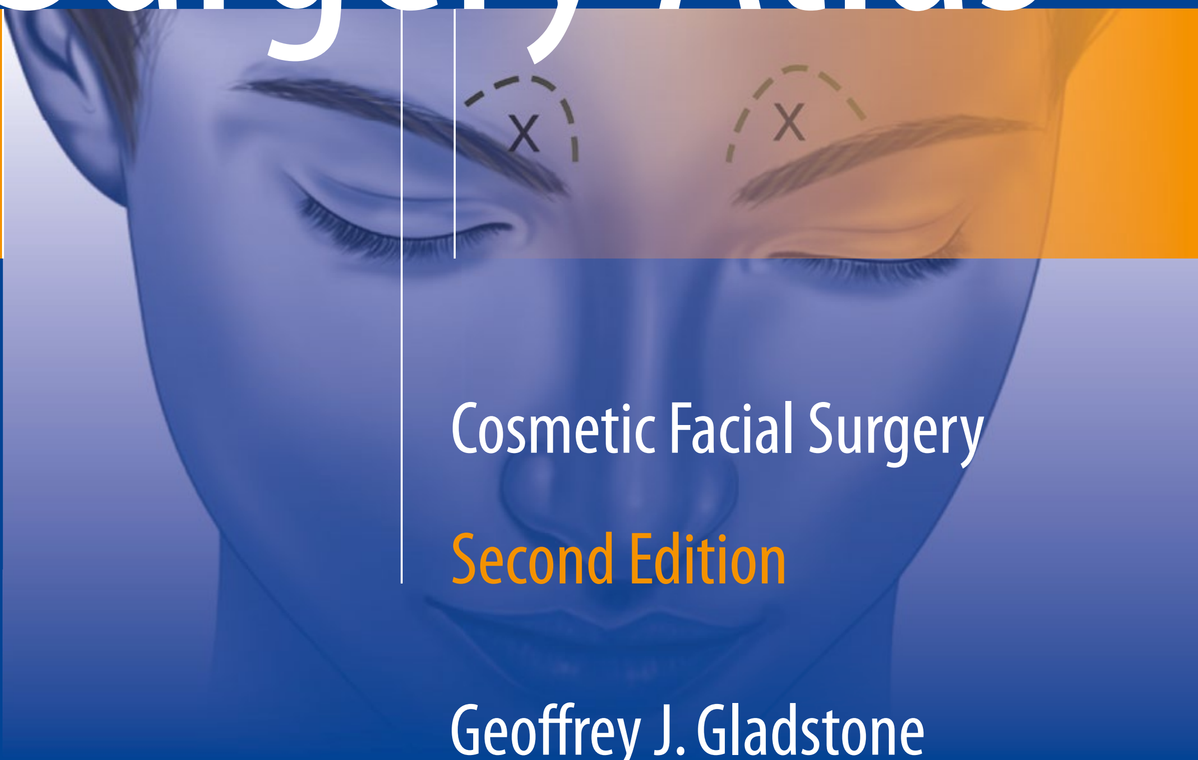
Oculoplastic Surgery Atlas



Cosmetic Facial Surgery

Second Edition

Geoffrey J. Gladstone
Frank A. Nesi
Evan H. Black *Editors*

EXTRAS ONLINE

Springer

Oculoplastic Surgery Atlas

Geoffrey J. Gladstone • Frank A. Nesi
Evan H. Black
Editors

Oculoplastic Surgery Atlas

Cosmetic Facial Surgery

Second Edition

Springer

Editors
Geoffrey J. Gladstone, MD, FAACS
Consultants in Ophthalmic and Facial
Plastic Surgery, PC, Southfield
MI, USA

Oakland University William Beaumont
School of Medicine, Royal Oak
MI, USA

Wayne State University School of
Medicine, Detroit, MI, USA

Evan H. Black, MD, FACS
Consultants in Ophthalmic and Facial
Plastic Surgery, PC, Southfield
MI, USA

Oakland University William Beaumont
School of Medicine, Royal Oak
MI, USA

Wayne State University School of
Medicine, Detroit, MI, USA

Frank A. Nesi, MD, FAACS
Consultants in Ophthalmic and Facial
Plastic Surgery, PC, Southfield
MI, USA

Oakland University William Beaumont
School of Medicine, Royal Oak
MI, USA

Wayne State University School of
Medicine, Detroit, MI, USA

Electronic Supplementary Material can be downloaded from
https://link.springer.com/book/10.1007/978-3-319-67331-8

ISBN 978-3-319-67330-1 ISBN 978-3-319-67331-8 (eBook)
https://doi.org/10.1007/978-3-319-67331-8

Library of Congress Control Number: 2017960820

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

There is no greater joy in medicine than to pass on knowledge. The benefits are innumerable. Patients receive better care, the physician practices a higher quality of medicine, and the field of medicine achieves a more advanced state by the synthesis of knowledge from many sources.

The teacher's benefits are less obvious but just as meaningful and rewarding. Seeing a resident or practicing physician broaden their knowledge or perfect a new surgical technique provides a wonderful sense of accomplishment. It is also a way to repay those who have selflessly given their knowledge in the past.

This book is dedicated to those who seek knowledge. It is hoped that in some small way these books and high-quality videos will improve your practice of medicine and simplify the application of appropriate oculo-facial surgical procedures.

Geoffrey J. Gladstone, MD, FAACS

Foreword

The desire to teach and the fulfillment attained from teaching have again prompted us to produce a work that we hope will be both useful and enlightening to our readers.

The field of oculo-facial plastic surgery has grown and evolved to include all aspects of eyelid and facial plastic surgery. Our literature now reflects the advancements and direction of our field. Knowledge of anatomy, the basis of all surgery and the root of surgical principles and techniques, is the basis of our ability to deliver the highest quality care to our patients.

We have therefore combined text and diagrams and supplemented them with high definition streaming video technology to provide those who wish to perform this surgery with the best possible instruction and preparation. We hope that our attempts to accomplish this will be rewarded by the use of our material by our colleagues and the acknowledgment of our unique and logical progression in the field of oculo-facial plastic surgery.

Frank A. Nesi, MD, FAACS

Preface to First Edition

The desire to teach and the fulfillment attained from teaching have again prompted us to produce a work that we hope is both useful and enlightening to our readers. The field of oculoplastic surgery has grown and evolved to include all aspects of eyelid and facial plastic surgery. Our literature must now reflect the advancements and direction of our field. Knowledge of anatomy, the basis of all surgery and the root of surgical principles and techniques, supports our ability to deliver the highest quality care to our patients.

We have therefore combined text and diagrams and supplemented them with DVD digital video technology to enable those who wish to perform this surgery the best possible instruction and preparation. We hope that our attempts to accomplish this will be rewarded by the use of this material by colleagues and the acknowledgment of our unique and logical progression in the field of eyelid and facial plastic surgery. The previous volume in this series covered reconstructive eyelid surgery. This volume presents many aspects of facial cosmetic surgery, including blepharoplasty, endoscopic forehead surgery, rhytidectomy, and other related procedures. Future volumes will present facets of lacrimal and orbital surgery.

Southfield, MI, USA Frank A. Nesi, MD, FAACS

Preface to Second Edition

These books update our previous volumes published almost 15 years ago. One of the major advances since that time is the availability of high-quality streaming video. Coupled with our updated text and really beautiful illustrations, these new volumes are concise and immediately useful to those who read them. The chapters thoroughly cover patient evaluation and decision making for each procedure. A detailed description of each procedure is provided that correlates with the videos.

The books are intended for ophthalmologists, ophthalmic plastic surgeons, otolaryngologists, general plastic surgeons, and others wanting a better knowledge of eyelid and facial surgery. They are geared for the beginner/intermediate level and include only practical, immediately useful techniques. They are limited in scope to keep them practical and quickly useful. These books are accompanied by tightly edited, high definition video exactly and completely showing each procedure. They will provide a unique learning experience for the reader.

More and more comprehensive ophthalmologists, otolaryngologists, and plastic surgeons are interested in eyelid and facial surgery. This text offers them an unparalleled learning experience.

Southfield, MI, USA Geoffrey J. Gladstone, MD, FAACS

Acknowledgments

Bringing a book project to fruition is always a complicated process involving many people. It is through their dedication, professionalism, and team effort that it all comes together.

Our medical illustrators deserve special recognition for the quality and beauty of their work; their illustrations clarify the text in a way that only visual images can. The ease with which they communicated during the illustration process is appreciated.

Rebekah Amos Collins, our executive editor, did a wonderful job initiating the creation of the two volumes. Lee Klein, our editor at Springer, worked tirelessly with me to complete the process. His gentle prodding to complete the task was necessary and appreciated.

Drs. Servat and Baylin updated the anatomy chapters for this edition. We want to once again thank Drs. Rose, Lucarelli, Cook, and Lemke for their work on the first-edition anatomy chapters.

Most importantly, Dr. Nesi and I would like to pay tribute to our mentors. Without Drs. Byron Smith and Allen Putterman, none of this would have been possible. They guided and molded us during our fellowships and have had a decades-long influence on us. It is because of them that we are able to give back to our profession in this way. Thank you Allen and Byron.

Geoffrey J. Gladstone, MD, FAACS
Frank A. Nesi, MD, FAACS
Evan H. Black, MD, FACS

Contents

Contributors

Eric B. Baylin, MD Oculofacial Plastic Surgeons of Georgia, Northside/Johns Creek Medical Office, Suwanee, GA, USA

Evan H. Black, MD, FACS Consultants in Ophthalmic and Facial Plastic Surgery, PC, Southfield, MI, USA

Oakland University William Beaumont School of Medicine, Royal Oak, MI, USA

Wayne State University School of Medicine, Detroit, MI, USA

Francisco Castillo, MD Ophthalmic Facial Plastic and Reconstructive Surgery, Oakland University, William Beaumont School of Medicine, Southfield, MI, USA

Geoffrey J. Gladstone, MD, FAACS Consultants in Ophthalmic and Facial Plastic Surgery, PC, Southfield, MI, USA

Oakland University William Beaumont School of Medicine, Royal Oak, MI, USA

Wayne State University School of Medicine, Detroit, MI, USA

Shoib Myint, DO, FAACS, FAOCO Ophthalmology, Myint Center for Eye and Facial Plastic Surgery, Nevada Eye Physicians, UNLV School of Medicine, Henderson, NV, USA

J. Javier Servat, MD Oculofacial Plastic Surgeons of Georgia, Northside/Johns Creek Medical Office, Suwanee, GA, USA

Cèsar A. Sierra, MD Bridgeport Hospital, Westport, CT, USA

Kathryn P. Winkler, MD Kresge Eye Institute, Wayne State University School of Medicine, Detroit, MI, USA

Cosmetic Facial Anatomy

1

J. Javier Servat and Eric B. Baylin

A complete knowledge of the complex anatomy of the face is fundamental to safely perform cosmetic facial surgery. The different techniques discussed in this book are easier to accomplish if the underlying anatomical principles are completely understood. This chapter is a discussion of the anatomy of the face, with special emphasis on the eyelids, as it applies to cosmetic facial surgery.

Forehead and Eyebrow

As an important source of support for the eyelids and a major determinant in facial expression, the eyebrows should be included in any evaluation of eyelid dysfunction. Eyebrow position strongly influences eyelid position and architecture, and many cases of upper eyelid ptosis and apparent dermatochalasis are, in fact, a consequence of eyebrow ptosis. Similarly, frontalis muscle recruitment can mask significant blepharoptosis. In these situations, addressing only the lids may lead to an inadequate or undesirable surgical result.

The ideal contour of the eyebrows is highly debated and varies according to age and gender [1]. The medial and lateral ends of the brow are typically at the same vertical level, although the lateral brow may be slightly higher. The apex should lie above the region between the lateral limbus and the lateral canthus [2]. The male eyebrow generally rides lower and flatter than that of the female [3].

Eyebrow contour and position are influenced by five principal muscles: frontalis, orbicularis, corrugator, procerus, and depressor supercilii. Contraction of the frontalis elevates the eyebrows, while contraction of the orbicularis depresses them. The corrugator depresses the medial eyebrows toward the midline and forms the vertical furrows in the glabella. The procerus depresses the glabella and forms horizontal wrinkles across the dorsum of the nose. The depressor supercilii also depresses the eyebrows medially, contributing to the formation of vertical glabellar wrinkles.

Cook et al. demonstrated that the depressor supercilii originates in either one or two heads that separate the angular vessels [4]. The frontalis lies approximately 3 mm beneath the skin, and the eyebrow depressors lie approximately 5 mm beneath the skin [5].

Underneath the eyebrow lies the eyebrow fat pad or retroorbicularis oculi fat (ROOF), which supports the eyebrow over the supraorbital ridge. Dense, fibrous attachments anchor the ROOF to the supraorbital ridge. Because the ridge underlies only the medial one-third to one-half of the eyebrow, the lateral eyebrow lacks the same

J. Javier Servat, MD (✉) • E.B. Baylin, MD
Oculofacial Plastic Surgeons of Georgia, Northside/Johns Creek Medical Office, 3890 Johns Creek Parkway, Suite 240, Suwanee, GA 30024, USA
e-mail: javierservat@gmail.com; baylinopsg@gmail.com

G.J. Gladstone et al. (eds.), *Oculoplastic Surgery Atlas*, https://doi.org/10.1007/978-3-319-67331-8_1

degree of underlying support. This has been proposed as an explanation for the fact that the lateral eyebrow often droops more with age than does the medial eyebrow [6].

Eyelid Topography

Eyelid topography is influenced by age, race, ethnicity, and surrounding facial anatomy. In most individuals, the lateral canthus sits 2 mm higher than the medial canthus, with slightly greater elevation in individuals of Asian descent. The adult interpalpebral distance measures 28–30 mm horizontally and 9–12 mm at its greatest vertical extent centrally. The upper eyelid margin rests approximately 1–2 mm below the superior limbus. The lower eyelid margin rests at the inferior limbus. Laxity of the canthal ligaments not only causes poor apposition of the eyelids to the globe, but also changes the contour of the interpalpebral fissure. The upper eyelid is gently curved, with the highest point nasal to the center of the pupil [7, 8].

The upper eyelid crease is an important surgical landmark, as it is often an incision site. The crease is formed by the superficial insertions of the levator aponeurosis [9] and should generally be re-formed if these attachments are disturbed [10]. It rides parallel to the lid margin and lies 8–11 mm above the eyelid margin in women and 7–8 mm above in men [8]. In people of European ancestry, the septum-levator insertion occurs 2–5 mm superior to the upper edge of the tarsus [11]. In Asians, the orbital septum inserts low on the levator aponeurosis [11], below the superior tarsal border [12], yielding a low or poorly defined lid crease [13]. This is an important point to keep in mind when operating on Asian eyelids.

The lower eyelid crease is less prominent. It begins medially 4–5 mm below the lower eyelid margin. It slopes inferiorly as it proceeds laterally. It is formed by fibers that extend anteriorly from the capsulopalpebral fascia into the subcutaneous tissues [14].

Skin and Margin

The eyelid skin is the thinnest in the body, mainly owing to its attenuated dermis. Eyelid incisions therefore heal rapidly. The thinness of the skin also helps to keep scarring to a minimum. As it crosses over the orbital rim, the eyelid skin abruptly thickens.

The surface of the eyelid margin contains numerous important anatomical landmarks for eyelid surgery (Fig. 1.1). The upper eyelid margin has approximately 100 eyelashes, while the

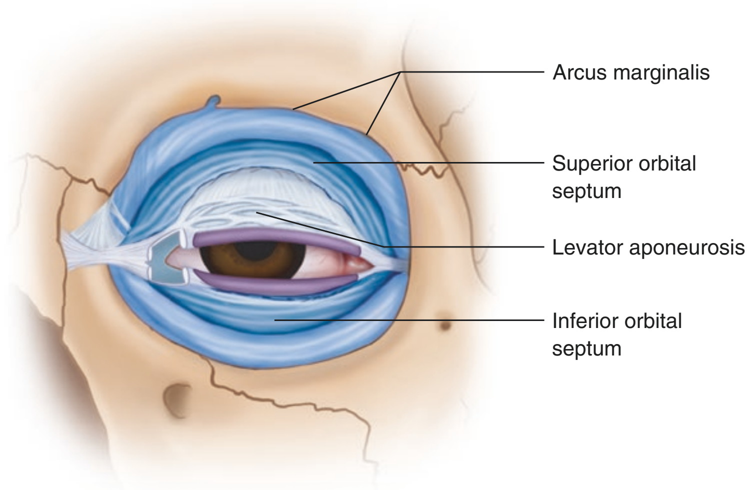


Fig. 1.1 Orbital septum and its relationship with adjacent structures

lower has about 50. Several sebaceous Zeiss glands empty into each lash follicle, while Moll sweat glands are located between follicles. Posterior to the lash line on the eyelid margin is the easily noticeable line of meibomian glands, which emanate from the edge of the tarsus. Between the lash line and the meibomian line lies a faint gray line, which is more pronounced in younger individuals. This represents the edge of the muscle of Riolan, a striated muscle in the same plane as, but distinct from, the orbicularis oculi [15]. The gray line serves as an important surgical landmark, separating the eyelid vertically into the anterior lamella—skin and orbicularis—and posterior lamella: tarsus, retractors, and conjunctiva [16].

Eyelid Connective Tissue

Orbital Septum

The orbital septum (Fig. 1.1) is the boundary between the eyelids and the orbit. It is commonly encountered during eyelid surgery and is easily identified by tugging inferiorly on it to confirm its strong attachment to the orbital rim. The orbital septum is a multilamellar layer of dense connective tissue that lines the orbit and terminates by fusing at the periosteum of the orbital rim. This termination forms the arcus marginalis [11]. Laterally, the septum inserts anteriorly onto the lateral canthal ligament and posteriorly on Whitnall's tubercle on the lateral orbital rim. Medially, the septum splits and inserts in both the posterior and anterior lacrimal crest. Multiple fibrous attachments emanate from the orbital septum, anchoring it anteriorly to the orbicularis muscle [17]. The preaponeurotic fat lies immediately posterior to the orbital septum. In the lower eyelid, the orbital septum fuses with the capsulopalpebral fascia 5 mm inferior to the lower border of the tarsus [14]. In addition, in many Asians a subcutaneous fat pad exists anterior to the septum [18].

The strength of the orbital septum varies among individuals and with age. With time, the septum attenuates, resulting in anterior prolapse of orbital fat [8, 19].

Tarsal Plates

The tarsal plates (Fig. 1.2) provide rigidity to the eyelids. They are composed of dense, fibrous connective tissue. The upper tarsus measures 10–12 mm vertically, and the lower measures 3–5 mm [20]. The tarsal borders adjacent to the

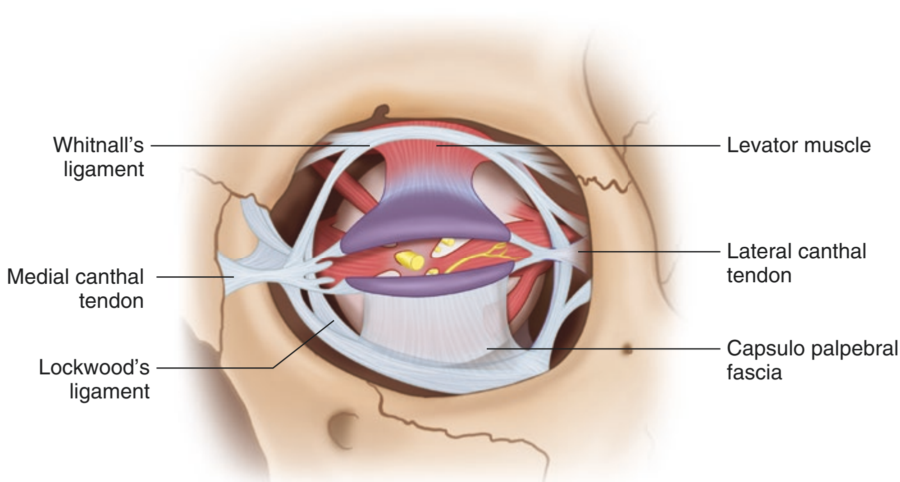


Fig. 1.2 Canthal tendons insertion and Whitnall's ligament

lid margin are straight, whereas the opposite edges have a convex curvature. The posterior edge of the tarsus is firmly attached to the palpebral conjunctiva, which extends onto the eyelid margin.

Within the tarsus lie branched, acinar, sebaceous glands with long central ducts. Known as the meibomian glands, they open at the eyelid margin just posterior to the gray line and secrete the oily layer of the tear film. There are about 25 in the upper eyelid and 20 in the lower [11]. Inflammation of these glands, known as meibomitis, may, over a long term, result in trichiasis [21]. A common treatment for trichiasis, electrohyfrecation, may cause focal necrosis of the tarsus, resulting in notching at the eyelid margin [8]. Similarly, excessive cryotherapy for distichiasis can cause a wider-than-planned area of lash loss and scarring.

Canthal Ligaments

Emanating from the medial and lateral borders of the tarsi and anchoring them to the orbital rim are the canthal ligaments. These are formed by a confluence of the upper and lower crura, the extensions of the margins of the upper and lower tarsi, respectively. They support not only the tarsi but also the orbicularis. The medial canthal ligament splits into three arms: anterior, posterior, and superior. The anterior arm attaches to the maxillary bone, anterior to the lacrimal crest; the posterior arm attaches to the posterior lacrimal crest [22, 23]; and the superior arm inserts onto the orbital process of the frontal bone [24]. The lateral canthal ligament inserts 3–4 mm inside the lateral orbital rim at Whitnall's tubercle, on the zygomatic bone (Fig. 1.2) [25, 26]. During lower eyelid-tightening procedures, which usually involve surgical manipulation of the lateral aspect of the lower tarsus and the lateral canthal ligament, the posterior direction and periosteal insertion of the lateral canthal ligament must be reestablished. Laxity of the canthal ligaments can cause ectropion, as well as cosmetically apparent shortening of the horizontal palpebral fissure [27].

Whitnall's Ligament and Levator Aponeurosis

An important support for the upper eyelid is Whitnall's ligament (Fig. 1.2). Its role has been debated; it may serve as a fulcrum-like check ligament for the levator or as a swinging suspender, providing vertical support for the upper eyelid [17, 28, 29]. Despite this debate, it is understood that Whitnall's ligament suspends the lacrimal gland, superior oblique ligament, levator muscle (with the primary support for the levator coming from the globe), and Tenon's capsule. Whitnall's ligament is a transverse fibrous condensation that inserts medially inside the superomedial orbital rim on the frontal bone at the trochlea and laterally inside the superolateral orbital rim, near the frontozygomatic suture, where it fuses with fibers of the lacrimal gland capsule. It encircles the levator complex [30] at the level of the junction of the levator muscle and the fibrous levator aponeurosis. The levator aponeurosis extends another 14–20 mm inferior to Whitnall's ligament to insert on the lower third of the anterior face of the upper tarsus (Fig. 1.3). Dehiscence of the levator aponeurosis is responsible for most cases of involutional ptosis, and when encountered during ptosis repair it can be identified as a band of pearly, white tissue that retracts on attempted upgaze (Fig. 1.3).

