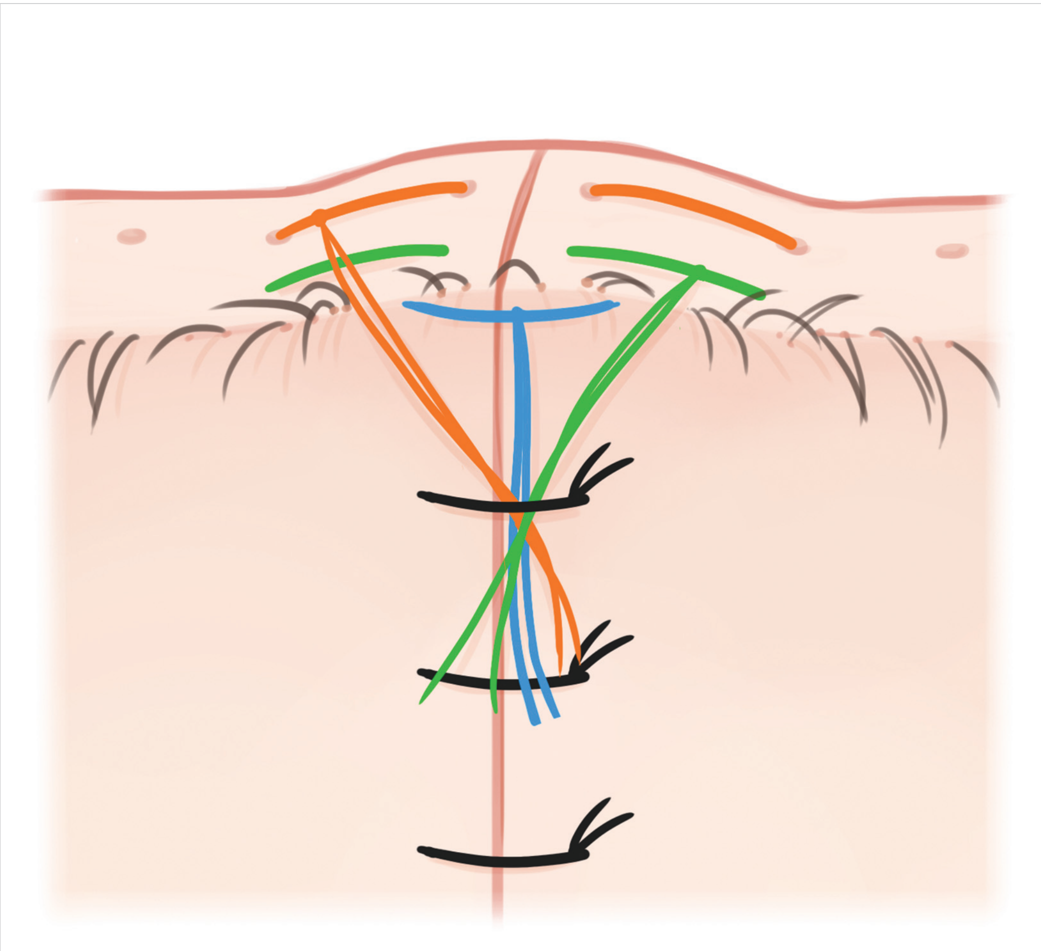

Fig. 8.5 Incorporating marginal suture tails. This figure illustrates the incorporation of suture tails from the eyelid margin (*orange*) into an interrupted suture just adjacent to the margin (*blue*). If no skin laceration exists, the marginal tails should still be incorporated into an interrupted suture just superior to the lash line.