Eyelid Musculature

Orbicularis Oculi, Muscle of Riolan, and Horner's Muscle

The orbicularis oculi muscle surrounds the anterior orbit and can be divided into three components: pretarsal, preseptal, and orbital [31]. The pretarsal orbicularis originates from the anterior and posterior arms of the medial canthal ligament, and it is firmly adherent to the anterior face of the tarsi. Medially, the pretarsal orbicularis divides into a superficial head, which surrounds the canaliculi, and a deep head, which inserts on the posterior lacrimal crest and lacrimal fascia. These insertions allow the pretarsal orbicularis to

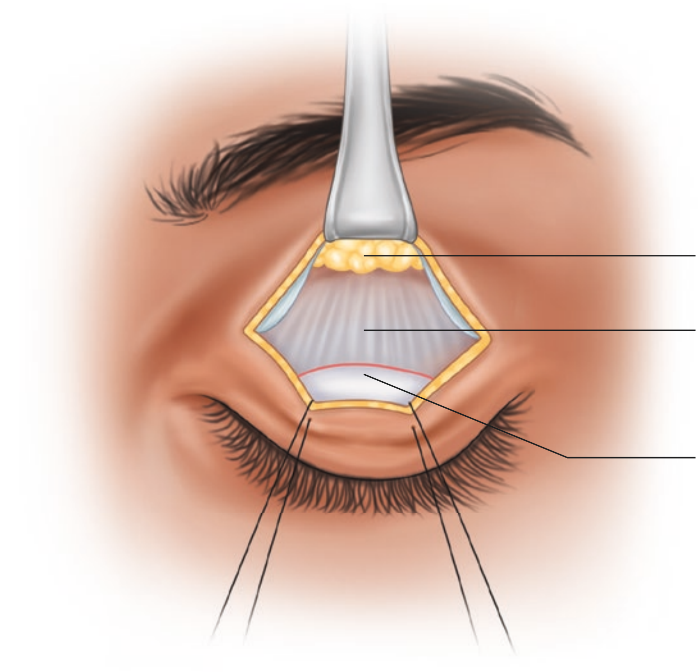


Fig. 1.3 Levator aponeurosis and its relationship to the orbital fat

play an important role in the lacrimal pump mechanism. The preseptal orbicularis originates from the upper and lower margins of the medial canthal ligament and inserts lateral to the orbital rim on the zygoma. It overlies the orbital septum and orbital rim; it is separated from the septum by a fibrofatty layer, the postorbicularis fascia [8]. This layer is an important surgical dissection plane. The orbital orbicularis originates from the maxillary and frontal bones, as well as from the medial canthal ligament; it overrides the orbital rims and inserts at the same location as the preseptal orbicularis. The latter two portions of the orbicularis are responsible for forced eyelid closure (Fig. 1.4).

Two important components of the orbicularis are the muscle of Riolan and Horner's muscle. The muscle of Riolan is a small segment of the orbicularis that is separated from the pretarsal orbicularis by the eyelash follicles [15]. It corresponds to the gray line seen at the eyelid margin [16]. The deep pretarsal head of the orbicularis is known as Horner's muscle. Contraction of this muscle pulls the eyelids medially and posteriorly. In so doing, Horner's muscle compresses the canaliculi and lacrimal ampullae, pushing tears toward the lacrimal sac and, at the same time, creating negative pressure within the lacrimal sac [32]. This mechanism, known as the lacrimal pump [33], can therefore be compromised by weakening or laxity of the eyelids, resulting in epiphora [34].

Levator Palpebrae Superioris

The main retractor of the upper eyelid is the levator palpebrae superioris (Fig. 1.5). It originates at the superior edge of the annulus of Zinn in the orbital apex and courses anteriorly through the superior orbit, along the superior aspect of the superior rectus muscle. As it approaches the upper eyelid, the levator is encircled by Whitnall's ligament [30]. At this point, the levator muscle transitions into the fibrous levator aponeurosis, which courses inferiorly for another 14–20 mm, where the posterior one-third of the lamellae attach to the inferior third of the anterior surface

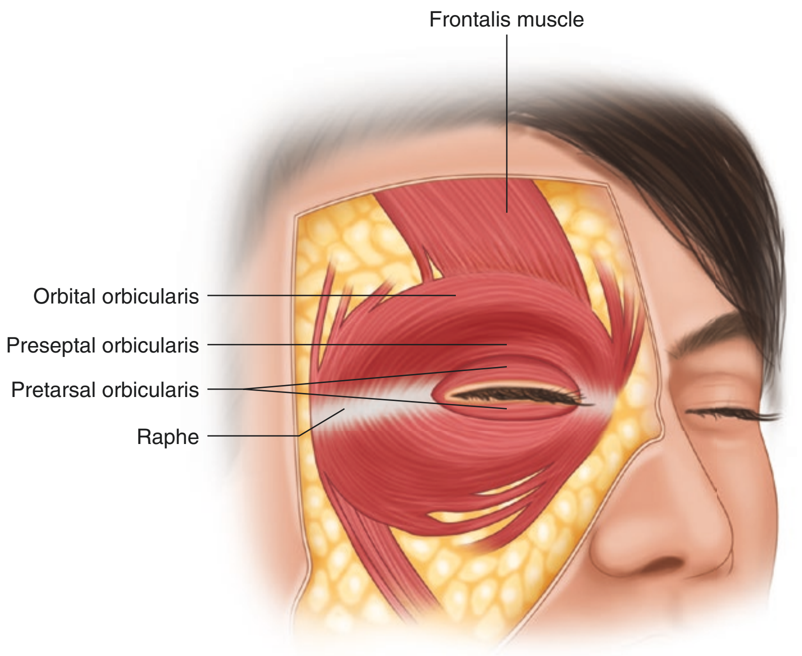


Fig. 1.4 Pretarsal, preseptal, and orbital orbicularis oculi muscle

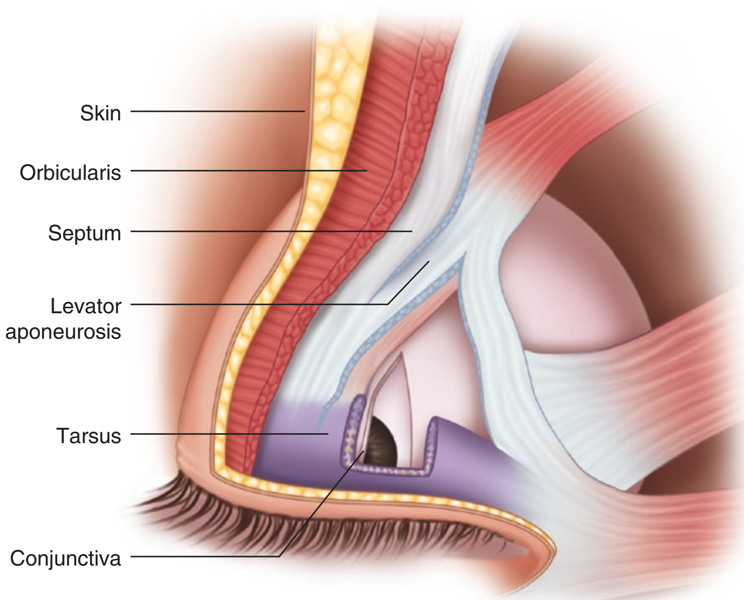


Fig. 1.5 Levator muscle and its relationship to surrounding structures

of the tarsus. Also at the level of Whitnall's ligament, the levator sends off lateral and medial horns. The lateral horn attaches to the zygomatic bone. The medial horn fuses with the posterior arm of the medial canthal ligament and inserts on the posterior lacrimal crest. The lateral and medial horns help ensure that the upper eyelid maintains a curvature that keeps it apposed to the globe during opening [7]. The anterior two-thirds of the lamellae of the levator aponeurosis sends fibers anteriorly through the septum and orbicularis to the skin; these insertions form the upper eyelid crease (Fig. 1.5) [9].

Aging affects both the levator muscle and the aponeurosis. Age-related thinning and dehiscence of the aponeurosis from the tarsus is a common cause of involutional ptosis [35, 36]. In addition, the muscle belly can become infiltrated with fat and connective tissue [8].

Müller's Muscle

Underlying the levator aponeurosis and attached to it via loose connective tissue is Müller's muscle, which is sympathetically innervated and composed of smooth muscle fibers. It originates from the undersurface of the levator and courses inferiorly for approximately 15 mm to insert with elastic fibers onto the superior edge of the tarsus in the upper eyelid (Fig. 1.6). A lateral extension of Müller's muscle divides the lacrimal gland into its two lobes [37]. It is generally accepted that Müller's muscle is a secondary transmitter of lift to the upper eyelid, as evidenced by the 2–3 mm ptosis seen either in sympathetic denervation syndromes, such as Horner's syndrome, or in the normal fatigue-related decrease in sympathetic tone. Some have suggested that Müller's muscle may serve as a primary transmitter of levator muscle tone to the tarsal plate [38].

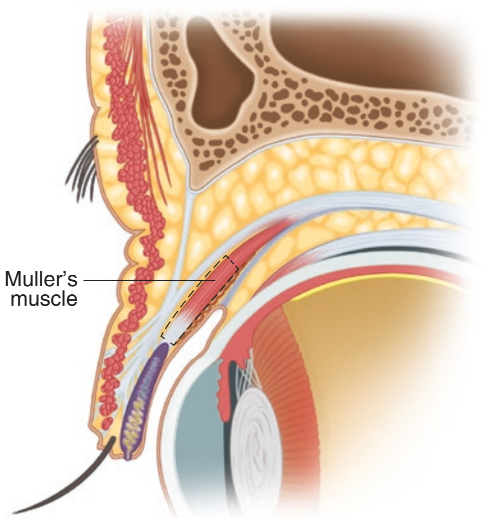


Fig. 1.6 Sagittal view of the Muller's muscle

Lower Eyelid Retractors

Less well-defined than their counterparts that elevate the upper eyelid, the lower eyelid retractors—capsulopalpebral fascia and inferior tarsal muscle—are palpebral extensions of the inferior rectus muscle.(Fig. 1.7). The inferior rectus muscle, through these lower eyelid retractors, is responsible for the full extent of depression of the lower eyelid during downgaze [8]. A fibrous extension of the inferior rectus muscle, the capsulopalpebral head of the inferior rectus wraps around the inferior oblique muscle, at which point the capsulopalpebral head splits into inferior and superior divisions. The inferior division, which is the capsulopalpebral fascia, then rejoins the superior division, the inferior tarsal muscle [14], which, like Müller's muscle, is composed of smooth muscle fibers. These two layers are not generally distinct during surgical dissection.

The lower eyelid retractors have three insertions. Posteriorly, the retractors insert on Tenon's fascia. Centrally, the inferior tarsal muscle fibers terminate a few millimeters inferior to the tarsus [14], and a fibrous continuation attaches to the inferior border of the tarsus. Anteriorly, the capsulopalpebral fascia fuses with the orbital septum 4 mm inferior to the tarsus. Fibers continue through the septum and attach to the subcutaneous tissue, forming the lower eyelid crease [7].

Eyelid Fat Pads

The eyelid fat pads (Fig. 1.8) play an important role in the appearance and contour of the eyelids. In the youthful face, this anterior orbital fat imparts a fullness and smoothness to the upper

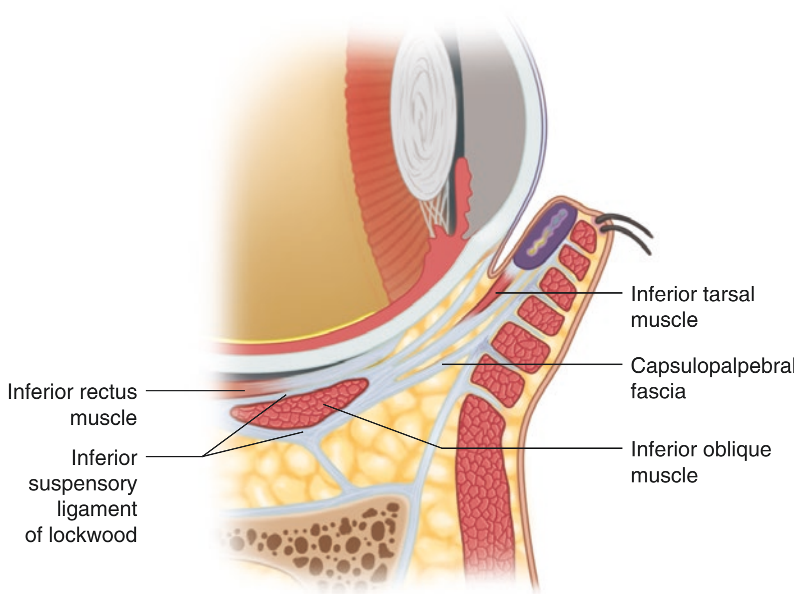


Fig. 1.7 Sagittal view of the capsulopalpebral fascia and its relationship with the lower eyelid retractors

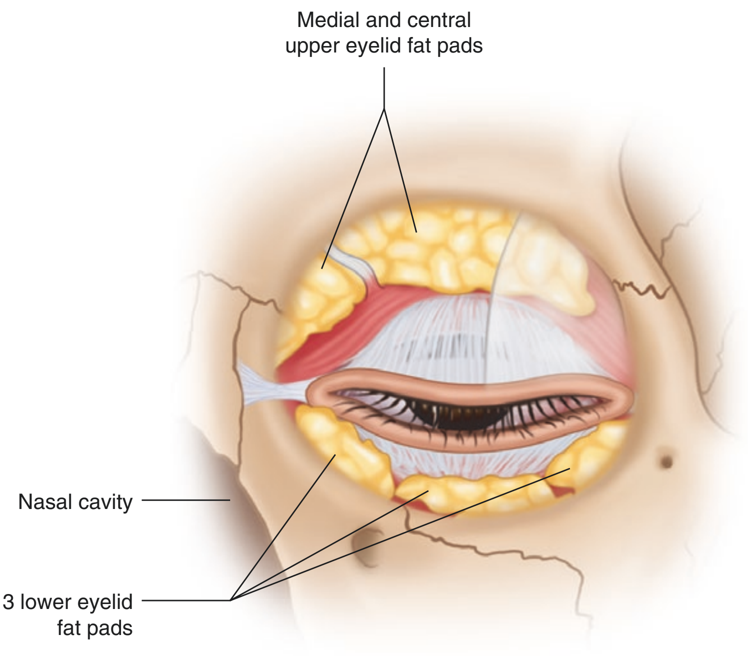


Fig. 1.8 Diagram showing the two fat pads on the upper eyelid, which are located posterior to the orbital septum and immediately anterior to the levator muscle and aponeurosis. The lower eyelid contains three fat pads

and lower eyelids. With age, atrophy of eyelid fat can cause the eyelids to sink posteriorly, resulting in involutional enophthalmos and a lid crease displaced away from the lid margin [27]. In addition, weakening of the orbital septum can allow anterior prolapse of the anterior orbital fat, resulting in puffy-appearing eyelids, known as steatoblepharon [19].

The upper eyelid contains two fat pads, separated by the trochlea and superior oblique tendon, which are located posterior to the orbital septum and immediately anterior to the levator muscle and aponeurosis. This anatomic relation is a reliable guide for the eyelid surgeon who wishes to combine levator aponeurosis repair with blepharoplasty, fat pad excision, or both. This region of the upper eyelid is divided into three fibrous compartments. The medial and central compartments contain the medial and preaponeurotic fat pads [39], and the lateral compartment contains the lacrimal gland. Care must be taken not to confuse the lacrimal gland with eyelid fat in the upper eyelid. The lacrimal gland, which sits lateral to the two upper eyelid fat pads, appears grey and firm, in contrast to the glistening, yellow, loose-appearing fat in the central preaponeurotic pad and the whiter, more fibrous nasal fat pad.

The lower eyelid contains three fat pads that are enclosed in three fibrous compartments: medial, central, and lateral. The inferior oblique muscle courses between the medial and central compartments in the lower eyelid; and the central and lateral fat pads are separated by a fibrous septae extension passing from the inferior oblique to the inferior lateral orbital wall. Because the eyelid fat pads are anterior projections of orbital fat, care must be taken intraoperatively not to cause excessive traction, as orbital hemorrhage may result during the intra- or post-operative period.

Eyelid Vasculature

Arteries

Eyelid blood supply arises from both the external and internal carotid arteries (Fig. 1.9). The external carotid artery gives rise to the facial artery, the superficial temporal artery, and the infraorbital artery. As it courses across the face diagonally toward the nasolabial folds, the facial artery becomes the angular artery, which lies directly underneath the orbicularis and feeds the vascular arcades of the eyelids at the medial canthus. The internal carotid artery gives rise to the ophthalmic

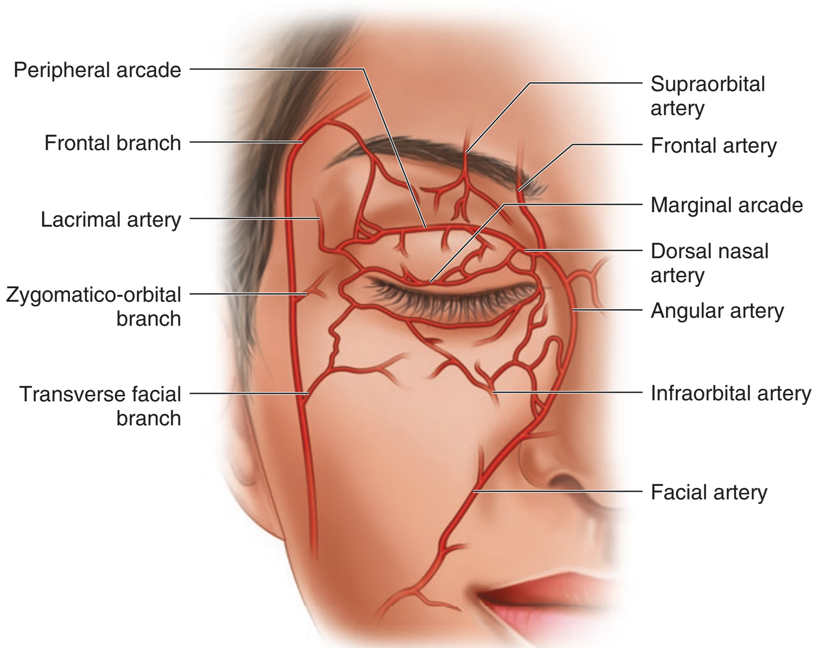


Fig. 1.9 Arterial blood supply to the eyelids

artery, which in turn terminates as the lacrimal, frontal, supraorbital, supratrochlear, and nasal arteries. Anastomoses between the angular, lacrimal, and supratrochlear arteries form the superior marginal arcade and superior peripheral arcade in the upper eyelid. The angular artery anastomoses in the lower eyelid with the infraorbital and zygomaticofacial arteries to form the inferior marginal arcade. A poorly developed inferior peripheral arcade is present in some individuals [7, 8].

In the upper and lower eyelids, the marginal arcades lie just anterior to the tarsi, 2–4 mm from the eyelid margin. Also in the upper eyelid, the superior peripheral arcade lies just anterior to Müller's muscle, superior to the tarsus. This arcade serves not only the upper part of the upper eyelid; it also supplies the superior conjunctival fornix and communicates with the anterior ciliary vessels near the limbus. Dissection in the plane of Müller's muscle can cause hemorrhage from this arcade [8].

Veins

The facial vein is the principal venous drainage source for the eyelids. It courses superficial and lateral to the facial artery. It begins near the medial canthus as the angular vein and anastomoses with the superior ophthalmic vein via the supraorbital vein.

Lymphatics

Lymphatic drainage of the eyelids has been somewhat elusive, but a study by Cook et al. demonstrated in a primate model that the entire upper eyelid drains to the parotid lymph nodes, with additional drainage from the medial upper eyelid to the submandibular lymph nodes [40, 41]. The medial canthus and lateral lower eyelid drain to the parotid lymph nodes. The central and medial lower eyelid drain to the submandibular lymph nodes.

Eyelid Innervation

Sensory Innervation

Sensory innervation to the upper eyelid is provided by the ophthalmic division of the trigeminal nerve (cranial nerve V_1), which has three branches—lacrimal, frontal, and nasociliary—all of which enter the orbit via the superior orbital fissure (Fig. 1.10). The lacrimal nerve supplies the lacrimal gland conjunctiva and lateral upper eyelid, and it sends off a branch that anastomoses with the zygomaticotemporal nerve. The frontal nerve courses anteriorly between the periorbita and levator, dividing into the supraorbital and supratrochlear nerves. The supratrochlear nerve innervates the medial upper eyelid and forehead,

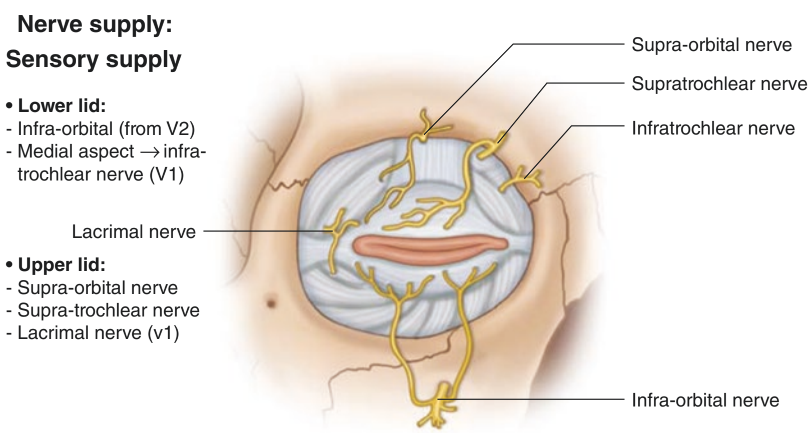


Fig. 1.10 ophthalmic division of the trigeminal nerve (cranial nerve V_1) and the maxillary branch of the trigeminal nerve (cranial nerve V_2)

while the two divisions of the supraorbital nerve innervate most of the remainder of the forehead. A superficial division passes anterior to the frontalis muscle to innervate the forehead skin, and a deep division that passes laterally anterior to the pericranium and supplies the frontoparietal scalp [42]. The nasociliary branch gives rise to the posterior and anterior ethmoidal nerves, two or three long ciliary nerves to the globe, a sensory root to the ciliary ganglion, and a sensory root to the infratrochlear nerve [8].

Sensory innervation to the lower eyelid is provided by the maxillary branch of the trigeminal nerve (cranial nerve V_2). The zygomatic branch from V_3 divides into the zygomaticofacial and zygomaticotemporal nerves. The zygomaticofacial nerve courses along the inferolateral orbit, passes through the zygomaticofacial foramen, and supplies the skin of the cheek. The zygomaticotemporal nerve exits the orbit into the temporal fossa, innervating the lateral forehead. The infraorbital nerve, a continuation of V_2, exits via the infraorbital foramen, yielding several terminal branches—the inferior palpebral, lateral nasal, and superior labial nerves—which supply the skin and conjunctiva of the lower eyelid, the skin and septum of the nose, and the skin and mucosa of the upper lip, respectively [8].

Motor Innervation

Eyelid motor innervation is achieved by cranial nerve III (the oculomotor nerve), cranial nerve VII (the facial nerve), and sympathetic nerve fibers.

Cranial nerve III courses within the muscle cone of the orbit, entering the superior rectus from its inferior aspect, 15 mm from the orbital apex. At this point, it also sends off terminal fibers, which pass around or through the medial aspect of the superior rectus to innervate the levator.

The facial nerve (CNVII) innervates the orbicularis oculi, frontalis, procerus, and corrugator supercilii muscles, and supports eyelid protraction. After originating at its nucleus in the pons, the facial nerve leaves the facial canal via the stylomastoid foramen. It then passes through the parotid gland and gives rise to several divisions: temporal, zygomatic, buccal, mandibular, and cervical nerves. The temporal branch innervates the frontalis muscle and is one of the most commonly injured nerves during forehead and temporal surgical dissection. The temporal, zygomatic, and buccal divisions all innervate the orbicularis oculi, with significant overlap of regions innervated by each nerve.

Sympathetic fibers contribute to upper eyelid innervation of the superior tarsal muscle (Müller's muscle). Sympathetic fibers also innervate the inferior tarsal muscle.

Mid-face and Lower Face

Osteology

The topography of the mid-face is determined to a significant extent by the bony anatomy. The facial bones are demarcated from the bones of the cranium at the level of the orbits. The superior extent of the mid-face is the zygomaticofrontal suture, and the teeth form the inferior border. The posterior border is defined by the sphenoethmoid junction and the pterygoid plates.

Most of the mid-facial bones extend from the borders of the orbit. The zygoma, which forms the lateral facial buttress, and the greater wing of the sphenoid, together form the lateral orbital wall. The medial orbital wall includes the ethmoid, lacrimal, sphenoid, and maxillary bones. Associated with them are the bony nasal turbinates. The maxilla extends from the inferior portion of the medial wall to the orbital floor and extends inferiorly to form the anterior bony surface of the mid-face until giving rise to the upper teeth. The contour of the maxilla has recently been shown to undergo characteristic changes with age [43]. The palatine bone, at its superior extent, forms the posterior orbital floor and extends inferiorly into the posterior mid-face.

The mandible provides skeletal support to the lower face. It forms a synovial joint with the skull

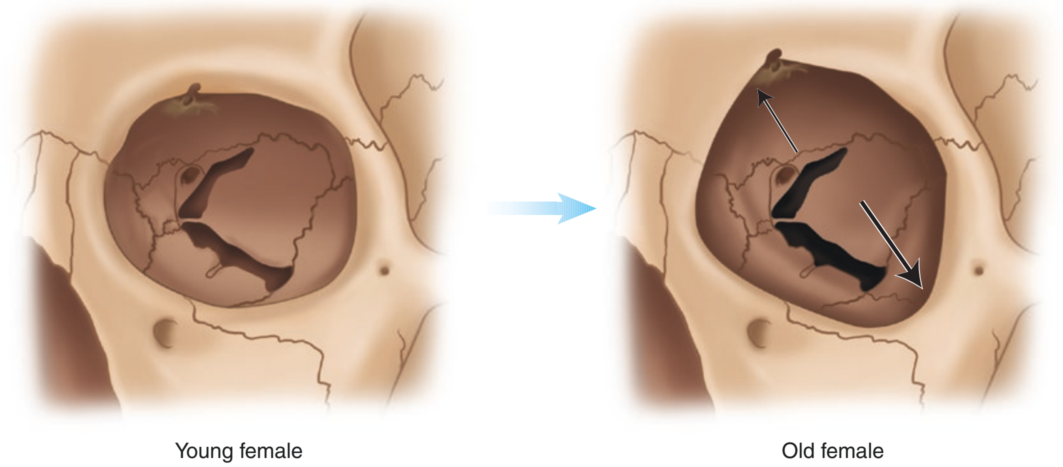


Fig. 1.11 The maxillary arch and the orbital aperture curvature increase with age

at the condyles; the muscles of mastication stabilize this joint.

A series of studies by Pessa et al. indicated that the facial bones remodel throughout adulthood and are partly responsible for the aging changes seen in the mid-face. Specifically, the orbital rim appears to move posteriorly with respect to the plane of the cornea [44], and the maxillary arch and the orbital aperture curvature increase with age (Fig. 1.11) [43, 45].

Skin and Subcutaneous Tissues

The facial skin and subcutaneous tissues vary in thickness, texture, color, and mobility, dividing the face into the aesthetic units discussed in this chapter. The skin consists of three layers: epidermis, dermis, and subcutaneous tissue. The epidermis consists of keratinized, stratified, squamous epithelium. The underlying dermis is divided into a superficial papillary dermis comprised of randomly oriented collagen fibrils and a deeper reticular dermis, which is vascularized and has collagen fibrils oriented parallel to the epidermal surface [46]. The underlying subcutaneous fibrofatty layer varies in thickness among individuals and facial aesthetic units, with the cheeks, temples, and neck being the thickest.

Age-related changes in the skin are usually seen in conjunction with photodamage. They include loss of elasticity, atrophy of subcutaneous fat, and pigmentary changes [47].

Connective Tissue

The predominant connective tissue layer in the mid-face is the superficial musculoaponeurotic system (SMAS) (Fig. 1.12). First described more than 40 years ago [48], the SMAS has been suggested to be a transmitter and distributor of facial muscular contractions to the skin and a key structure in the development of mid-face ptosis. Further anatomic study has characterized the SMAS in the periocular and mid-face regions [49, 50]. In the past two decades, the SMAS has been identified as an important structure in facial rhytidectomy, and the SMAS-invested muscles are recognized as targets for facial soft-tissue augmentation [5].

Structurally, the SMAS is a fibromuscular plane that divides the parotid and cheek fat into two layers [48]. It invests the zygomaticus major, zygomaticus minor, and levator labii superioris [5] and lies 11–13 mm deep to the skin at mid-cheek [51]. It is continuous with the frontalis in the upper face, the platysma in the lower face [52–57], and the anterior and posterior orbicu-

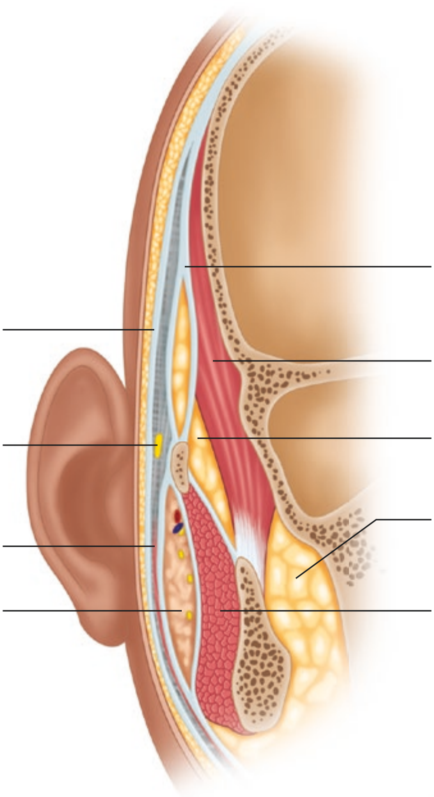


Fig. 1.12 SMAS and its relationship with surrounding structures

laris fascia [50] in the orbital region. The major vessels and nerves, including the motor branches of the facial nerve, lie deep to the SMAS and send perforating branches anteriorly through it.

The following soft tissue attachments support the SMAS: the parotid fascia, the masseteric fascia via masseteric cutaneous ligaments [49], the platysma via platysma auricular ligaments and anterior platysma cutaneous ligaments [58], and the zygomatic major and minor muscles via their bony attachments. Bony attachments are at the zygomatic arch [48, 55] and the mandible [58], as well as at the inferior orbital rim via the orbitomalar ligament [50], which in turn sends fibers anteriorly to the skin to form the nasojugal fold.

The SMAS is subject to age-related changes, which are in large part responsible for mid-face ptosis. Lucarelli et al. demonstrated age-related attenuation of the orbitomalar, masseteric cutaneous, and zygomatic ligaments, which support the SMAS and associated malar and buccal fat pads [49]. Cutaneous projections of the orbitomalar ligament help form the nasojugal and malar skinfolds; increased traction on the ligament by a descended SMAS may be partly responsible for the accentuation of the nasojugal and malar skin folds that appear with age [50]. Involutional descent of the malar fat pad, which attaches to the superficial surface of the SMAS, results in increased prominence of the nasojugal fold [59–61]. A recent outcomes study by Hamra indicated that the malar fat pad may continue to descend more rapidly than the SMAS following facelift surgery [62].

Musculature

The muscles of facial expression are flat muscles that have high variability from one individual to another. Freilinger et al. reported in 1987 the three-dimensional arrangement of these muscles in the mid-face and lower face, dividing the muscles into four layers [63]. The first and most superficial layer includes the orbicularis oculi, zygomaticus minor, and depressor anguli oris. The second layer includes the zygomaticus major, levator labii superioris nasae et alaque, platysma, risorius, and depressor labii inferioris. Progressing deeper, the third layer includes the orbicularis oris and levator labii superioris. The fourth and deepest layer includes the mentalis, levator anguli oris, and buccinator. The facial nerve branches travel between the third and fourth layers, innervating the first three layers from below and the fourth layer from above. Subsequent study has shown the zygomaticus major, zygomaticus minor, and levator labii superioris all to be invested in the SMAS [51], illustrating an evolving understanding of the muscular anatomy of the mid-face.

The muscles of mastication include the masseter and temporalis, with two associated muscles: the buccinator and orbicularis oris. The orbicularis oris acts as a sphincter at the mouth, and the buccinator provides medially directed tension on the cheeks, keeping food in the center of the mouth. The masseter originates at the zygomatic arch and inserts in the mandible. The temporalis inserts at the temporalis fossa and at the medial mandibular ramus and coronoid process. The temporalis is covered by a tough fascia, the deep temporalis fascia. Superior to the zygomatic arch, the superficial temporalis fascia arises and is separated from the deep temporalis fascia by the superficial temporal fat pad. The superficial temporalis fascia is continuous with the SMAS. Densely adherent to the deep aspect of the superficial temporal fascia is the temporal branch of the facial nerve; dissection in this region must therefore be deep to the superficial temporalis fascia, in the plane of the deep temporalis fascia, to avoid injuring the nerve.

Mid-face Fat Pads

The suborbicularis oculi fat pad (SOOF) and the malar and buccal pads are the principal fat pads in the mid-face (Fig. 1.13). The malar fat pad

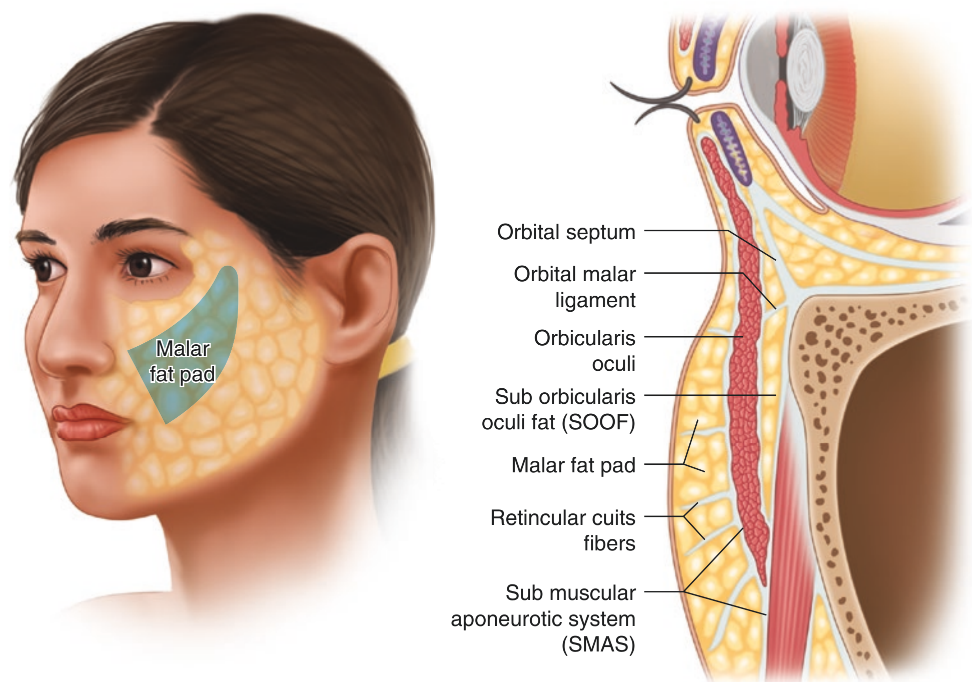


Fig. 1.13 Malar fat pad and SOOF

comprises the subcutaneous fat in the cheek and is continuous with both the jowl fat underneath the jaw-line [60] and the SOOF [49]. The buccal fat pad rests deeper in the face, bounded medially by the buccal mucosa, with buccal, temporal, and pterygoid extensions [64, 65]. This sub-SMAS fat in the malar region has been demonstrated to be continuous with the ROOF fat [50].

Although frequently postulated as a rationale for facial soft tissue augmentation [66–70], few studies since the initial work of Gonzalez-Ulloa and Flores [71] have demonstrated actual volume loss of facial fat and muscles with age.

Facial Vasculature

The facial vasculature arises from the internal and external carotid arteries. The first branch of the internal carotid artery is the ophthalmic artery, which supplies the eyelids, forehead, and dorsum of the nose. The forehead is supplied by the supraorbital and supratrochlear arteries. The eyelids are vascularized by the infraorbital, palpebral, and marginal arteries. The nose is supplied by the anterior and posterior ethmoid arteries.

The external carotid artery branches into the facial, internal maxillary, and superficial temporal arteries. The facial artery supplies the lips via the superior and inferior labial arteries, as well as the lateral nose and nasal dorsum, with anastomoses to the anterior and posterior ethmoidal arteries. Because of these anastomoses, high-pressure injection of steroids or soft-tissue fillers can result in retrograde flow, embolization of the ophthalmic artery or central nervous system vasculature, and ultimately blindness [72–74] or stroke [75, 76]. The internal maxillary artery gives off the infraorbital artery, which enters the orbit at the infraorbital fissure and courses along the infraorbital groove, exiting the orbit at the infraorbital foramen to supply the lower eyelid. Care must be taken not to damage the infraorbital artery and associated nerve during surgical dissection along the orbital floor and inferior orbital rim. The superficial temporal artery branches from the external carotid artery in the parotid gland. At the level of the zygomatic arch, it gives off the transverse facial artery to supply the lateral canthal area. Superior to the zygomatic arch, the superficial temporal artery travels within the plane of the SMAS and gives off the middle temporal artery, which supplies the superficial temporal fat pad and temporalis muscle. Terminal branches of the superficial temporal artery supply the parietal area and forehead, with anastomoses to the supraorbital and supratrochlear arteries.

Facial Innervation

Motor innervation to the mid-face and lower face is via the facial nerve (CN VII). After exiting the stylomastoid foramen, it enters the parotid gland, where it divides into its main branches: temporal, zygomatic, buccal, mandibular, and cervical. The two most subject to surgical injury are the temporal and mandibular nerves.

The temporal nerve exits the parotid gland at its superior border and travels superiorly on the underside of the SMAS to reach the underside of the superficial temporalis fascia superior to the zygomatic arch [63]. Dissection in this region must therefore be deep to the SMAS and superficial temporalis fascia to avoid damage to the temporal nerve.

The mandibular nerve, also at risk for surgical injury, passes superior and parallel to the inferior border of the mandible, deep to the platysma. As it courses medially, it becomes more superficial to innervate the depressor labii superioris and depressor anguli oris posteriorly [77]. Although the mandibular nerve is protected during sub-SMAS dissection laterally, it is subject to injury from medial dissection along the mandible.

Sensory innervation to the face is via the three divisions of the trigeminal nerve (CN V): ophthalmic nerve, maxillary nerve, and sensory mandibular branch (Fig. 1.14). The ophthalmic nerve serves the forehead, upper eyelids, scalp, and dorsum of the nose. Careful attention during dissection in the regions of the supraorbital and supratrochlear foramens prevents injury to these nerves during browlift procedures. The maxillary nerve serves the mid-face, from the lower eyelids

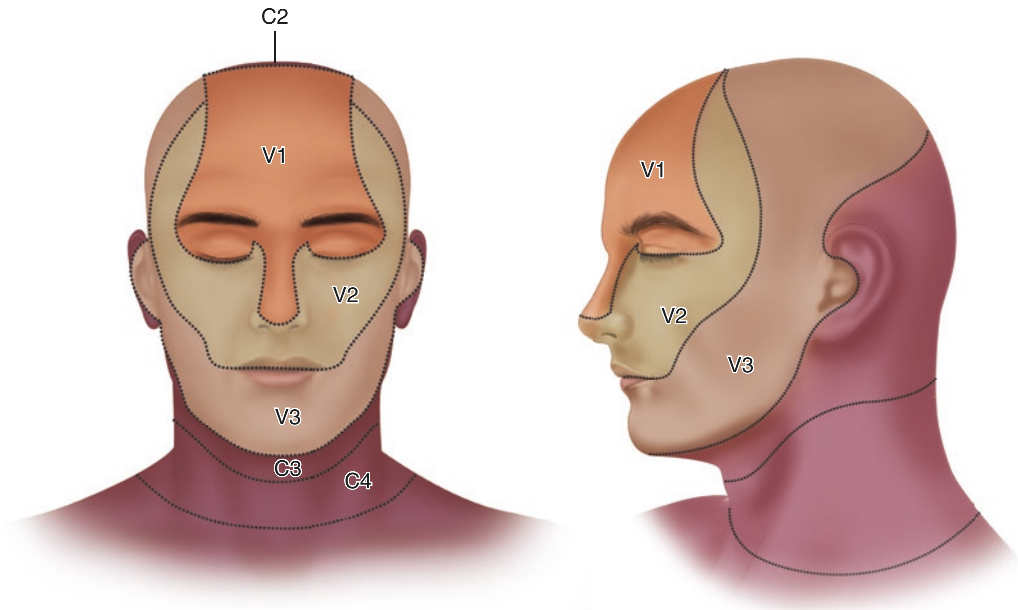


Fig. 1.14 Sensory innervation of the face

to the upper lip. Dissection in the region of the infraorbital foramen during subperiosteal midface lifts can result in cheek paresthesia if the infraorbital nerve is injured. The mandibular branch innervates the lower lip, mandible, and temples; a motor branch provides motor innervation to the temporalis, masseter, and medial and lateral pterygoid muscles.

Acknowledgment *John G. Rose, Jr., MD, Mark J. Lucarelli, MD, and Bradley N. Lemke, MD, FAACS wrote this chapter in the first edition of the* Oculoplastic Surgery Atlas: Cosmetic Facial Surgery.

References

1. Westmore MG. Facial cosmetics in conjunction with surgery. In: Presented at the Aesthetic Plastic Surgical Society Meeting. Vancouver, BC; 1975.
2. Gunter JP, Antrobus SD. Aesthetic analysis of the eyebrows. Plast Reconstr Surg. 1997;99:1808–16.
3. Bosniak SL, Zilkha MC. Cosmetic blepharoplasty and facial rejuvenation. Philadelphia: Lippincott-Raven; 1999.
4. Cook BE, Lucarelli MJ, Lemke BN. The depressor supercilii muscle: anatomy, histology, and cosmetic implications. Ophthal Plast Reconstr Surg. 2001;17:404–11.
5. Rose J, Lemke BN, Lucarelli MJ, Boxrud CA, Dortzbach KL, Dortzbach RK, et al. Anatomy of facial recipient sites for autologous fat transfer. Am J Cosmet Surg. 2003;20(1):17–25.
6. Lemke BN, Stasior OG. The anatomy of eyebrow ptosis. Arch Ophthalmol. 1982;100:981–6.
7. Tarbet KJ, Lemke BN. Clinical anatomy of the upper face. Ophthalmol Clin. 1997;37:11–28.
8. Kikkawa DL, Lemke BN. Orbital and eyelid anatomy. In: Dortzbach RK, editor. Ophthalmic plastic surgery: prevention and management of complications. New York: Raven; 1994.
9. Stasior GO, Lemke BN, Wallow IH, Dortzbach RK. Levator aponeurosis elastic fiber network. Ophthalmic Plast Reconstr Surg. 1993;9:1–10.
10. Gavaris P. The lid crease [editor's note]. Adv Ophthalmic Plast Reconstr Surg. 1982;1:89–93.
11. Meyer D, Linberg JV, Wobig JL, McCormick SA. Anatomy of the orbital septum and associated eyelid connective tissues: implications for ptosis surgery. Ophthalmic Plast Reconstr Surg. 1991;7:104–13.
12. Jeong S, Lemke BN, Dortzbach RK, Park YG, Kang HK. The Asian upper eyelid: an anatomical study with comparison to the Caucasian eyelid. Arch Ophthalmol. 1999;117:901–12.
13. Doxanas MT, Anderson RL. Oriental eyelids: an anatomic study. Arch Ophthalmol. 1984;102:1232–5.
14. Hawes MJ, Dortzbach RK. The microscopic anatomy of the lower eyelid retractors. Arch Ophthalmol. 1982;100(8):1313.
15. Lipham WJ, Tawfik HA, Dutton JJ. A histologic analysis and three-dimensional reconstruction of the

muscle of Riolan. Ophthalmic Plast Reconstr Surg. 2002;18:93–8.
16. Wulc AE, Dryden RM, Khatchaturian T. Where is the grey line? Arch Ophthalmol. 1987;105:1092–8.
17. Anderson RL, Dixon RS. The role of Whitnall's ligament in ptosis surgery. Arch Ophthalmol. 1979;97:705–7.
18. Uchida J. A surgical procedure for blepharoptosis vera and for pseudo-blepharoptosis orientalis. Br J Plast Surg. 1962;15:271–6.
19. Furnas D. Festoons, mounds and bags of the eyelids and cheek. Clin Plast Surg. 1993;20:367–85.
20. Wesley RE, McCord CD Jr, Jones NA. Height of the tarsus of the lower eyelid. Am J Ophthalmol. 1980;90:102–5.
21. Scheie HG, Albert DM. Distichiasis and trichiasis: origin and management. Am J Ophthalmol. 1966;61:718–20.
22. Lemke BN, Della Rocca RC. Surgery of the eyelids and orbit: an anatomical approach. East Norwalk: Appleton and Lange; 1990.
23. Dutton JJ. Atlas of clinical and surgical orbital anatomy. 2nd ed. Philadelphia: Saunders; 2011.
24. Anderson RL. The medial canthal tendon branches out. Arch Ophthalmol. 1977;95:2051–2.
25. Anastassov GE, van Damme PA. Evaluation of the anatomical position of the lateral canthal ligament: clinical implications and guidelines. J Craniofac Surg. 1996;7:429–36.
26. Whitnall SE. On a tubercle on the malar bone, and on the lateral attachments of the tarsal plates. J Anat Physiol. 1911;45:426–32.
27. Van den Bosch WA, Leenders I, Mulder P. Topographic anatomy of the eyelids, and the effects of sex and age. Br J Ophthalmol. 1999;83:347–52.
28. Whitnall SE. The anatomy of the human orbit. London: Oxford University Press; 1932.
29. Goldberg RA, Wu JC, Jesmanowicz A, Hyde JS. Eyelid anatomy revisited: dynamic high-resolution images of Whitnall's ligament and upper eyelid structures with the use of a surface coil. Arch Ophthalmol. 1992;110:1598–600.
30. Codère F, Tucker NA, Renaldi B. The anatomy of Whitnall ligament. Ophthalmology. 1995;102:2016–9.
31. Jones LT. An anatomical approach to the problems of the eyelids and lacrimal apparatus. Arch Ophthalmol. 1961;105:111–24.
32. Doane MG. Blinking and the mechanics of the lacrimal drainage system. Ophthalmology. 1981;88:844–51.
33. Jones LT. Epiphora: its causes and new surgical procedures for its course. Am J Ophthalmol. 1954;38:824–31.
34. Hill JC. Treatment of epiphora owing to flaccid eyelids. Arch Ophthalmol. 1979;97:323–4.
35. Dortzbach RK, Sutula FC. Involutional blepharoptosis: a histopathological study. Arch Ophthalmol. 1980;98:2045–9.
36. Jones LT, Quickert MH, Wobig JL. The cure of ptosis by aponeurotic repair. Arch Ophthalmol. 1975;93:629–34.
37. Morton AD, Elner VM, Lemke BN, White VA. Lateral extensions of the Müller muscle. Arch Ophthalmol. 1996;100:1486–8.
38. Bang YH, Park SH, Kim JH, Cho JH, Lee CJ, Roh TS. The role of Müller's muscle reconsidered. Plast Reconstr Surg. 1998;101:1200–4.
39. Sires BS, Lemke BN, Dortzbach RK, Gonnering RS. Characterization of human orbital fat and connective tissue. Ophthalmic Plast Reconstr Surg. 1998;14:403–14.
40. Cook BE Jr, Lucarelli MJ, Lemke BN, Dortzbach RK, Kaufman PL, Forrest L, et al. Eyelid lymphatics. I. histochemical comparisons between the monkey and human. Ophthalmic Plast Reconstr Surg. 2002;18(1):18–23.
41. Cook BE Jr, Lucarelli MJ, Lemke BN, Dortzbach RK, Kaufman PL, Forrest L, et al. Eyelid lymphatics. II. A search for drainage patterns in the monkey and correlations with human lymphatics. Ophthalmic Plast Reconstr Surg. 2002;18(2):99–106.
42. Knize DM. A study of the supraorbital nerve. Plast Reconstr Surg. 1995;96:564–9.
43. Zadoo VP, Pessa JE. Biological arches and changes to the curvilinear form of the aging maxilla. Plast Reconstr Surg. 2000;106:460–6.
44. Pessa JE, Desvigne LD, Lambros VS, Nimerick J, Sugunan B, Zadoo VP. Changes in ocular globe-to-orbital rim position with age: implications for aesthetic blepharoplasty of the lower eyelids. Aesthet Plast Surg. 1999;23:337–42.
45. Pessa JE, Chen Y. Curve analysis of the aging orbital aperture. Plast Reconstr Surg. 2002;109:751–5.
46. Obagi S, Bridenstine J. Lifetime Skincare. Oral Maxillofac Surg Clin North Am. 2000;12:531–40.
47. Glogau RG. Physiologic and structural changes associated with aging skin. Dermatol Clin. 1997;15:555–9.
48. Mitz V, Peyronie M. The superficial musculoaponeurotic system (SMAS) in the parotid and cheek area. Plast Reconstr Surg. 1976;58:80–8.
49. Lucarelli MJ, Khwarg SI, Lemke BN, Kozel JS, Dortzbach RK. The anatomy of midfacial ptosis. Ophthalmic Plast Reconstr Surg. 2000;16:7–22.
50. Kikkawa DO, Lemke BN, Dortzbach RK. Relations of the superficial musculoaponeurotic system to the orbit and characterization of the orbitomalar ligament. Ophthalmic Plast Reconstr Surg. 1996;12:77–88.
51. Rose J, Lucarelli MJ, Lemke BN. Radiologic Measurement of the Subcutaneous Depth of the SMAS in the Midface. Orlando: In Proceedings of American Society of Ophthalmic Plastic and Reconstructive Surgery, Oct. 18–19, 2002.
52. Gosain AK, Yousif NJ, Madiedo G, Larson DL, Matloub HS, Sanger JR. Surgical anatomy of the SMAS: a reinvestigation. Plast Reconstr Surg. 1993;92:1264–5.
53. Jost G, Lamouche G. SMAS in rhytidectomy. Aesthet Plast Surg. 1982;6:69–74.
54. Ruess W, Owsley JQ. The anatomy of the skin and fascial layers of the face in aesthetic surgery. Clin Plast Surg. 1987;14:677–82.