Canalicular trauma can be obvious, as in the case of a near-total eyelid avulsion (▶ Fig. 8.6) or discrete (▶ Fig. 8.7). What first may appear to be a small scratch medial to the punctum may prove to be a full thickness canalicular transection. Gentle exploration will help demonstrate laceration depth. Using a punctal dilator as needed, probing and irrigation can be used to discern the integrity of the canalicular system.[4] Similarly, the lacrimal irrigation cannula or a Bowman lacrimal probe can be advanced and may demonstrate the lateral transected edge of the canaliculus. Careful examination of the medial edge of the wound should demonstrate the medially transected edge, though this can prove challenging. At times, irrigation with fluorescein-tinged saline through the punctum of the opposing eyelid will help demonstrate the location of the transected canaliculus.

Fig. 8.6 Medial eyelid avulsion. This patient presented with a nearly complete avulsion of the right lower eyelid. Canalicular involvement is guaranteed, and can be repaired as described using canalicular intubation and reanastomosis. Interrupted sutures along the extensive lower lid laceration site allow for excellent cosmesis. Deeper, potentially septum-involving sutures are not performed so as to help prevent eyelid retraction. **(a)** Initial presentation. **(b)** Immediately postrepair. **(c)** Three months after repair.

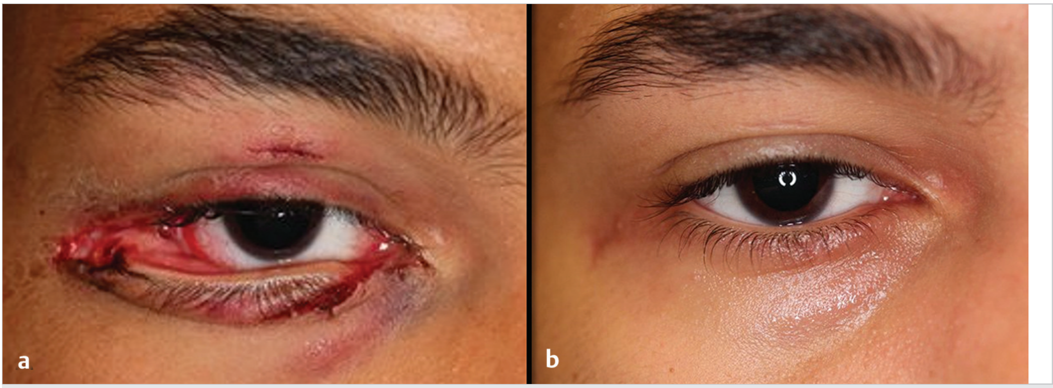

Fig. 8.7 Canalicular and lateral canthal tendon lacerations. This patient presented with a laceration involving the lateral canthal tendon, a seemingly superficial medial canthal laceration, and a small laceration of the upper eyelid. The lateral laceration was repaired via reapproximation of the lateral canthal tendon. The medial canthal laceration proved to be deeper than initially suspected, involving the inferior canalicular system. This was repaired using a monocanalicular stent, canalicular reanastomosis sutures, and interrupted sutures along the margin. **(a)** Initial presentation. **(b)** Three months after repair with an excellent result.

Keeping a Bowman probe in place in the lateral aspect while envisioning or anatomically reapproximating the eyelid can also help predict directionality of the canalicular system. In difficult cases, some advocate placing a pigtail probe through the opposing, uninjured canaliculus. A thorough knowledge of lacrimal anatomy is required to avoid damage when using a pigtail probe, and as a result, its use is discouraged by many experts.