55. Stuzin JM, Baker TJ, Gordon HL. The relationship of the superficial and deep facial fascias: relevance to rhytidectomy and aging. Plast Reconstr Surg. 1992;89:441–9.
56. Thaller S, Kim S, Patterson H, Wildman M, Daniller A. The submuscular aponeurotic system (SMAS): a histologic and comparative anatomy evaluation. Plast Reconstr Surg. 1990;86:690–6.
57. Wassef M. Superficial fascial and muscular layers in the face and neck: a histologic study. Aesthet Plast Surg. 1987;11:171–6.
58. Furnas DW. The retaining ligaments of the cheek. Plast Reconstr Surg. 1989;83:11–6.
59. Hamra ST. Lifting the malar fat pad for correcting nasolabial folds. Plast Reconstr Surg. 1994;93:661–2.
60. Owsley JQ. Elevation of the malar fat pad superficial to the orbicularis oculi muscle for correction of prominent nasolabial folds. Clin Plast Surg. 1995;22:279–93.
61. Owsley JQ, Fiala TG. Update: lifting the malar fat pad for correction of prominent nasolabial folds. Plast Reconstr Surg. 1997;100:715–22.
62. Hamra ST. A study of the long-term effect of malar fat repositioning in face lift surgery: short-term success but long-term failure. Plast Reconstr Surg. 2002;110:940–51.
63. Freilinger G, Gruber H, Happak W, Pechmann U. Surgical anatomy of the mimic muscle system and the facial nerve: importance for reconstructive and aesthetic surgery. Plast Reconstr Surg. 1987;80:686–90.
64. Kahn J, Wolfram-Gabel R, Bourjat P. Anatomy and imaging of the deep fat of the face. Clin Anat. 2000;13:373–82.
65. Stuzin JM, Wagstrom L, Kawamoto H, Baker TJ, Wolfe SA. The anatomy and clinical applications of the buccal fat pad. Plast Reconstr Surg. 1990;85:29–37.
66. Amar R. Microinfiltration adipocytaire (MIA) au niveau de la face, ou restructuration tissulaire par greffe de tissu adipeux. Ann Chir Plast Esthet. 1999;44:593–608.
67. Coleman SR. Facial recontouring with lipostructure. Facial Cosmet Surg. 1997;24:347–67.
68. Coleman SR. Structural fat grafts: the ideal filler? Clin Plast Surg. 2001;28:111–9.
69. Donofrio LM. Structural autologous lipoaugmentation: a pan-facial technique. Dermatol Surg. 2000;26:1129–34.
70. Klein AW, Wexler P, Carruthers A, Carruthers J. Treatment of facial furrows and rhytides. Dermatol Clin. 1997;15:595–607.
71. Gonzalez-Ulloa M, Flores E. Senility of the face: basic study to determine its causes and effects. Plast Reconstr Surg. 1965;36:239–46.
72. Coleman S. Complications of fat grafts and structural fillers. In: New techniques in minimally invasive aesthetic surgery. Los Angeles; 2002.
73. Ellis P. Occlusion of the central retinal artery after retrobulbar corticosteroid injection. Am J Ophthalmol. 1978;85:352–6.
74. Shafir R, Cohen M, Gur E. Blindness as a complication of subcutaneous nasal steroid injection. Plast Reconstr Surg. 1999;104:1180–2.
75. Feinendegen D, Baumgartner R, Schroth G, Mattle HP, Tschopp H. Middle cerebral artery occlusion and ocular fat embolism after autologous fat injection in the face. J Neurol. 1998;245:53–4.
76. Feinendegen D, Baumgartner R, Vuadens P, Schroth G, Mattle HP, Regli F, et al. Autologous fat injection for soft tissue augmentation in the face: a safe procedure? Aesthet Plast Surg. 1998;22:163–7.
77. Liebman E, Webster R, Gaul J, Griffin T. The marginal mandibular nerve in rhytidectomy and liposuction surgery. Arch Otolaryngol Head Neck Surg. 1988;114:179–81.

2 Endoscopic Foreheadplasty

Evan H. Black, Kathryn P. Winkler, and
Geoffrey J. Gladstone

The positioning of the eyebrow is important for maintaining a periorbital contour and symmetry that is aesthetically pleasing. Many authors have described formulas for positioning the "ideal" brow, but in reality this depends on the patient's characteristics. Each person has unique physical attributes that make him or her attractive, and there is no formula that can encompass these factors. The surgeon must look at each eyebrow on an individual basis.

Etiology

The positioning of the eyebrow is affected by such factors as brow elevator and depressor muscles, genetics, gravity, skin laxity, surgery, trauma, and the patient's expressivity. All or some of these factors result in brow ptosis. Although each eyebrow has its own shape, position, and contour, in general the female eyebrow should lie approximately at or above the superior orbital rim. It should have a curve with the tail of the brow higher than the head of the brow. The male eyebrow should be at the level of the superior orbital rim with a less curved configuration. When planning brow surgery, the imbalance between the elevators (frontalis muscle) and the depressors (orbicularis oculi, depressor supercilii, corrugators, procerus) must be addressed.

The frontalis muscle originates at the skin and superficial fascia of the orbicularis muscle. It inserts into the galea aponeurotica. The main function of the frontalis muscle is to elevate the eyebrows, and it is responsible for the transverse rhytids in the forehead. The corrugator muscle originates at the medial orbital rim and inserts into the frontalis muscle and skin of the eyebrow. It primarily shortens the glabellar space and causes descent of the tail of the brow. It is responsible for the vertical glabellar frown lines. The orbicularis oculi muscle originates at the medial orbital rim and medial canthal tendon and inserts on the medial aspect of the bony orbit. It depresses the total brow and is responsible for vertical rhytids. The depressor supercilii muscle also originates at the medial orbital rim and medial canthal tendon, and it inserts on the medial aspect

Electronic Supplementary Material The online version of this chapter (doi:10.1007/978-3-319-67331-8_2) contains supplementary material, which is available to authorized users.

E.H. Black, MD, FACS
G.J. Gladstone, MD, FAACS (✉)
Consultants in Ophthalmic and Facial Plastic Surgery, PC, 29201 Telegraph Rd #324, Southfield, MI 48034, USA

Oakland University William Beaumont School of Medicine, Royal Oak, MI 48034, USA

Wayne State University School of Medicine, Detroit, MI 48034, USA
e-mail: bleph@att.net; facialwork@gmail.com

K.P. Winkler, MD
Kresge Eye Institute, Wayne State University School of Medicine, 4717 St. Antoine Street, Detroit, MI 48201, USA
e-mail: kathryn.winkler@gmail.com

G.J. Gladstone et al. (eds.), *Oculoplastic Surgery Atlas*, https://doi.org/10.1007/978-3-319-67331-8_2

of the bony orbit. It is responsible for depressing the head of the brow. The procerus muscle originates at the nasal bone fascia and upper cartilages. It inserts onto the skin at the medial lower forehead. Like the depressor supercilii, the procerus depresses the head of the brow. It is responsible for the horizontal rhydits at the radix of the nose. These muscles comprise the forehead musculature with which the surgeon must be thoroughly familiar for endoscopic dissection.

Clinical Evaluation

The surgeon must recognize the fundamentals of forehead rejuvenation by understanding the changes that occur in the aging upper face. Forehead ptosis should be suspected in every patient who has redundant upper eyelid skin even if the eyebrow appears to be in a normal position. Many patients lift up the eyebrow with their finger when they want eyelid surgery (Flower's sign). This should be a cue to the surgeon to evaluate the patient for forehead, not eyelid, surgery. This should also help begin to align the surgeon with the patient's expectations. Upper eyelid skin hanging over the eyelid margin in the lateral periorbital area (Connell's sign) is also a feature of forehead ptosis. The patients should be evaluated in repose to determine the situation accurately. Those with deep transverse forehead creases also suffer from forehead ptosis. Patients sometimes present with chronic forehead spasms, giving a falsely normal brow height. It is important to have the patient relax the forehead by gently closing the eye, which relaxes the frontalis muscle. This muscle is then blocked with the examiner's finger and the patient opens his or her eyes gently. The true level of the brow can then be measured accurately. The most common error is assuming that forehead ptosis is not present because the eyebrow appears normal. It is also important to note that patients, women more than men, pluck their lateral brow to give the illusion that it is higher. It is also important to note any brow tattoos that are present. Often, patients will have tattoos placed higher than their actual brow position to correct the appearance of brow ptosis. Presence of these tattoos should be noted and discussed with patients prior to surgery.

The goal of endoscopic forehead surgery is to elevate the brow, decrease forehead rhytids, decrease vertical glabellar rhytids, improve lateral canthal hooding, and decrease infrabrow skin. A proportional face should be divided into equal thirds, and a balanced face should be five eyewidths wide. Patients should be given a handheld mirror during the examination. This gives them the opportunity to look at themselves and specifically point to areas of concern. They can also describe their goals. Watch carefully for Flower's sign, and look for Connell's sign; this practice allows you to show them possible realistic surgical outcomes. Additionally, this practice allows the surgeon to demonstrate the contribution of brow position as well possible dermatochalasis to upper eyelid crowding. A lid creaser device can help demonstrate what a blepharoplasty alone might accomplish versus forehead elevation. Document this in writing and with photographs. It is best to determine a standardized approach to recording brow position in the patient's chart.

Two useful preoperative quantitative measurements are the glide test and the frame height. The glide test measures brow excursion in the medial, central, and lateral portions of the brow. The frame height measures the distance from midpupil to the top of the brow. Typically, the best improvements using the endoscopic forehead procedure occur with frame heights of 1.5–2.0 cm and glide test values of 2.0–3.0 cm. It is more common to undercorrect than overcorrect brow height. Most surgeons lift the brow 1.0–1.5 cm.

Medical Management

Once the forehead evaluation is complete, the surgeon must develop a management plan. Medical management with botulinum toxin can be used for mild brow ptosis. This is a temporary measure, lasting around 3–4 months. Injection of superolateral portion of the orbicularis oculi muscle below the lateral third of the brow can achieve elevation of the brow. In some female patients, injection into the central orbicularis oculi below the brow can alleviate some brow ptosis. This technique may be used independently or in conjunction with a forehead lifting procedure. For moderate to severe brow ptosis, however, botulinum toxin alone is unlikely to produce a significant, noticeable change. It is essential for those administering botulinum toxin to understand that placing this medication in the frontalis muscle will *not* raise the brow. This will inhibit frontalis function and may lower the brow and/or decompensate the frontalis effort that the patient is using to keep the brow elevated.

Surgical Management

Several surgical options exist for lifting the brow. Preoperatively it is important to discuss the patient's goals and expectations to determine the appropriate surgical option. If the patient is interested in lifting the brow for functional purposes only, and they don't mind the potential resultant scar, direct or temporal direct brow lifts are good options. These procedures involve excising an ellipse of tissue directly above each brow. A mid-forehead lift is an option in patients with deep forehead rhytides. The incision line is marked the entire length of the forehead within a forehead furrow and an ellipse of tissue is excised (Fig. 2.1). An internal brow pexy or transblepharoplasty brow lift is performed through an upper blepharoplasty incision by dissecting to the superior orbital rim and fixating the brow with either suture or fixation devices. Cosmetic options include pretrichial, coronal, and endosopic forehead lifts. A pretrichial forehead lift is best used in patients with a high forehead, as it is a forehead shortening technique. A pretrichial incision just anterior to the hairline and a direct visualization dissection is carried out to release the forehead. A coronal approach raises the forehead through an elliptical scalp incision anterior to the coronal suture extending from ear to ear. Finally, an endoscopic forehead approach allows a minimally invasive forehead lift with incisions hidden in the hairline (Video 2.1).

For an endoscopic forehead lift, marking is critical when planning for the surgery (Video 2.2). The supraorbital nerve can be measured approximately 2.4 cm from the midline, and the supratrochlear nerve is usually 1.6 cm from the midline. Sometimes branches of the supraorbital nerve are located more temporally and supply the surface of the skin. An arch extending 1.5–2 cm above the brow is marked to prevent injury to the supraorbital nerve. This nerve exits at the notch most frequently but emerges from a foramen up to 1 cm above the brow (Fig. 2.2). Blunt subperiostial dissection can be done up to this point. A 1 cm safety zone is marked in the temporal area to prevent injury to the facial nerve. Blunt dissection can be performed temporally with reasonable safety up to this point.

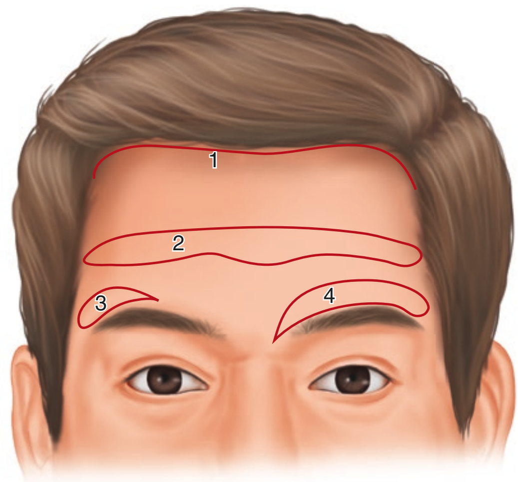


Fig. 2.1 Incision placement for varies types of forehead lifts

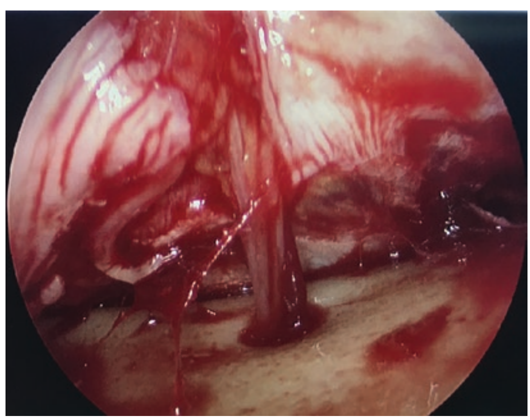


Fig. 2.2 Supraorbital nerve emerging from a foramen

One central, two lateral, and two temporal incisions are made (Fig. 2.3). Sometimes only two paracentral and two temporal incisions are needed. The central incision is marked at 1 cm behind the hairline, extending 1.0–1.5 cm in length. The paramedian incisions are marked approximately 4.5 cm lateral to prevent injury to the superficial branches of the supraorbital nerve, which supply sensation between these areas. This incision extends 1.0–1.5 cm in length. The fixation points for the scalp are marked just anterior and lateral to the paramedical incisions superior to the area of the brow with the desired maximal arch in a female. In a male, more medial placement of the fixation points will allow for the more masculine "T-shaped" brow. The temporal markings are done 2.5 cm posterior to the hairline, extending 3.5 cm in length. The midline of this incision is perpendicular to a line drawn from the lateral nasal ala to the lateral canthal angle. In the presence of male pattern baldness, these incisions can be made behind the fringe line. The temporal incisions help raise the lateral canthal angle and temporal brow. Many surgeons prefer to excise an ellipse at the temporal incisions. This reduces the skin redundancy when the temporal area is elevated. Typically this ellipse would be no more than 10–15 mm in thickness.

There is a temporal crescent that separates the two areas of dissection: the frontal pocket and the temporal pocket. This crescent is where the periosteum transitions to the deep temporal fascia and where the galea aponeurotica and superficial temporal fascia fuse. Anatomically, this is referred to as the conjoint fascia/tendon or the superior temporal septum. It can be palpated along the lateral portion of the superior orbital rim, and it extends superolaterally. It is more pronounced when the patient clenches the jaw. A marking is placed at the right and left lateral orbital rims at the level of the lateral canthal angle. This denotes the approximate area of the

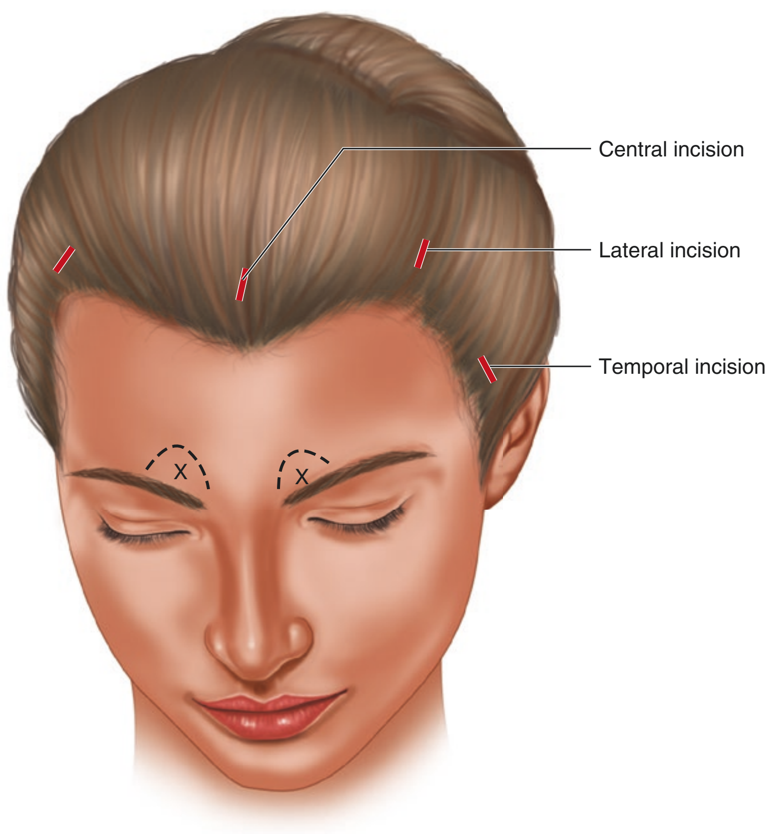


Fig. 2.3 Incision sites for endoscopic foreheadplasty. The X marks the supraorbital notch, and the dotted line encloses an area where dissection is performed with direct visualization

zygomaticotemporal (sentinel) vein. This is an important landmark at it denotes approximate location where the temporal branch of the facial nerve traverses the dissection plane to become more superficial. The temporal branch of the facial nerve runs from the lower portion of the tragus to 1.5 cm above the temporal eyebrow. It originates deep near the parotid gland and courses superiorly over the periosteum at the zygomatic arch. It then becomes more superficial and runs on the deep surface of the superficial temporalis fascia before entering the undersurface of the frontalis muscle. The sentinel vein should be the extent of the lateral dissection for the procedure.

Many cases are performed under local anesthesia with sedation. When first starting this procedure, it may be wise to use general anesthesia in the event the patient becomes uncomfortable or moves. A 50/50 mixture of 2% lidocaine with 1:100,000 epinephrine and 0.5% bupivacaine with 1:100,000 epinephrine is used for bilateral supraorbital nerve blocks. The same mixture is then administered along the surgical markings, across the entire forehead and along the lateral orbital rims. Always limit the amount of lidocaine and bupivacaine to a safe dose for the patient's weight.

A No. 15 blade is used to incise along the temporal incision/ellipses. Blunt dissection is carried out to identify the superficial temporalis fascia. Once identified, a skin flap is removed to expose the superficial temporalis fascia. Further dissection is carried to expose the deep temporalis fascia, which is immediately superficial to the temporalis muscle. This fascia is a shiny, white, fibrous glistening tissue. The plane at the superficial layer of the deep temporalis fascia is the plane of dissection (Fig. 2.4). The temporal branch of the facial nerve lies within the

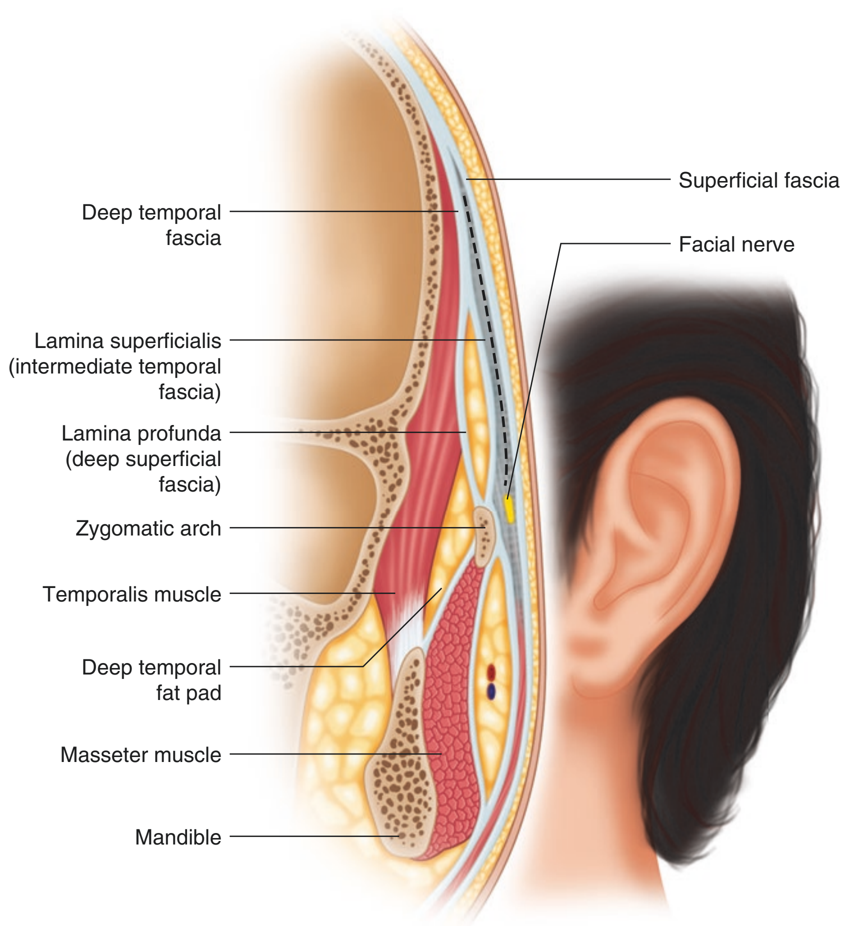


Fig. 2.4 Anatomy in the temporal area. The *dotted line* is the appropriate plane of dissection

superficial temporalis fascia and is superior to the surgical plane, out of harm's way. The temporal artery is often encountered during this dissection. It should be ligated or avoided if possible. Blunt dissection using a flat elevator and/or finger dissection is performed toward the lateral orbital rim, staying at least 2 cm from the mark at the lateral canthal angle denoting the approximate area of the sentinel vein.

The endoscope is now introduced through the temporal incision above the deep temporalis fascia. A blunt elevator and blunt dissection with scissors is used to dissect toward the lateral canthal angle under direct visualization. At the lateral orbit, the orbicularis-temporal ligament is visible as a tough ligament joining the lateral orbicularis and the deep temporal fascia. The sentinel vein is encountered just beyond this point. It is typically 5 mm temporal to the zygomaticofrontal suture line. It is here that branches of the facial nerve are located, so the dissection should be minimal. Once the sentinel vein is visualized, no further dissection inferior or most lateral is required. The lateral canthal angle can be released under direct visualization.

Attention is then turned to the central and lateral incisions. A No. 15 blade is used to incise the skin and scalp down to the periosteum. Using a flat elevator, blind blunt dissection is carried out across the forehead in the subperiostial plane, avoiding the area marking the supraorbital nerve. The procerus muscle is detached using a flat elevator either blindly or under direct visualization with the endoscope to reduce the horizontal rhytides at the radix of the nose. The temporal and central pockets are connected blindly, laterally too medially, detaching the conjoint fascia/tendon. If necessary, under direct endoscopic visualization, sharp dissection with scissors may be used to sever all attachments of the conjoint fascia/tendon, taking care to remain in the appropriate plane. Dissection should be carried out until the periosteum is completely released across the orbital rim. The periosteum and galea should be horizontally severed for adequate release (Fig. 2.5).

The arcus marginalis is then released along the superior orbital rim, lateral to medial, avoiding the supraorbital nerve. This can be undertaken blindly using either an elevator or finger dissection. The endoscope is once again brought into the field to identify the supraorbital nerve. Once the supraorbital nerve is located, a supraperiosteal pocket is formed above the bridge of the nose to address the depressor muscles (procerus, corrugator, depressor supercilii, and orbicularis). Using blunt dissection, the tissues are moved side to side to separate the muscles for better visualization. At this point the tough corrugators can be seen with their insertion and origin on both sides. The corrugators can be avulsed, rather than cut, to prevent injury to the supratrochlear nerve. This can be accomplished with endoscopic scissors or laser. Branches of the supratrochlear nerve are sometimes seen within the corrugator and should be avoided. The depressor supercilii should also be avulsed and not cut because of vessels within it.

Fixation

Once the periosteum has been adequately released, attention is given to fixation. There are many methods available to fixate the scalp. The key to the endoscopic forehead procedure is not as much the fixation as it is the release of the periosteum and the muscles. Anchor or screw techniques for fixation include use of an internal screw or plate, Mitek anchor, external screw, and k-wire. Other techniques include galeafrontalis-occipitalis release, use of lateral suspension sutures or bolster fixation sutures, anterior scalp port excision, galea-frontalis advancement, creation of a cortical tunnel, and use of tissue adhesives. The Endotine™ forehead fixation device (MicroAire Aesthetics, Charlottesville, VA) was introduced in 2003. The anchoring device is made of a biodegradable, polyactic acid implant on a triangular platform with five times and a bone peg for attachment. Regardless of the technique, it must achieve simplicity, reproducibility, safety, and long-term results. If the fixation is under tension, brow ptosis occurs. We prefer Endotine™ fixation (Video 2.3).

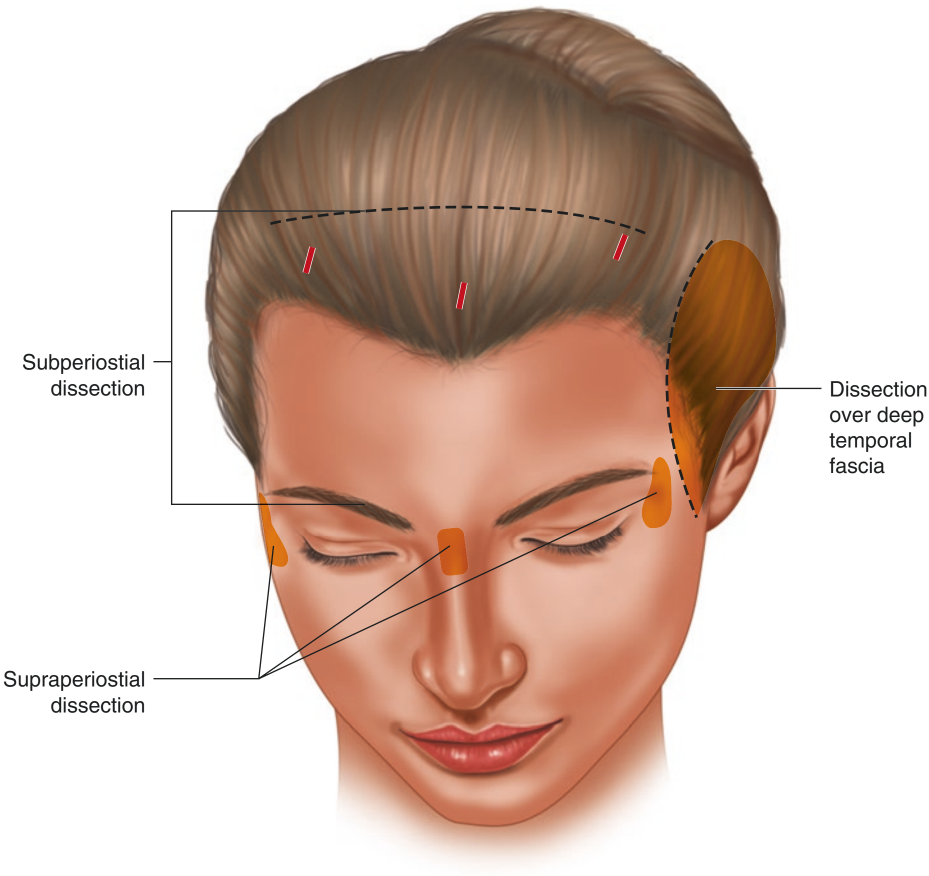


Fig. 2.5 Areas of subperiostial and supraperiostial dissection

The site for the planned Endotine™ placement is approximately 1.0–1.5 cm from the anteriormost portions of the lateral or paracentral incisions. A Bovie cautery can be used to score the bone to reduce slippage of the drill. The Endotine™ drill bit has a cutting surface and a stop to prevent drilling too deeply into the outer calvarium. Gentle downward pressure should be exerted on the drill while the other hand rotates the drill. Once drilled, the Endotine™, grasped by an insertion device, is inserted, ensuring it is perpendicular to the bone. The Endotine™ should snap into position and should not easily move. The scalp is pulled superiorly and placed onto the Endotine™ (Fig. 2.6). The central and temporal incisions are closed using staples or suture. The superficial temporalis fascia is advanced and closed used buried, interrupted 2–0 PDS suture. The incisions are then closed using skin staples or suture.

Postoperative Care

After the hair is washed with shampoo, ABD pads and Kerlex dressings are placed around the forehead for 24 h. Complete wound healing usually occurs within 42–60 days. Postoperative antibiotics, anti-inflammatories, and analgesics are provided at the discretion of the physician. The staples are removed in 7–10 days. Patients usually can return to work in 3–5 days. They are instructed preoperatively that scalp numbness

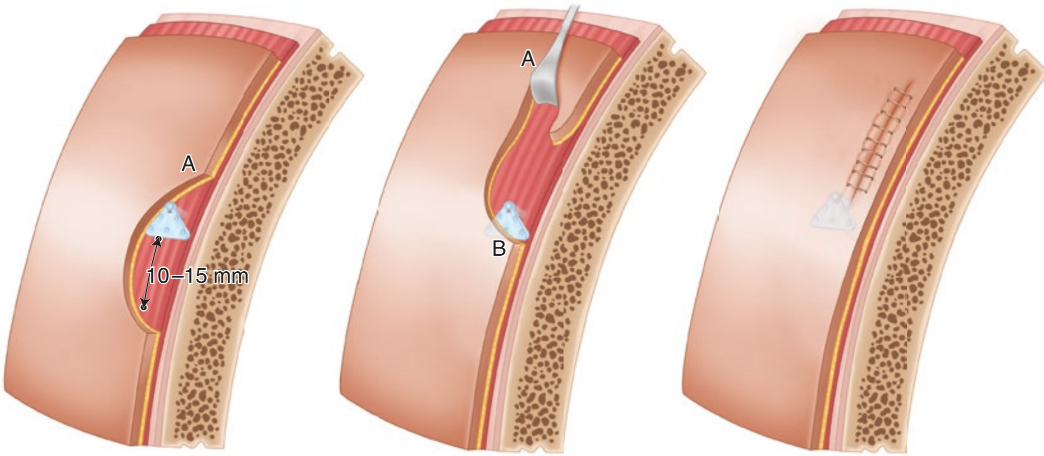


Fig. 2.6 Brow fixation technique with Endotine

may persist for 3 months, and "hair shock" can result in some alopecia around the incision sites also, lasting 3 months.

A worrisome complication is injury to the facial nerve, but it can usually be avoided by carefully dissecting in the correct plane. Hematomas and infections are rare. This procedure can be performed on bald patients with minimal scarring. Endoscopic foreheadplasty is an accurate procedure that has a higher patient acceptance rate than the traditional coronal lift. With good technique, release, and fixation, the results are long lasting. It is a nice addition to the surgeon's armamentarium of brow lift procedures.

3 Direct Eyebrow Lift

César A. Sierra and Geoffrey J. Gladstone

Before moving to more complex approaches such as the endoscopic eyebrow lift, the surgeon must master the fundamental concepts of preoperative evaluation, indications for surgery, surgical anatomy, and the basic direct browlift procedure.

The direct eyebrow lift is generally performed with local anesthesia and requires excising the tissues adjacent to the superior portion of the brow. The advantages of a direct approach include less operating time, less anesthesia, and the ability to address the whole eyebrow or a specific segment of it by manipulating the shape of the excised tissue. In general, the closer the surgery is performed to the eyebrow the more effective it is. The direct browplasty is therefore an excellent option in cases of severe brow ptosis or in patients with a receding hairline or baldness where incisions used for other approaches would still leave scars. The degree of elevation and the long-term results are excellent when compared with other approaches. The major negative aspect is the inferior cosmetic outcome with a supraciliary scar that is sometimes more visible and depressed than expected, depending on the healing ability of the patient.

Etiology

As the aging process continues, the gravitational syndrome occurs at different rates in different people, resulting in sagging or involutional ptosis of the eyebrow with redundancy of skin. Downward displacement of the tissues also takes place as a result of facial overactivity patterns such as squinting and frowning. In these cases the overactive depressor muscles determine the most affected area of the brow. Paralysis of the facial nerve [cranial nerve (CN) VII] or its temporal branch also leads to moderate-to-severe eyebrow ptosis with blunting of the ipsilateral forehead rhytids due to loss of tone of the frontalis muscle.

Preoperative Evaluation and Incision Markings

The position of the eyebrows is extremely important when evaluating a patient who complains of superior visual blockage or drooping eyelids. It is

Electronic Supplementary Material The online version of this chapter (doi:10.1007/978-3-319-67331-8_3) contains supplementary material, which is available to authorized users.

C.A. Sierra, MD
Bridgeport Hospital, 125 Kings Highway North, Westport, CT 06880, USA

G.J. Gladstone, MD, FAACS (✉)
Consultants in Ophthalmic and Facial Plastic Surgery, PC, 29201 Telegraph Rd #324, Southfield, MI 48034, USA

Oakland University William Beaumont School of Medicine, Royal Oak, MI 48034, USA

Wayne State University School of Medicine, Detroit, MI 48034, USA
e-mail: facialwork@gmail.com

G.J. Gladstone et al. (eds.), *Oculoplastic Surgery Atlas*, https://doi.org/10.1007/978-3-319-67331-8_3

common for patients who present with upper eyelid ptosis or dermatochalasis to also have eyebrow ptosis. This sagging of the eyebrow can add fullness and weight that, when combined with excessive eyelid skin, can result in more hooding and loss of superior visual field. Recognition is crucial to prevent inadequate surgical management and failure to help the patient.

Gender differences exist, with eyebrows being higher, more arched, and slightly raised laterally in women. Male eyebrows are usually described as T-shaped: They tend to be flat and lower, with the inferior border at the level of the superior orbital rim. This baseline difference could be the reason that brow ptosis is more prevalent in men than in women.

The preoperative evaluation is always performed with the patient sitting upright with relaxed frontalis muscle action. A 1:1 lift desired/skin excised ratio is used. The eyebrow is manually elevated to an appropriate position. This amount of lift is measured using a ruler in the lateral, central, and medial aspects of the eyebrow. A fusiform skin incision pattern is usually obtained where the upper line of eyebrow hair follicles dictates the inferior marking, and the superior marking is given by the measurements previously taken for each portion of the eyebrow. It is recommended that the supraorbital notch be marked to maintain awareness of where the supraorbital neurovascular bundle exits and becomes more superficial.

Surgical Management

After the skin markings are outlined with a surgical marking pen, the area is adequately infiltrated with local anesthetic. The incision (Fig. 3.1) is started at the inferior marking where the superior-most brow follicles follow a cephalad orientation. The incision must be made with the blade beveled approximately 15° away from these follicles in order to prevent both excessive loss of eyebrow hair and a conspicuous scar (Fig. 3.2). The incision on the superior marking follows, with the blade angled in the same direction to provide adequate apposition and eversion of the wound edges. Care should be taken to incise superficially in the area of the supraorbital neurovascular bundle to avoid inadvertent injury. Deeper sharp dissection and excision of the skin and subcutaneous tissue are done laterally, where there is no risk of

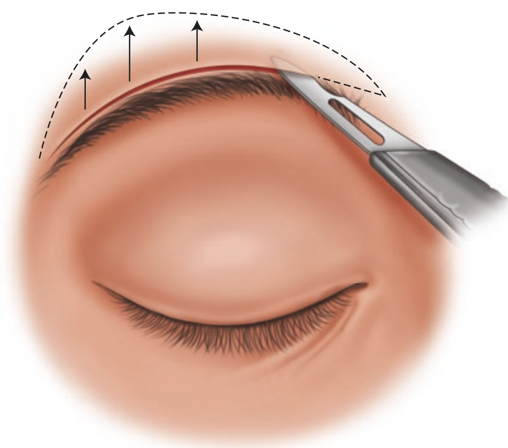


Fig. 3.1 Suprabrow incision after marking the incision site

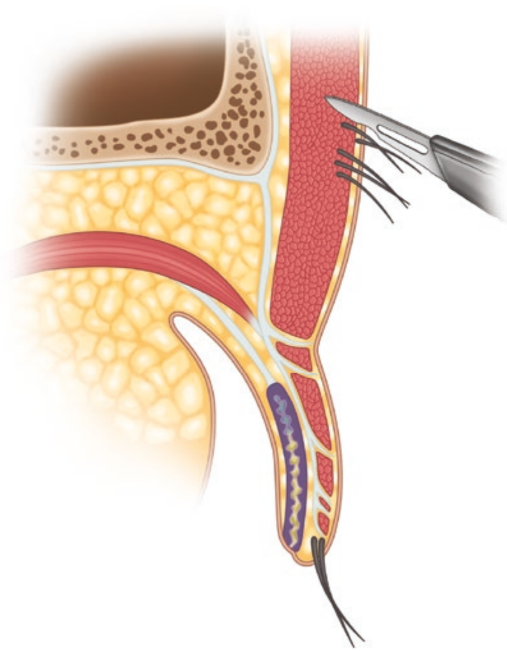


Fig. 3.2 Incision is beveled away from the brow hairs to parallel the direction of the follicles

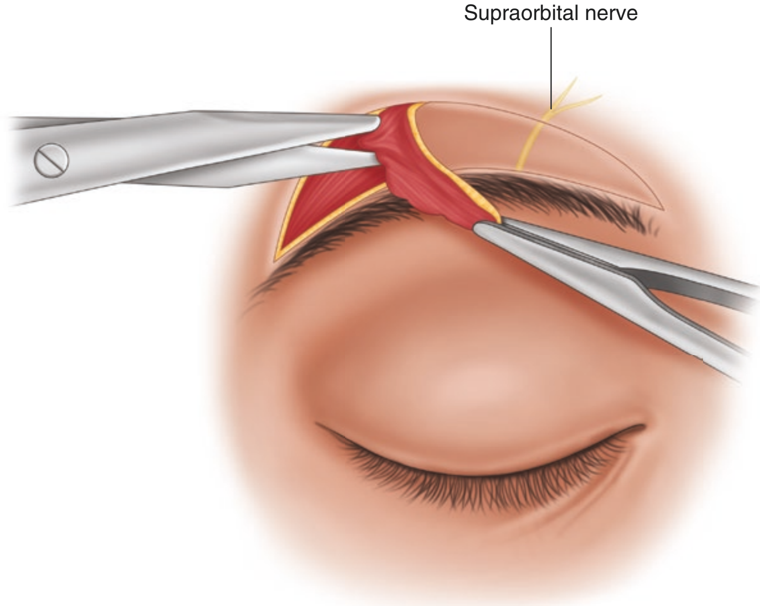


Fig. 3.3 Skin and muscle flap are removed with scissors. In the region of the supraorbital nerve, the dissection must be superficial to avoid damaging the nerve

damage to the supraorbital neurovascular bundle (Fig. 3.3). Careful superficial dissection in the medial aspect of the eyebrow and hemostasis follows.

The wound is first approximated with multiple, buried subcutaneous 5–0 Vicryl sutures. Each suture must be perfectly aligned in the plane horizontal to the wound edges. It is also crucial that the bites taken with this suture maintain exactly the same depth in the vertical aspect of both sides of the wound to provide precise apposition of the edges, thereby decreasing scar formation.

The tendency of the scar, as it heals, is to draw the skin toward the vertical axis, depressing it. Therefore the epidermis should be closed with a 6–0 non-absorbable suture in a vertical or horizontal mattress fashion to achieve an adequate amount of eversion of the skin edges to allow the expected flattening.

For cases of severe facial nerve (CN VII) paralysis, it is recommended that dissection be carried deeper through the frontalis muscle and nonabsorbable 5–0 or absorbable 4–0 sutures be carefully passed though the muscle and periosteum in a buried fashion to achieve better fixation of the ptotic brow. For milder cases of brow ptosis, this technique would create a more depressed scar and diminish the action of the frontalis muscle. The asymmetry created by unilateral blunting of the deep forehead rhytides in these cases can be corrected if the incision is created in the mid forehead instead of the superior edge of the eyebrow (Video 3.1).

Postoperative Care

Ophthalmic antibiotic ointment or a combination of antibiotic and steroid is applied at the end of the case. Bandaging is generally not necessary. The patient is instructed to use ice packs 15 min each hour while awake for the next 2–3 days and to elevate the head with several pillows at bedtime. Straining, lifting heavy objects, and bending should be avoided for one week. The sutures can be removed 10–14 days after surgery. Surgical adhesive strips may be used at this time if needed. To minimize the evidence of a scar, the patient is instructed to reduce sun exposure to the area by wearing a hat or applying lotions with a sun-protection factor of 30 or more.

Endoscopic Midface Lift

4

Francisco Castillo and Geoffrey J. Gladstone

Over the past two decades, new techniques for facial rejuvenation have been developed to address not only the excess laxity of the aging facial skin, but also the inferior descent that characterizes the aging face. The traditional facelift, even with a SMAS plication, is directed at correcting excess laxity, but in the author's opinion it has the drawback of tightening the tissues in an anteroposterior direction without adequately addressing age-related tissue descent. A vertical lift is a more anatomically correct method of counteracting the vertical displacement of the face that is responsible for prominent nasolabial folds, a skeletonized appearance of the lower eyelids and malar prominence, and, to a lesser degree, the pre-jowl sulcus.

Electronic Supplementary Material The online version of this chapter (doi:10.1007/978-3-319-67331-8_4) contains supplementary material, which is available to authorized users.

F. Castillo, MD (✉)
Ophthalmic Facial Plastic and Reconstructive Surgery, Oakland University William Beaumont School of Medicine, 29201 Telegraph Rd, Suite 324, Southfield, MI 48034, USA
e-mail: francisco.castillo@beaumont.org

G.J. Gladstone, MD, FAACS (✉)
Consultants in Ophthalmic and Facial Plastic Surgery, PC, 29201 Telegraph Rd #324, Southfield, MI 48034, USA

Oakland University William Beaumont School of Medicine, Royal Oak, MI 48034, USA

Wayne State University School of Medicine, Detroit, MI 48034, USA
e-mail: facialwork@gmail.com

Patient Selection

The pre-surgical consultation seeks to identify the features that are most concerning to the patient. Special emphasis should be placed on the position of the pre-malar fat pad, the prominence of the nasolabial folds, and the presence or absence of a pre-jowl sulcus. In addition to this, it is important to identify potential access points for surgical dissection; if the patient has a receding hairline, rarefied hair density, or a high forehead, the infra-ciliary or transconjunctival approach may be preferable. On the other hand, if the patient undergoes a simultaneous forehead and brow lift, the same incisions can be utilized for an endoscopic midface lift. It is important to consider the presence or absence of herniated orbital fat, redundant lower eyelid skin, tear trough deformity, or any bony asymmetry between the orbits by carefully palpating the orbital rims. The quality of the apposition of the patient's lower eyelids to the ocular globes should also be examined and documented. The author's preferred method to assess the integrity of the canthal tendons is to perform the eyelid distraction and snapback tests. A distraction of less than 3 mm from the ocular surface with gentle anterior traction on the lower eyelid, and a prompt return to apposition against the globe upon release, is confirmatory of adequate lower eyelid medial and lateral canthal tendon integrity. If the patient has had previous surgery in the periocular region,

G.J. Gladstone et al. (eds.), *Oculoplastic Surgery Atlas*, https://doi.org/10.1007/978-3-319-67331-8_4

it is important to note any anterior or posterior lamellar deficits. The position of the lower eyelids should be noted by taking a careful MRD2 measurement. The buccal-gingival sulcus should be evaluated, as sometimes it is necessary to perform an incision in this location to complete the subperiosteal dissection. Any volume deficits should be noted, paying special attention to the skeletal prominences of the face, as sometimes it is necessary to address these with implanted fat, fat transfers from the orbit, fillers, or alloplastic implants.