Once both edges of the transected canaliculus are identified, an untied interrupted 7–0 polyglactin suture can be preplaced in the posterior aspect of the canalicular cut edges, such that once tied, the knot will be external to the canalicular system. This will allow for posterior canalicular suture anastomosis after the placement of a canalicular stent. If only one canaliculus is traumatized, a monocanalicular stent can be cut to the desired length, threaded through the involved punctum, out the lateral transected edge, and into the medial transected edge. Of note, a beveled cut of the canalicular stent will allow for easier threading. If both ipsilateral canaliculi are involved, two monocanalicular stents can be placed; however, this will likely result in epiphora during the healing phase due to obstruction of the puncta. Hence, a bicanalicular stent is more stable and preferred. Bicanalicular stents significantly decrease wound tension by pulling the puncta medially, although excessive tension on the stent can cause elongation ("cheesewiring") of the puncta and tearing of the canaliculi longitudinally, for which repair tends to be frustratingly unsuccessful. Placement of a bicanalicular stent requires intranasal manipulation, which is best performed in the operating suite with the patient anesthetized. Once the canalicular stent is placed, the preplaced posterior anastomosing suture is tied, preferably without tension, as an assistant brings the wound together. An additional canalicular anastomosing suture is then placed anterior to the stent, again with the suture external to the canalicular lumen. Sutures of 6–0 polyglactin are then placed through deep tissue for structural stability, allowing for a release of tension on the canalicular anastomosing sutures. Finally, the epithelium of the eyelid margin is reapproximated. Should the laceration involve skin remote from the margin, 6–0 polypropylene, nylon, or polyglactin suture can be used in an interrupted manner.

Pearls

- Be vigilant for canalicular trauma.
- Consider preplacing posterior canalicular anastomosing sutures prior to inserting the canalicular stent.
- Place adequate deep sutures in the tissue surrounding the canalicular laceration to relieve wound tension.
- Monocanalicular stents are easily placed with no need for intranasal manipulation or patient sedation.
- Bicanalicular tubes are extremely helpful in apposing canalicular lacerations and relieving tension.

8.4.3 Canthal Tendon Avulsion

Canthal tendon injuries are not common but tend to be overt, with horizontal palpebral fissure shortening or canthal angle rounding.[5]

Medial

When the anterior limb of the medial canthal tendon is injured without involvement of the posterior limb, suture repair of the transected ends of the tendon using 6–0 polyglactin suture effects good stabilization. However, in many cases of trauma, there may be a transection of both the anterior and posterior limbs of the medial canthal tendon. Since the medial canthal tendon divides into anterior and posterior limbs to envelop the lacrimal sac, full transection of the anterior and posterior limbs forewarns of canalicular penetration and other possible nasolacrimal injury requiring concurrent repair. Anatomic reapproximation of the posterior limb of the medial canthal tendon to the posterior lacrimal crest is difficult because of its depth. To this end, some have advocated for a transcaruncular approach with direct suturing to the periosteum of the posterior lacrimal crest; others use a titanium Y-shaped miniplate screwed to stable bone with suture fixation. An osseous mini anchor (Mitek Mini Quickanchor suture anchor; Dupuy Synthes, Raynham, MA) can be of great use in this setting as well to allow solid fixation to bone in cases without associated bony fracture.

Pearls

- It is essential to evaluate nasolacrimal damage in the setting of medial canthal tendon disruption, as such damage will require concurrent repair.
- The fixation point for reattachment of the posterior limb of the medial canthal tendon to the posterior lacrimal crest bone must be accurate in order to avoid anterior displacement of the eyelid commissure resulting in exposure keratopathy and poor lacrimal outflow.

Lateral

The anatomy of the lateral canthal tendon is less complex than that of its medial counterpart, allowing for simpler repair. Repair of the lateral canthus can be compared to a laterally based ectropion repair. A suture, such as 5–0 polypropylene or polyglactin, is passed through the lateral end of the tarsus in an anterior-to-posterior manner, and then through the periosteum just internal to the lateral orbital rim, replicating the normal anatomic insertion on the lateral orbital tubercle (▶ Fig. 8.7).

In cases in which both the upper and lower eyelids are involved, each lateral canthal tendon can be approached separately, after which a cerclage suture approximating the superior and inferior canthal tendons can help reform the lateral canthal angle.

Pearls

- In the case of retrobulbar hemorrhage, a lateral canthal tendon avulsion may allow for the decompression of increased orbital pressure, in which case repair should be reserved for a later date.

In conclusion, understanding these basic principles will improve the surgeon's ability to effectively repair eyelid lacerations. However, the highest level of competence is, of course, achieved with ample experience and situational teaching.

8.5 References

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