Informed Consent

The consent should emphasize the standard risks of any surgical procedure on the face, which include scarring, asymmetric results, risk of bleeding, infection, and damage to neurovascular structures. It is particularly important to discuss with the patient the possibility of temporary or permanent paresis of the facial nerve with resultant asymmetry and weakness of the affected half of the face. It is also important to discuss the possibility of stretching and neuroapraxia to the infraorbital nerve. The latter is the most common complication, occurring in approximately 15% of patients. The authors always discuss with the patients the likelihood of numbness to the midface, lips, and upper teeth. In our experience this has resolved in the vast majority of patients within 3 months of surgery.

Surgical Technique

There are several surgical approaches to the midface, and the incision site should be selected according to the patient's overall anatomy, as well as any additional surgical procedures that would be accomplished simultaneously. The authors frequently combined endoscopic midface lift with removal of herniated orbital fat. The midface can then be accessed in the subperiosteal plane through a transconjunctival incision, following removal of the herniated orbital fat. If the surgeon wishes to transpose orbital fat to compensate for loss of suborbicularis oculi fat (SOOF), this is the method of choice. Conversely, if the surgeon wishes to perform further suspension of the temporal midface via an orbicularis sling, an infra-ciliary incision is preferred. Lastly, if the patient will be having an endoscopic forehead lift, the temporal scalp incisions can be utilized to access the midface without any additional incisions on the face (Figs. 4.1 and 4.2). The latter is our most common approach to the midface. We reserve the transoral approach for patients with very prominent maxillae, or for patients with tightly adherent periosteum that is difficult to elevate via other approaches. There are also several options for fixation of the elevated mid face. We prefer alloplastic, absorbable implants, but permanent solutions are adequate in some cases. The position of the fixation device must also be decided prior to surgery. Options include the orbital rim, a malar hang-back, or a temporoparietal fixation point with a long leash to support the midface anchoring device.

We will begin by describing the procedure to access the midface via a temporal scalp incision (Video 4.1). Once the plane of dissection reaches the malar prominence, the procedure is the same regardless of the surgical approach. Surgery is performed under monitored local anesthesia with sedation or under general anesthesia, depending on surgeon and patient preference. Nerve blocks of the supraorbital, orbitozygomatic, and infraorbital nerves are administered with a combination of 2% lidocaine with epinephrine and 0.5% Bupivacaine with epinephrine in a 50:50 mixture. A temporal scalp incision is made with a #15 Bard-Parker blade. Hemostasis is obtained with the monopolar cautery, being careful to preserve the hair follicles in this location. The monopolar cautery with a needle tip is then utilized to continue the dissection until the deep temporalis fascia is identified. For the novice surgeon it is sometimes reassuring to make a small incision on the deep temporalis fascia with a 15 blade to confirm that the temporalis muscle lies beneath, and that the dissection is thus in the correct plane. Initially under direct

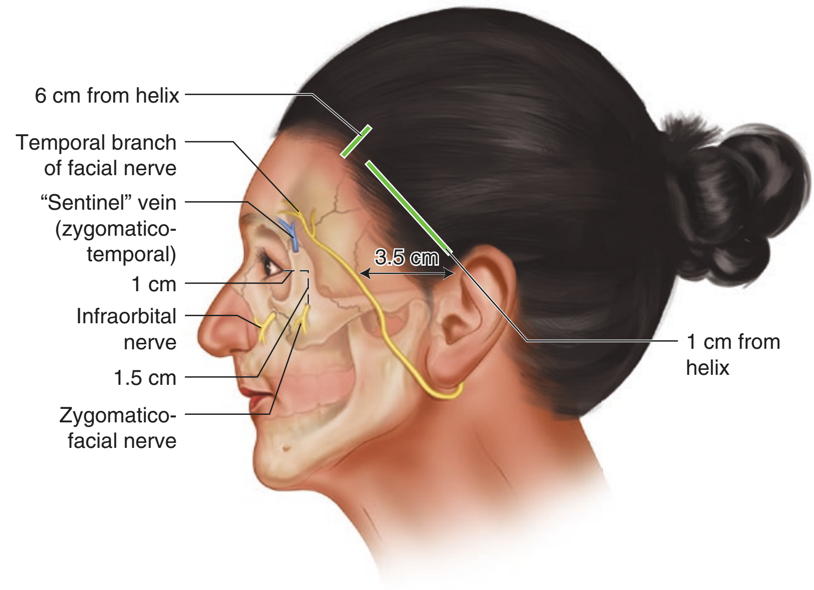


Fig. 4.1 Incision sites and important anatomy for endoscopic midface lift. Lateral view

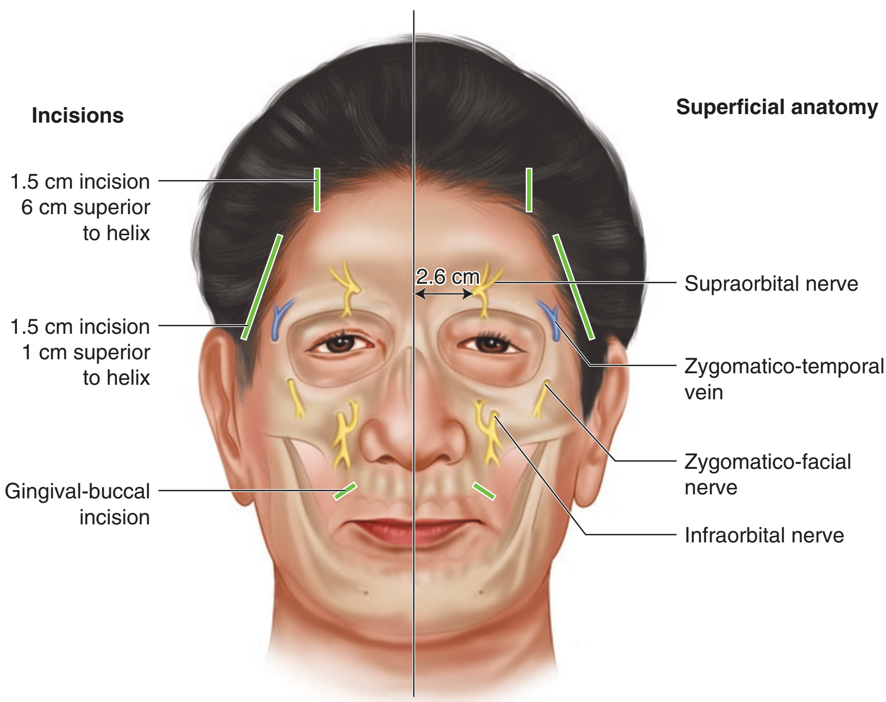


Fig. 4.2 Incision sites and important anatomy for endoscopic midface lift. Frontal view

visualization, by lifting the flap with an angled retractor, and then under endoscopic visualization after the plane has been started, dissection is carried out between the shiny, gray, deep temporalis fascia and the overlying gauzy superficial temporoparietal fascia. The facial nerve lies in the superficial temporoparietal fascia, so care must be taken to maintain an accurate plane immediately superficial to the deep fascia to avoid injury to this structure. The endoscope is utilized to carry the dissection inferomedially toward the lateral canthal region. As the superior orbital rim is approached, the deep temporalis fascia splits into two layers, separated by the intermediate temporal (Yasergil's) fat pad (Fig. 4.3) (Video 4.2).

Once Yasergil's fat pad is identified, the appropriate plane of dissection is on its surface, which is the undersurface of the superficial layer of the deep temporal fascia. This plane is followed down to the takeoff of the zygomatic arch, which can be palpated with the dissector before it is actually visualized. Careful blunt dissection should be performed in this region. Typically, a large vein emerges from Yasergil's fat pad approximately 2 cm lateral to the orbital rim and at about the level of the superior orbital rim; this sentinel vein should be sought and preemptively cauterized with bipolar cautery. The dissection is then continued subperiosteally over the zygoma along the lateral orbital rim, and infero-caudally in the subperiosteal plane on the zygomatic arch. If the surgeon decides to access this plane via an infra-ciliary or a transconjunctival incision, the dissection is carried in the subperiosteal plane starting at the inferior orbital rim, and extended laterally over the body of the zygoma. The dissection is continued nasally, being careful to identify the infraorbital neurovascular bundle. The dissection can then be continued both superior and inferior to the nerve all the way to the pyriform aperture. This is a lot easier to perform via a transconjunctival approach. It is not imperative to complete the dissection all the way to the pyriform aperture in most patients, and this should be aborted if further dissection would

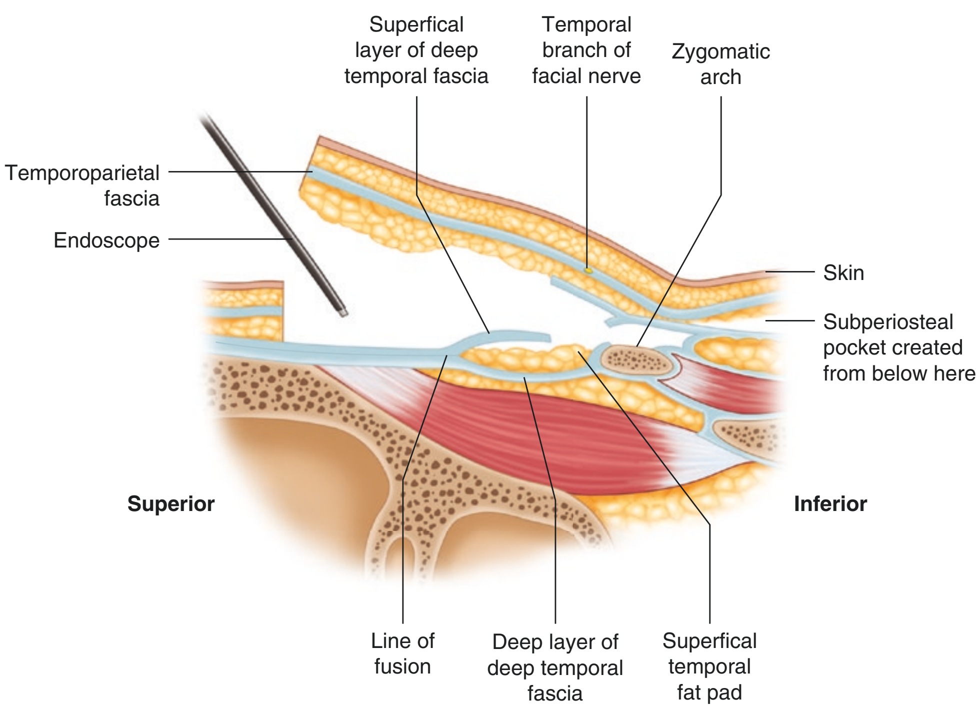


Fig. 4.3 Surgical approach for endoscopic midface lift

compromise the safety of the procedure. Once this has been completed, the dissection is carried caudally and temporally. The inferior edge of dissection should be the gingival cul de sac. In some patients, the periosteum over the maxilla is tightly adherent. In other patients, the curvature of the zygomatic arch over the maxillary bone is such that dissection over the body of the maxilla is difficult. In these patients, a gingival cul de sac incision can be performed and the dissection is carried in the subperiosteal plane via a transoral approach until both planes of dissection are joined together. Laterally, the surgeon seeks to identify the masseter muscle. The conjoined masseteric fascia is identified as a striated fibrous band emanating from the inferior edge of the zygomatic arch. This must be divided sharply in close apposition to the masseter muscle. The maxillary branch of the facial nerve courses over the masseteric fascia and is at risk during extensive dissection over the masseter. The periosteal attachments over the arch and the attachments of the masseteric aponeurosis and ligaments on the vertical medial edge of the masseteric fascia are critical to the success or failure of the surgery. Only by completely releasing these attachments can the midface be effectively elevated in the subperiosteal plane (Fig. 4.4).

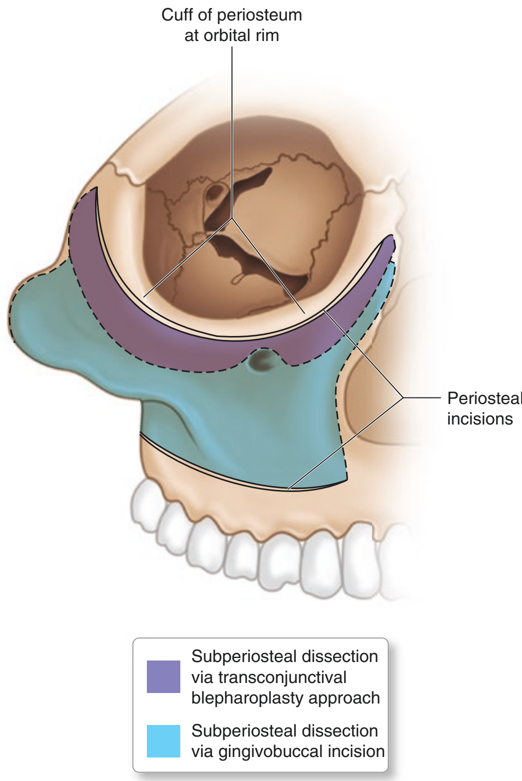


Fig. 4.4 Areas of subperiostial dissection with transconjunctival and gingivobuccal incisions

Once the entire dissection is completed, the surgeon can grasp the deep temporoparietal fascia with toothed forceps and mobilize the entire midface. If the flap is not freely mobilized, a finger should be introduced to identify any remaining bands of attachment. These should be released to ensure free mobilization of the midface. Only then can a long-lasting result be assured. Once the flap is adequately mobilized, it is secured in the elevated position. This can be accomplished with a fixation suture through the superficial temporoparietal fascia. The authors prefer the endotine midface™ fixation device (MicroAire®). After the endotine is inserted, the surgeon aims to secure the periosteum of the midface to the tine at the point of maximum desired lift. The authors typically select a point immediately lateral to the most prominent aspect of the nasolabial fold. Once the periosteum has been secured to the endotine, the leash is elevated to the desired final position of the midface. This is marked through one of the leash holes with a marking pen on either the orbital rim or the deep temporalis fascia. The endotine is then secured according to the manufacturer's instructions. In very heavyset patients, it is sometimes necessary to place a SMAS fixation suture in addition to the endotine to adequately support the midface. The authors prefer to utilize a 3-0 Vicryl in these patients. For patients with significant lateral midface descent, or patients with significant dermatochalasis of the lower eyelids or prominent festoons, the authors will sometimes combine a midface elevation procedure with an orbicularis sling. This further elevates the lateral aspect of the cheek, and helps increase the projection of the malar prominence. It also allows the surgeon to be slightly more aggressive with skin tightening as the lateral midface is supported by the periosteum of the lateral orbital rim. If there is any doubt about the integrity of the lateral canthal tendon, or if the preoperative evaluation suggests excess laxity of the lower eyelid, the authors routinely performed a lateral tarsal strip to avoid postoperative ectropion. Adequate positioning of the midface is confirmed, the incisions are closed in layers, and a surgical dressing is applied.

Postoperative Instructions

The patient is instructed to apply ice packs for 15 min of every hour while awake. Patients are asked to sleep with their head elevated with a couple extra pillows at night, and to avoid heavy exercise for 1 week. The patient is asked not to bend over and pick up anything over 5 pounds for 1 week. Postoperative medications include narcotic analgesia, a tapered dose-pak of 4 mg of methylprednisolone, a stool softener, and anti-nausea medication. The patient is also asked to keep the surgical dressing intact until it is removed by the treating surgeon 1 week postoperatively. If the procedure is combined with an endoscopic forehead lift, the head wrap can be removed 24 h postoperatively and the patient can shower, but must be careful to keep dry any Steri-Strips placed on the face.

References

1. Pascali M, Botti C, Cervelli V, Botti G. Vertical midface lifting with periorbital anchoring in the management of lower eyelid retraction: a ten-year clinical retrospective study. Plast Reconstr Surg. 2017;140(1):33–45. https://doi.org/10.1097/PRS.0000000000003452.
2. Sasaki GH, Cohen AT. Meloplication of the malar fat pads by percutaneous cable-suture technique for midface rejuvenation: outcome study (392 cases, 6 years' experience). Plast Reconstr Surg. 2002;110:635–57.
3. Keller GS, Namazie A, Blackwell K, Rawnsley J, Khan S. Elevation of the malar fat pad with a percutaneous technique. Arch Facial Plast Surg. 2002;4:20–5.
4. Chi JJ. Periorbital surgery: forehead, brow, and midface. Facial Plast Surg Clin North Am. 2016;24(2):107–17.
5. Sclafani AP, Dibelius G. Transpalpebral midface lift. Facial Plast Surg Clin North Am. 2015;23(2):209–19.
6. Engle RD, Pollei TR, Williams EF 3rd. Endoscopic midfacial rejuvenation. Facial Plast Surg Clin North Am. 2015;23(2):201–8.

5 Upper Eyelid Blepharoplasty

Geoffrey J. Gladstone

Evaluation

Upper eyelid blepharoplasty is a common procedure for aesthetic and functional treatment of excess eyelid skin, or dermatochalasis. A patient with this condition frequently has a combination of cosmetic and functional complaints. The initial evaluation should include the details of the patient's particular concerns. A handheld mirror is useful to help patients point out eyelid features that are bothersome to them. A complete medical and ophthalmic history, including the use of topical and systemic medications and drug sensitivities, is documented. Specifically ask the patient about aspirin and anticoagulant use. Additional historical questions should focus on dry eye symptoms, eyelid irritation or edema, and visual obscuration.

The complete ophthalmic examination is performed with particular attention to conditions that could adversely affect the outcome of blepharoplasty, including dry eye, meibomian gland dysfunction, keratitis, and corneal dystrophies. In addition to the biomicroscopic examination, one should measure lagophthalmos with gentle lid closure, Bell's phenomenon, and basic tear secretion using Schirmer's filter paper strips after applying a topical anesthetic or tear osmolarity.

There are specific measurements relevant to dermatochalasis. These include the margin-reflex distance (MRD_1), the margin-fold distance (MFD), the margin-crease distance (MCD), the vertical skin distance (VSD) and eyebrow position. The MRD_1 is the distance from the corneal light reflex (from a penlight on which the patient is fixating) to the upper eyelid margin. This should be normal (3.5–5.5 mm) in patients with isolated dermatochalasis. A low MRD_1 value indicates ptosis, and the patient should be worked up accordingly. Certainly, many patients have true ptosis with concomitant dermatochalasis, and both problems must be addressed to achieve an ideal outcome. The MFD is the distance from the upper eyelid margin to the lowest point on the fold of "hanging" upper eyelid skin. This may be zero if the skin is resting on the eyelashes or even a negative number if the skin hangs below the upper eyelid margin. The MCD is the distance from the eyelid margin to the eyelid crease. This crease is often hidden under the fold of dermatochalasis and is sometimes asymmetrical between the two eyelids. The normal MCD in a women is

Electronic Supplementary Material The online version of this chapter (doi:10.1007/978-3-319-67331-8_5) contains supplementary material, which is available to authorized users.

G.J. Gladstone, MD, FAACS
Consultants in Ophthalmic and Facial Plastic Surgery, PC, Southfield, MI 48034, USA

Oakland University William Beaumont School of Medicine, Royal Oak, MI, USA

Wayne State University School of Medicine, Detroit, MI, USA
e-mail: facialwork@gmail.com

G.J. Gladstone et al. (eds.), *Oculoplastic Surgery Atlas*, https://doi.org/10.1007/978-3-319-67331-8_5

about 10 mm and in a men about 8 mm. The Asian lid crease is at least several millimeters lower.

In addition to the skin and lid crease evaluation, assessment of the upper eyelid fat pads, lacrimal gland position, and brow position is essential to an ideal surgical outcome. The upper eyelid has medial and central fat pads. The lacrimal gland may cause a visible prominence laterally. If this is significant, the lacrimal gland can be repositioned at the time of blepharoplasty. These findings should be documented and addressed during the procedure. The brow position should be addressed qualitatively. It is important to differentiate brow skin from eyelid skin. If the patient plucks his or her eyebrows, the brow position appears misleadingly high, but close inspection reveals the change in skin thickness and consistency as the transition from thin eyelid skin to thicker brow skin occurs. If the primary cause of the patient's complaints is brow ptosis, this must be addressed with a brow elevation procedure, not with blepharoplasty.

Visual field testing is generally not necessary prior to cosmetic blepharoplasty. If functional dermatochalasis obscures the superior visual field, it should be documented using automated or kinetic perimetry with the lid in the natural position and then in a taped position. Preoperative photographs should be obtained including full-face views and side or oblique views.

Surgical Technique

The patient is taken to the operating room or procedure room, and eyelid marking is performed with the patient awake, prior to local anesthetic administration (Video 5.1). A fine marking pen is used to define the lid crease from directly over the punctum medially to directly over the lateral canthus laterally. The patient's natural lid crease is often appropriate, but it is sometimes necessary to correct the lid crease position. If the lid creases are significantly asymmetrical, the asymmetry should be corrected. If the lid crease is significantly lower than the normal MCD for that gender/ethnic group, it should be raised per the preoperative surgical decision-making and discussion with the patient. The lid crease marking then continues laterally to address any lateral "hooding." Once lateral to the lateral canthus, the marking should angle slightly upward and outward, preferably in a skin crease. The length of the lateral skin extension depends on the amount of lateral skin to be excised, but it generally extends 3–10 mm. The medial portion of the excision must be demarcated with particular care owing to potential problems with webbing or scarring. The line should slope upward at about a 30-degree angle once it is medial to the punctum. It is recommended to have 20 mm of vertical skin remain once surgery is completed. By using the VSD the amount of skin to be removed is determined. A pinch technique cam also be used to determine the width of skin to be excised. Non-toothed forceps are used to grasp the eyelid skin at the lid crease and pinching the excess skin. The eyelid should not be pulled open or too much skin may be removed. A conservative approach should be used, and the brow must not be pulled inferiorly with the forceps. The superior marking is placed with the marking pen, creating a "double gull wing" (Fig. 5.1). Similar markings are made on the opposite eyelid. Remember, upper blepharoplasty removes some skin and muscle, but that is not the only goal of the procedure, so markings should be placed conservatively.

Local anesthetic is administered to the subcutaneous tissue. The fat pads or lacrimal gland (or both) should be anesthetized if these tissues are to be reduced or repositioned. The eyelid skin is stretched, and the markings are incised with a blade. The skin/orbicularis muscle flap is then removed with Westcott scissors or cautery, depending on the surgeon's preference (Fig. 5.2). The medial and central fat pads may be removed by gently tenting the overlying septum and opening it with the cautery or scissors. The fat pad is then removed by the "clamp-cut-cautery"

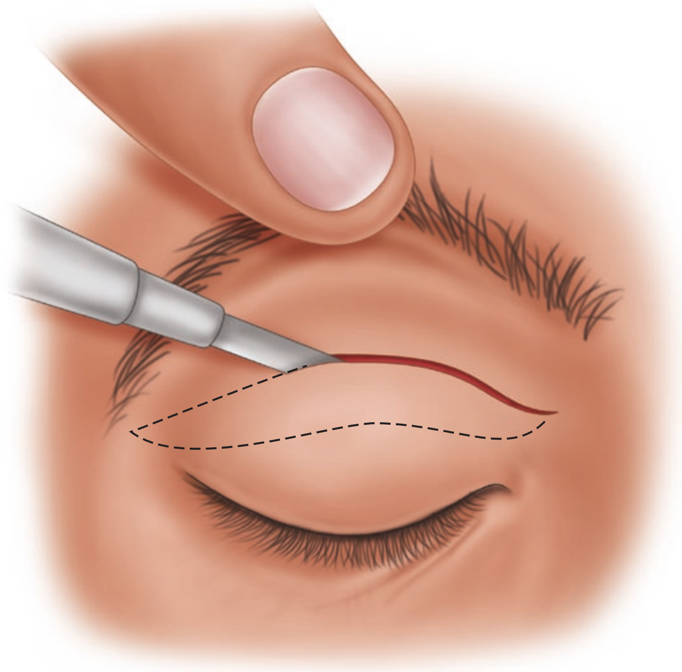


Fig. 5.1 Marking the upper eyelid and incision with a No. 15 blade

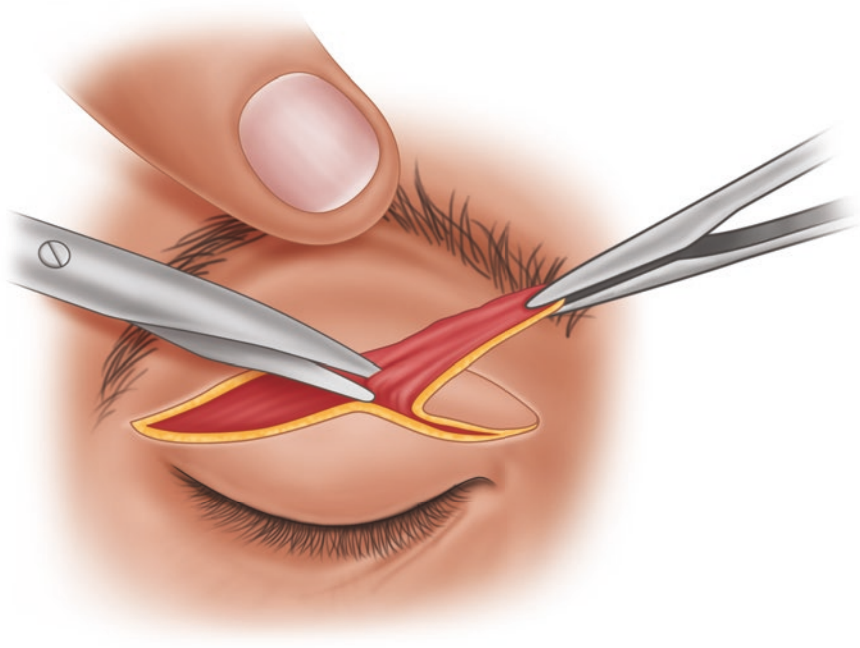
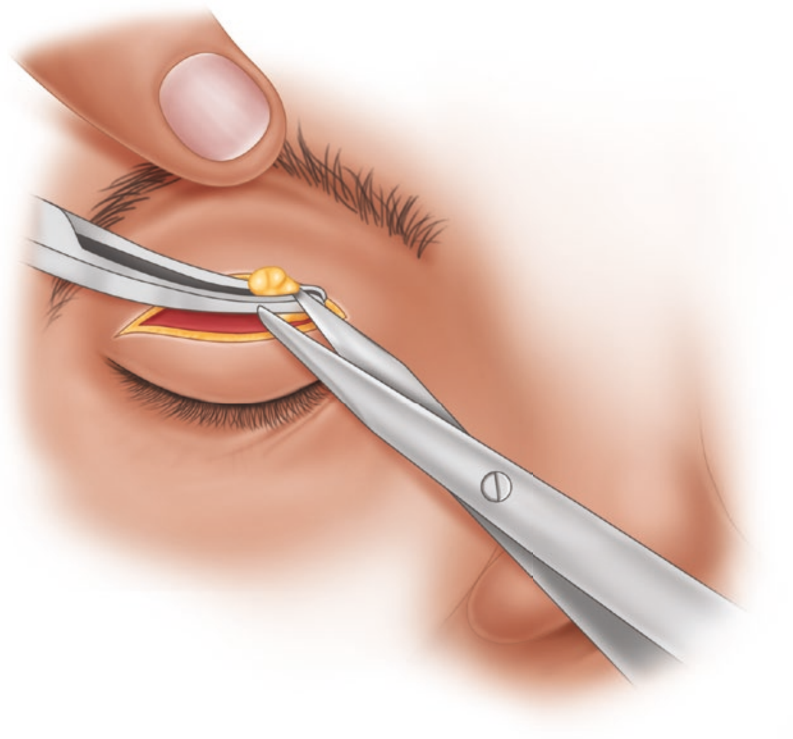


Fig. 5.2 A skin/muscle flap is removed with scissors

Fig. 5.3 Orbital fat is clamped with a hemostat and excised with scissors



technique. The fat is gently teased through the open septum with forceps or by applying gentle pressure to the globe. The fat is clamped with a hemostat and excised over the hemostat with scissors; and then the base is cauterized (Fig. 5.3). Forceps should be used to hold the stump as the hemostat is released until hemostasis is visually confirmed. This technique is continued until the appropriate amount of fat is removed from the region. A fat excision is recommended, especially with the middle fat pad, to avoid a superior sulcus deformity. The septum should not be sutured.

If the lacrimal gland is prominent, it should be posteriorly and superiorly repositioned at this point in the procedure. Dissection is continued through the lateral portion of the blepharoplasty incision by incising the septum. In a small number of cases, orbital fat is present between the septum and the lacrimal gland. This fat pad should be carefully excised, exposing the orbital lobe of the lacrimal gland. Dissection should extend to the superior orbital rim. A double-armed 6-0 polypropylene suture is passed in mattress fashion through the inferior portion of the prolapsed gland (Fig. 5.4) (Video 5.2). Each arm of this suture is then passed posteriorly to anteriorly through the periosteum of the lacrimal gland fossa, just underneath the superior orbital rim (Fig. 5.5). The suture is secured, pulling the lacrimal gland back into the fossa.

If the upper eyelid crease is too low it can be raised (Video 5.3). An incision is made at the desired lid crease height. A dissection is carried inferiorly past the old crease in order to obliterate the old crease. Several millimeters of orbicularis muscle are left attached to the skin just below the incision and the dissection then continues as a skin

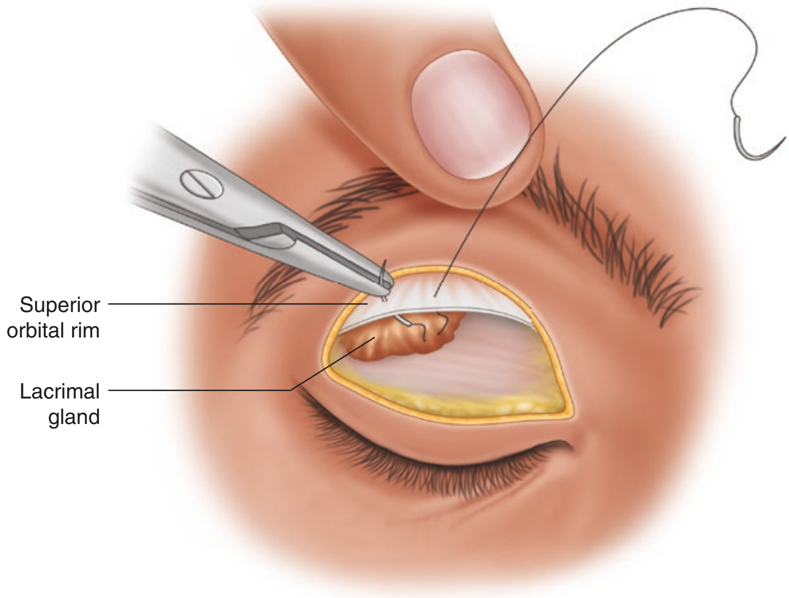


Fig. 5.4 Double-armed suture is passed through the prolapsed lacrimal gland and through the periosteum

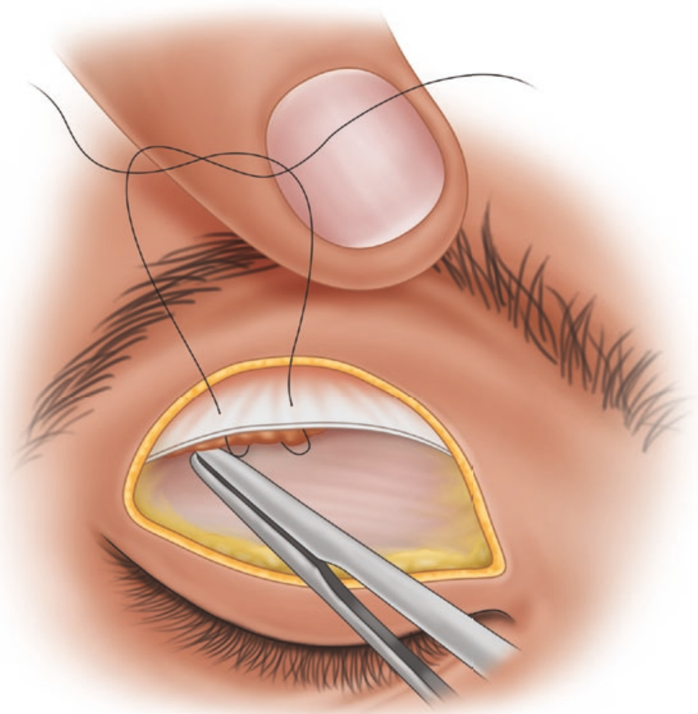


Fig. 5.5 Suture tightening pulls the lacrimal gland under the orbital rim

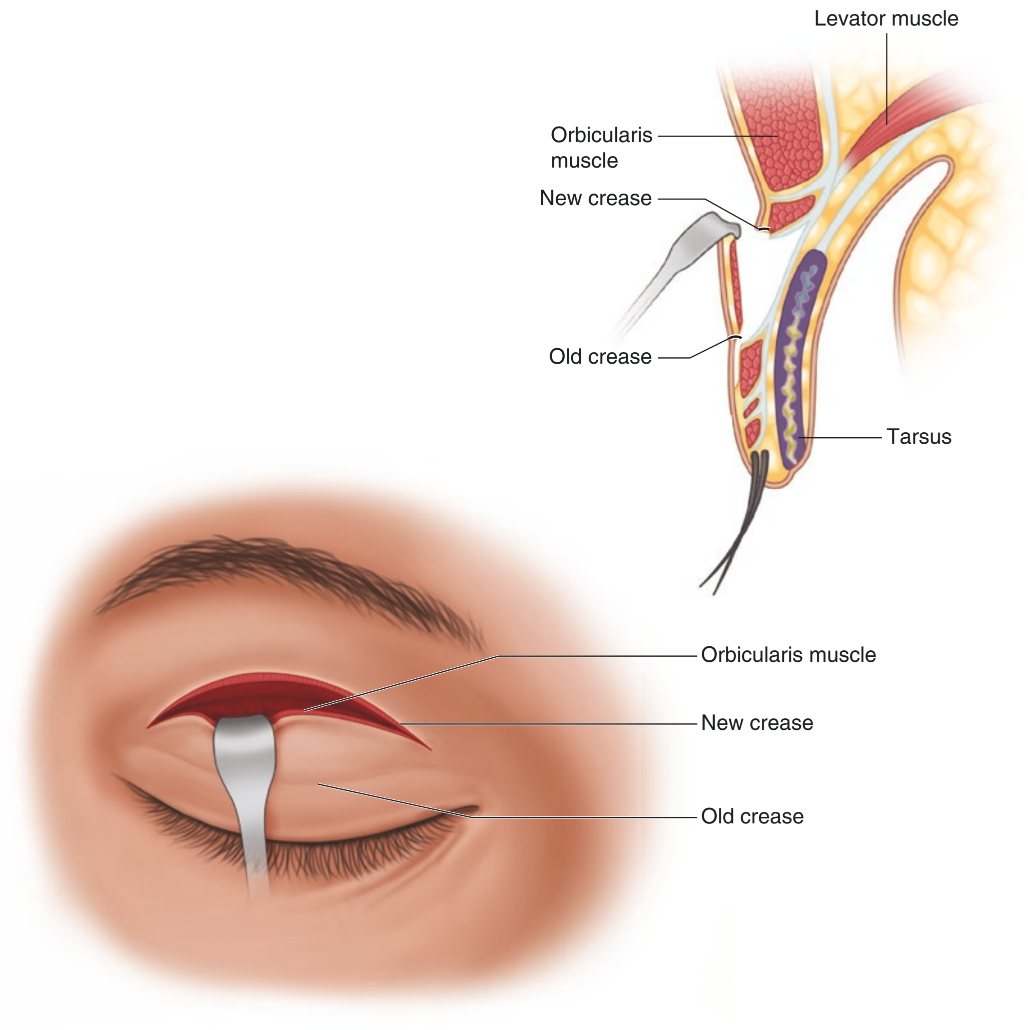


Fig. 5.6 Dissection for crease elevation

flap (Fig. 5.6). A deep dissection is performed that removes the tissue overlying the levator aponeurosis. Four 6-0 Vicryl sutures are space along the eyelid attaching the orbicularis muscle left just below the lower eyelid incision to the levator aponeurosis at the appropriate height (Fig. 5.7).

This maneuver locks the lid crease in place and facilitates subcuticular closure, which can then be accomplished in a running fashion with 6-0 polypropylene suture. The suture ends are left untied, and the entire incision, including the suture ends, are covered with steristrips.

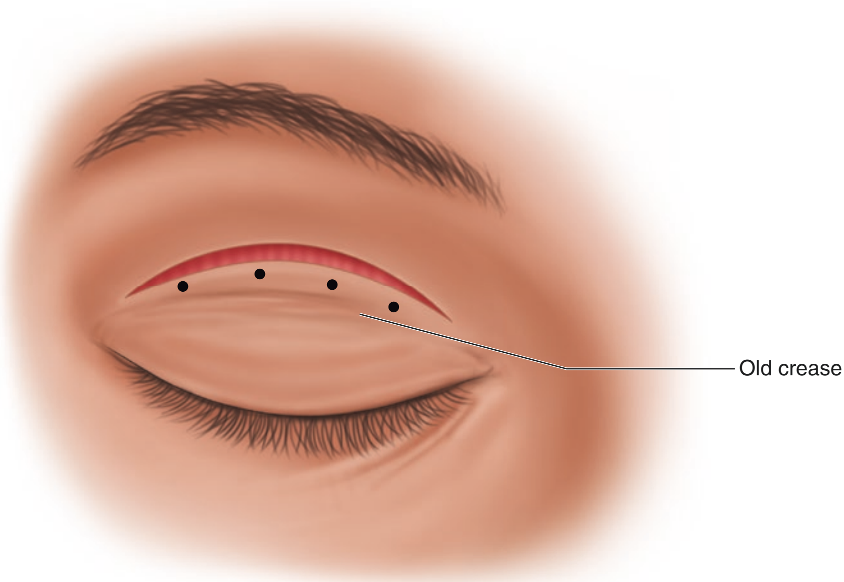


Fig. 5.7 Subcutaneous Vicryl sutures placed at height of new crease

Postoperative Care

Following surgery, the patient should be instructed to place cold or ice packs on the eyelids for about 15 min each hour during the day for 2 days. The patient should not engage in any lifting or bending activities and should sleep with his or her head elevated. The sutures are removed after 5–8 days by first peeling off the strip and then pulling one end of the subcuticular suture until the entire suture is free.

6 Lower Eyelid Blepharoplasty

Geoffrey J. Gladstone

Concerns about lower eyelid appearance are common in middle-aged and elderly patients. These concerns often occur in patients also undergoing evaluation for upper blepharoplasty, so it is beneficial to be able to offer these patients options for improving conditions that affect the lower eyelids. The primary cosmetic issues of the lower eyelids involve herniated orbital fat and lower eyelid rhytides, which may occur simultaneously or independently. The surgeon must consider the patient's age, appearance, skin type, and anatomy. The option of excising or repositioning herniated orbital fat or of performing direct skin excision, CO_2 laser skin resurfacing, mid-face lifting, or a combination of procedures can then be discussed with the patient. In this chapter, we describe techniques for lower eyelid evaluation, excision and repositioning herniated orbital fat, and direct lower eyelid skin excision.

Electronic Supplementary Material The online version of this chapter (doi:10.1007/978-3-319-67331-8_6) contains supplementary material, which is available to authorized users.

G.J. Gladstone, MD, FAACS
Consultants in Ophthalmic and Facial Plastic Surgery, PC, Southfield, MI 48034, USA

Oakland University William Beaumont School of Medicine, Royal Oak, MI, USA

Wayne State University School of Medicine, Detroit, MI, USA
e-mail: facialwork@gmail.com

Evaluation

A complete eye examination is performed, as described in Chap. 5. Particular attention is paid to lower eyelid horizontal laxity and skin laxity. If there is significant laxity of the lower eyelid and any type of skin tightening is planned, a horizontal tightening procedure must be performed with the blepharoplasty. A slow or failed snap back test is another indication to perform lower eyelid tightening in conjunction with the blepharoplasty. The quality and pigmentation of the skin is assessed. If the skin is lightly pigmented, CO_2 laser is an option for skin tightening and reducing rhytides. In a more darky pigmented patient direct skin excision should be considered.

The lower eyelid has medial, middle, and lateral fat pads. Herniated fat pads are identified, palpated, and documented using a scale consistent for that physician. We use a 0 to 4+ scale to describe the size of each pad. Gentle retropulsion of the globe often makes the fat pads more obvious. If there is significant herniated fat, a transconjunctival approach to excision is recommended. The examiner should also palpate and consider the position of the globe relative to the inferior orbital rim and the shape of the maxillary and zygomatic bones inferior to the fat pads. Close inspection of the conjunctival fornix should exclude active cicatricial disease.

G.J. Gladstone et al. (eds.), *Oculoplastic Surgery Atlas*, https://doi.org/10.1007/978-3-319-67331-8_6

The lower eyelid is an extension of the midface and is evaluated as such. Nasojugal grooves, festoons, descent of the malar fat pads, and midfacial skin laxity are all assessed. A handheld mirror is used to allow the patient to point out bothersome features. The lower eyelids are inspected with the patient's mouth open as well to check for possible retraction. External photography should include full face, oblique, and side views to show the extent of the fat herniation.

Surgical Techniques

Transconjunctival Lower Blepharoplasty

Local anesthesia containing epinephrine is injected into the conjunctival fornix. Some surgeons also infiltrate the anterior portions of the orbital fat pads.

A Desmarres retractor is used to pull the eyelid away from the globe, and a transconjunctival incision is made in the fornix, approximately 12 mm below the lid margin (Fig. 6.1) (Video 6.1). This incision can be made with a variety of instruments, such as a needle tip monopolar unit, radiofrequency unit, CO_2 laser, high-temperature cautery, or a blade. The blade technique is effective but offers the poorest hemostasis and is therefore not recommended. The retractor is always held in a position to protect the eyelid from the incising device. The septum is then incised, and herniated orbital fat becomes visible. Gentle pressure on the globe helps define and prolapse the fat into the wound once the septum is incised. Care is taken to avoid damaging the inferior oblique muscle, which originates from the medial aspect of the inferior orbital rim and is often visible between the medial and middle fat pads.

The fat is excised using the "clamp-cut-cautery" technique, which involves clamping the fat pad with a hemostat, cutting the fat above the hemostat with Westcott scissors, and cauterizing the base (Fig. 6.2).

Forceps are used to grasp the fat below the hemostat prior to releasing it to confirm hemostasis. This technique is used to remove all the herniated fat that prolapses easily. Overexcision of lower eyelid fat is avoided because it would create a hollow lower eyelid appearance. Removing a significant orbital volume can contribute to a superior sulcus deformity as well.

It is possible to improve the appearance of a nasojugal groove by dissecting a medial subperiostial pocket under the groove. The medial fat pad is then dissected as a narrow pedicle and mobilized into the subperiostial space. A double-armed 6-0 monofilament suture is threaded through the fat pad in a mattress fashion (Fig. 6.3) and then passed through the full thickness of tissue, where they are tied over a small bolster on the skin of the nasojugal groove (Fig. 6.4). This pulls the pedicle of fat under the groove and fills it in. The suture can be removed in about 5 days.

Lower Eyelid Skin Excision

Skin excision may be performed separately or in conjunction with herniated orbital fat excision. Either way, we recommend that the fat be excised by a separate, transconjunctival approach to reduce the risk of lower eyelid retraction associated with transcutaneous skin/fat removal.

A fine marker is used to draw an infraciliary incision line about 1.5 mm below the lash line. The marking extends laterally past the lateral canthus. An epinephrine-containing local anesthetic mixture is administered to the skin. A blade is used to incise the skin temporally, and Westcott scissors can undermine and incise the remainder of the infraciliary line (Fig. 6.5). A skin flap is dissected inferiorly with the scissors. We prefer a "skin-only" flap to smooth the fine lines of the lower eyelid and reduce the risk of retraction. The skin flap is advanced superiorly and slightly laterally, and an overlap technique defines how much skin should be excised (Fig. 6.6). The patient should be asked to open his or her mouth and look upward to ensure an extremely conservative approach to the skin removal. The skin is excised first horizontally with the scissors, and then a vertical excision removes a second triangle of skin laterally. Interrupted 6-0 plain gut suture is used to close

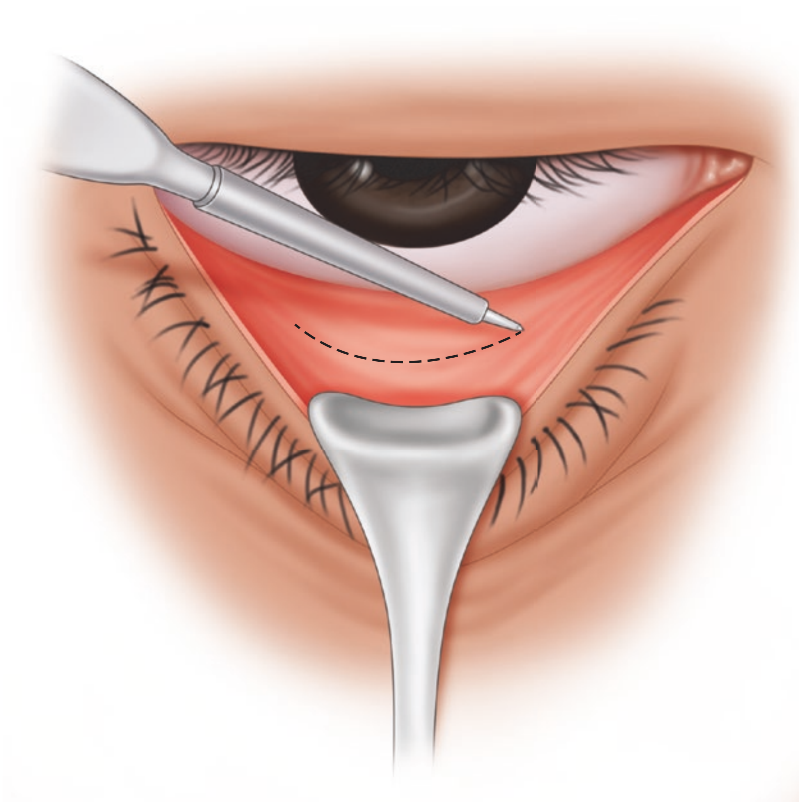


Fig. 6.1 Transconjunctival incision made with an electrocautery unit

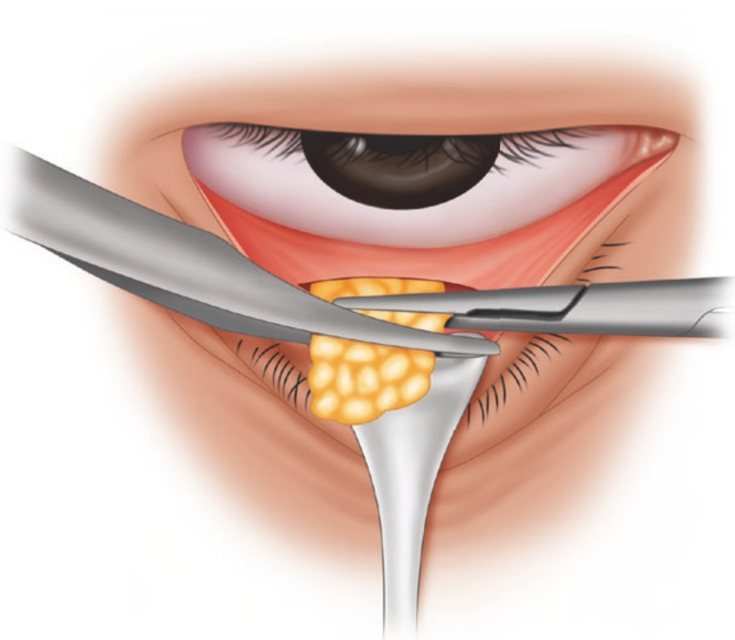


Fig. 6.2 Orbital fat is removed with scissors after being clamped with a hemostat

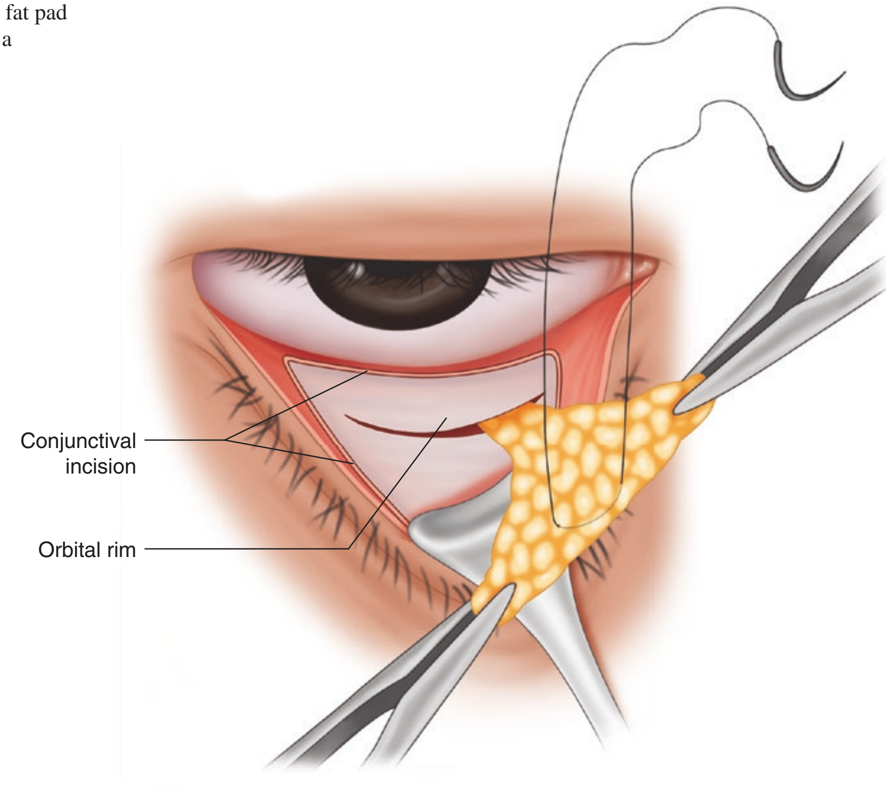


Fig. 6.3 Medial fat pad is fashioned into a T shape

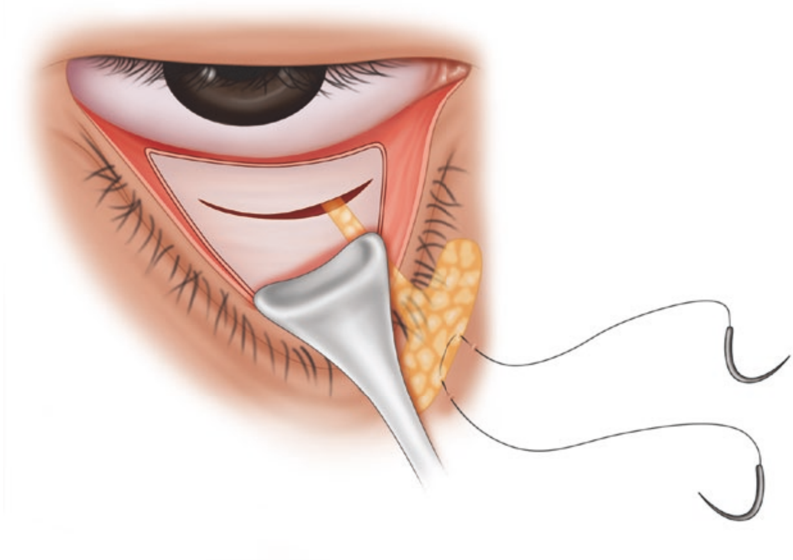


Fig. 6.4 Fat is transposed subperiostially to fill the nasojugal fold

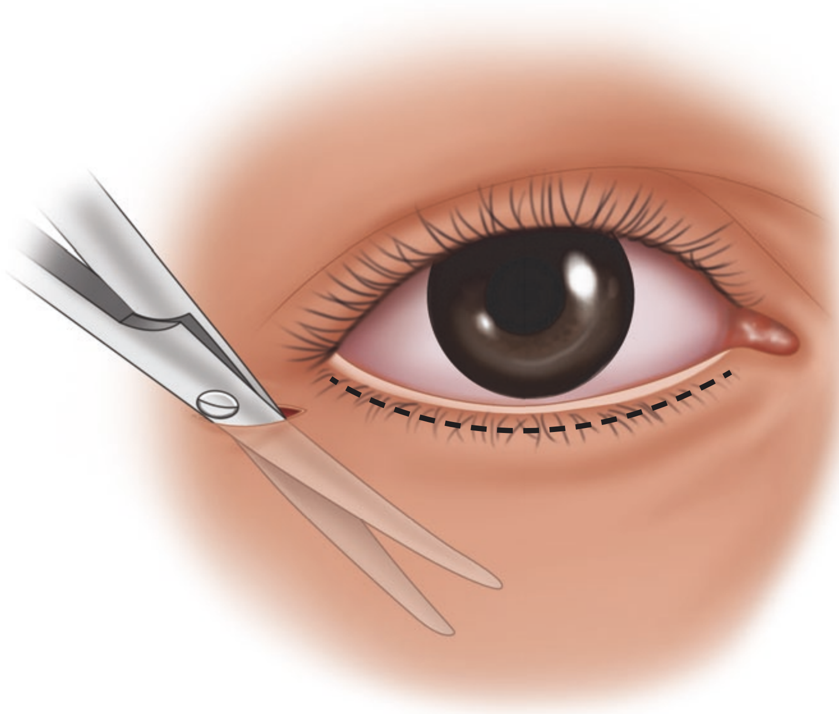


Fig. 6.5 Starting temporally, scissors are utilized to raise a skin flap

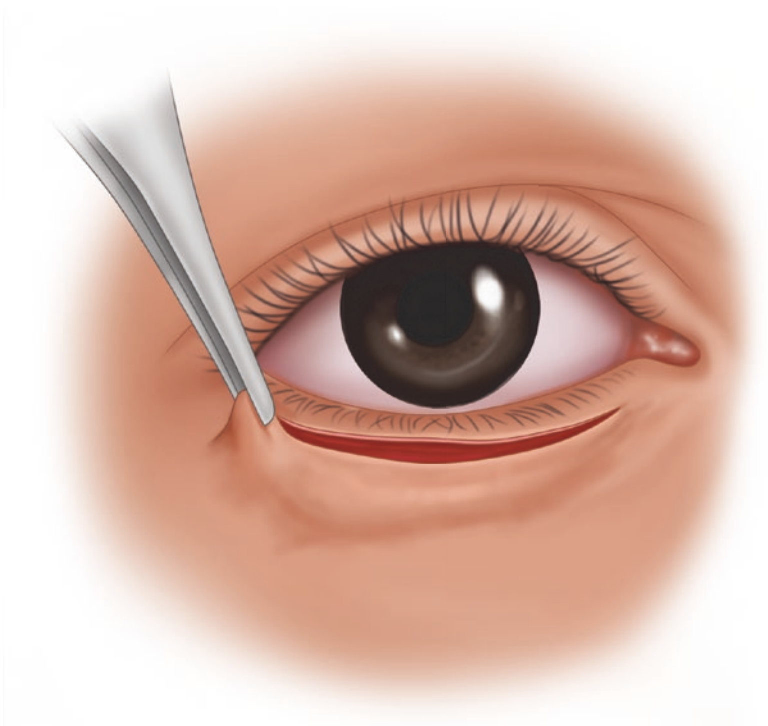


Fig. 6.6 Skin is advanced superiorly and laterally to determine the amount of excess present

the skin. Often, lateral canthal tightening via a tarsal strip or plication-type procedure is used in conjunction with lower eyelid skin removal to reduce the risk of retraction.

Patients can be given ophthalmic ointment or steroid drops following lower blepharoplasty. The eyes should not be covered by a patch. Ice packs are useful for minimizing edema. Patients are instructed to be aware of symptoms of the rare complication of retrobulbar hemorrhage and to consider it an emergency should it occur.

Laser Skin Resurfacing

7

Geoffrey J. Gladstone

The use of lasers to reduce the effects of age and sun damage to facial skin has gained widespread acceptance (Fig. 7.1). A carbon dioxide (CO_2) laser produces controlled cutaneous exfoliation with limited damage to surrounding tissue. Their wavelengths are highly absorbed by water, the main cellular constituent. Fractioned CO_2 have mostly replaced the older full ablation CO_2 models. These lasers allow a portion of the dermis to be treated with skip areas in between. This allows more rapid reepithelialization of the skin and minimizes the duration of postoperative hyperemia. Additionally, the depth of laser penetration can be altered to treat superficial or deeper rhytides.

Young patients with few, shallow rhytids are often treated with minimal dermal laser penetration. Older individuals with deep rhytids are usually treated with a combination of superficial and deep penetration. In general, faster healing follows treatment with the more superficial laser penetration settings.

Patients treated with the CO_2 laser tend to experience significant remodeling of collagen and tightening of skin (Fig. 7.2). To achieve more dramatic results and remove deep rhytids, deeper treatment with higher energy is the rule, but patients must expect longer healing times.

Evaluation

A detailed history with emphasis on wound healing and scar formation is imperative. The surgeon must know if a patient has a history of abnormal wound healing or skin disorders. Serious healing problems can result if there is a history of collagen vascular diseases, keloid formation, or immunologic abnormalities. The epithelium of the adnexal structures is the source of reepithelialization of the lasered skin. Isotretinoin (Accutane) and prior facial irradiation inhibit this process. Use of isotretinoin within 1 year of resurfacing is a contraindication to the procedure.

A patient's ethnic background and degree of pigmentation can have an influence on the outcome of resurfacing. The surgeon must distinguish the patient's normal, or "baseline," pigment from acquired pigmentation due to sun exposure or other conditions, including melasma. Extremely light-skinned individuals are more prone to have prolonged erythema postoperatively. Conversely, patients with dark baseline skin types have a

Electronic Supplementary Material The online version of this chapter (doi:10.1007/978-3-319-67331-8_7) contains supplementary material, which is available to authorized users.

G.J. Gladstone, MD, FAACS
Consultants in Ophthalmic and Facial Plastic Surgery, PC, Southfield, MI 48034, USA

Oakland University William Beaumont School of Medicine, Royal Oak, MI, USA

Wayne State University School of Medicine, Detroit, MI, USA
e-mail: facialwork@gmail.com

G.J. Gladstone et al. (eds.), *Oculoplastic Surgery Atlas*, https://doi.org/10.1007/978-3-319-67331-8_7

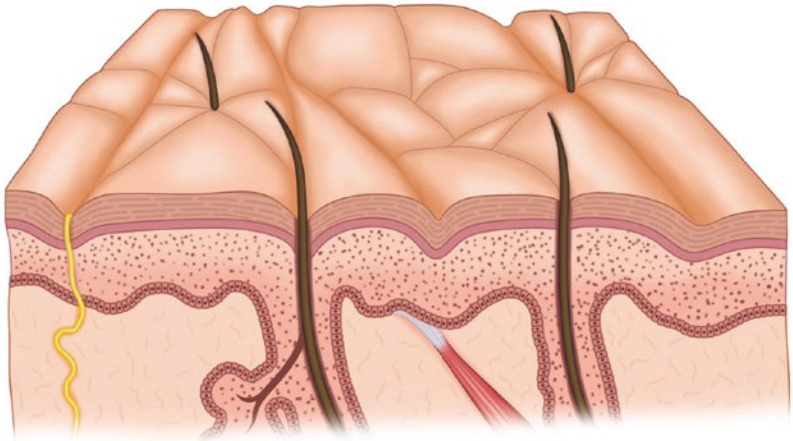


Fig. 7.1 Skin with wrinkles

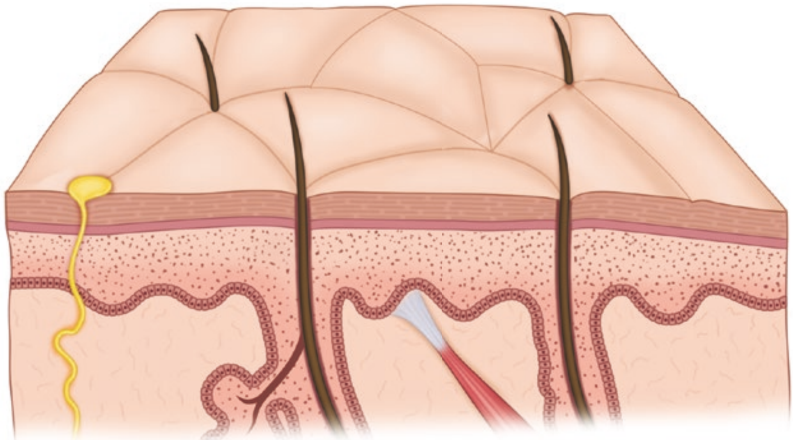


Fig. 7.2 Skin after CO_2 laser resurfacing, with reduction of wrinkles and improved collagen structure throughout the dermis

higher incidence of both hyperpigmentation and hypopigmentation.

In many patients, laser alone cannot achieve the desired skin tightening and wrinkle reduction. Other procedures are sometimes needed in conjunction with the laser treatment or at some later time. To rejuvenate the eyelids, endoscopic forehead lift and transconjunctival blepharoplasty are safely performed at the same time as laser application. The tissues retain adequate vascularity with these procedures.

Some surgeons recommend treating the skin prior to laser to improve postoperative healing and reduce inflammatory pigmentary changes. However, a study indicated that preoperative treatment using either 10% glycolic acid or 4% hydroquinone and 0.025% retinoic acid did not affect postoperative hyperpigmentation in patients regardless of the skin type. The probable reason is that the epidermal melanocytes, which are affected by these agents, are destroyed by the laser and therefore do not contribute to the pigmentary changes.

The surgeon should pretreat the patient with antiviral medicine such as acyclovir (Zovirax), famciclovir (Famvir), or valacyclovir (Valtrex). An appropriate treatment would be valacyclovir 1000 mg PO bid (or famciclovir 500 mg PO bid or tid) starting the day of the laser treatment and continue for up to 7 days or until complete reepithelialization occurs.

Patients must be made aware of the possibility of prolonged healing and erythema, and they must follow detailed postoperative instructions. The postoperative course typically involves more care from the physician than with most surgical procedures. Consideration should be given to the postoperative use of hydroquinone 2% or 4% starting 2 weeks after laser treatment. This will often prevent post-laser hyperpigmentation. It is use 2–4 times per day and continued for a month.

Technique

All instruments, including the protective eye shields, should have a dulled metal surface. Areas that are not to be treated should be protected with wet towels (Video 7.1). Laser goggles used by personnel involved in the operation should be wavelength-appropriate. A high quality smoke evacuator is essential to reduce the plume created by the laser treatment.

There is a risk of the laser igniting the supplementary oxygen. If the patient is under general anesthesia, additional protection is needed to avoid lasering the endotracheal tube and igniting the flammable gases. The agents used for skin preparation should be of a nonflammable nature.

Laser settings must be verified between the surgeon and the technician. The laser should be tested prior to use on a tongue depressor to ensure its proper pattern and function.

Periorbital Resurfacing

Prior to starting the application of laser energy, the outlines of the area to be ablated are outlined with a marking pen. For periorbital resurfacing the lower lids are being treated, as well as the area of the crow's feet. The treatment is brought close to the eyelashes.

A Syneron Candela laser is used in its fractionated mode. If mild superficial rhytides are present the treatment with the "mid" mode is appropriate. If deeper rhytides are present or significant skin tightening is needed, a combination of the "mid" and "deep" mode know as "fusion" is necessary. A coating of Aquaphor ointment is then applied to the lasered area. Ablated tissue is not removed prior to applying the ointment.

Perioral Resurfacing

CO_2 laser skin resurfacing in areas other then the eyelids is performed with a Syneron Candela laser. To have any significant effect on the deeper rhytides seen in this area, treatment with the "fusion" mode at fairly high powers is needed. In the perioral area it is important to overlap the vermilion border by several millimeters and protect the teeth from the laser energy.

A single pass of the laser is typically utilized. Hypopigmentation is rarely seen with the fractionated laser. Therefore a feathering pass of the laser at the periphery of the treated area is not used. A thin coating of Aquaphor ointment is placed.

Postoperative Care

For the first 1–2 days the treated area should be kept cool, but not wet, by applying ice compresses for 15 min of each hour while awake. A thin coating of Aquaphor is reapplied several times throughout the day. This regimen is continued until the epidermis is healed completely, usually by day 5.

The primary postoperative goal is to facilitate healing of the epithelium. An "open" technique of wound care, in which the lasered skin is thoroughly and continuously covered by a suitable ointment (Aquaphor), is appropriate for most cases. The epidermis tends to regenerate faster and heal with fewer complications if the wounds remain clean and moist.

An analgesic is often necessary to maintain patient comfort for several days, particularly following full-face laser. If the treatment is local, such as to the periorbital area, acetaminophen alone may suffice.

Mild to moderate hyperemia is usually present. With the "mid" treatment this is gone by 2 weeks, while with the fusion treatment it can persist for several weeks longer. After the epithelium has healed, camouflaging cosmetics may be applied until the redness has subsided. Green concealer will hide the reddish discoloration. Avoidance of sun exposure is necessary until complete resolution of the erythema. Complete sun block must be applied when outdoors while erythema persists.

Postinflammatory hyperpigmentation occurs 1–2 months following laser in up to half of the patients treated with the "fusion" mode. This risk is greater in patients with darker skin. Pigmentary changes are usually transient. Regimens to reduce hyperpigmentation include bleaching agents such as hydroquinone, kojic acid, and azelaic acid, with or without facial glycolic acid or trichloroacetic acid peeling treatments. Care must be taken to avoid inducing erythema with these treatments, which can result in increased hyperpigmentation.

During the healing period, the newly epithelialized skin is hypersensitive to allergens in topical preparations and the air. Even after the epithelium has healed, the skin remains hypersensitive. The use of hypoallergenic and fragrance-free soaps is recommended.

8 Neuromodulator: Cosmetic Botox

Shoib Myint

History

The desire for flawless skin and the search for the fountain of youth have consumed people since the beginning of time. Some were prepared to do all sorts of wacky things to improve their appearance in the past. In the 1400s, ladies in the French Court of Louis XI ate mostly soup, as they believed chewing gave them wrinkles. In the 1600s, uncooked egg whites were used to glaze the skin, creating a smooth shell that hid wrinkles.

Botulinum was first described in the 1820s, when Justinus Kerner, a small-town German medical officer, made clinical observations of so-called sausage poisoning. Seventy years later, seven strains of botulinum toxin (A–G) were discovered, four of which were harmful to humans (A, B, E, F) [1]. In the 1950s, researchers discovered that injecting small amounts of Botulinum toxin type A into hyperactive muscles relaxed them. After scientists and researchers began to experiment with its helpful side effects in the 1960s, botulinum toxin type A became the go-to toxin in all research labs. The FDA finally approved botulinum toxin type A for use on humans in the 1980s. It was primarily approved for treating facial spasms. Alan B. Scott, an ophthalmologist, and his colleagues injected botulinum toxin in the first strabismus patient in 1977 with much success. He coined it *Oculinum*™ ("eye aligner") [2]. He sold his stake in this drug to Allergan Corporation in the 1990s and thus was born BOTOX Cosmetic. It is the trade name of botulinum toxin type A, a purified, sterile neurotoxin complex produced from a strain of *Clostridium botulinum*.

Botox has been approved by the U.S. Food and Drug Administration (FDA) for treatment of strabismus and blepharospasm associated with dystonia, including benign essential blepharospasm or seventh cranial nerve disorders in patients 12 years of age and older. It has also been used successfully in the treatment of cervical dystonia and migraine headaches. The successful use of Botox for cosmetic purposes has led to its application for numerous clinical conditions. It gained FDA approval in 2002 for temporarily improving the appearance of individuals with glabellar lines (frown lines) associated with corrugator or procerus muscle activity in adult patients.

Electronic Supplementary Material The online version of this chapter (doi:10.1007/978-3-319-67331-8_8) contains supplementary material, which is available to authorized users.

S. Myint, DO, FAACS, FAOCO
Ophthalmology, Myint Center for Eye and Facial Plastic Surgery, Nevada Eye Physicians, UNLV School of Medicine, 2598 Windmill Parkway, Henderson, NV 89074, USA
e-mail: shoibmyint@gmail.com

G.J. Gladstone et al. (eds.), *Oculoplastic Surgery Atlas*, https://doi.org/10.1007/978-3-319-67331-8_8

Mechanism of Action

There are two kinds of wrinkles: static and dynamic. Static rhytids are present when the face is relaxed. Dynamic rhytids appear during facial animation. Botox is beneficial for reducing the appearance of dynamic rhytids in the forehead and periorbital regions. Static rhytids that were initially present are also likely to be reduced, although not necessarily eliminated. Botulinum reduces these dynamic rhytids by blocking neuromuscular conduction by binding to motor nerve terminals and inhibiting release of acetylcholine [3]. Following intramuscular injection, the result is temporary chemical denervation-induced muscle paralysis.

Types of Neuromodulators

Other formulations of botulinum are available and may provide similar results. Myobloc (botulinum toxin type B; Elan Pharmaceuticals, South San Francisco, CA, USA) is indicated for treatment of cervical dystonia to reduce the severity of abnormal head position and neck pain. This drug was not found effective in aesthetic patients due to its shorter clinical effect and pain on injection site. Dysport (Medicis Corp Scottsdale, AZ) was FDA cleared in 2009 with a 3:1 ratio in dilution when compared to Botox. Xeomin (Merz Aesthetics, Greensboro, NC) has no inactive proteins, which allows for less chance of potential antibody formation against the product. For those patients who might not respond well to Botox or Dysport from possible antibody formation, Xeomin maybe an option.

Dosage

According to the manufacturer Allergan, Botox should be diluted with preservative-free 0.9% NaCl saline. The vial is vulnerable to surface denaturation, so the surgeon must be cautious not to shake or agitate the bottle when diluting the solution. The saline should be gently introduced into the vial to prevent foaming of the Botox solution. The amount of dilution varies with the site treated. High concentrations (50–100 units/mL) theoretically give a more localized effect with fewer side effects. If a large volume of solution at lower concentration (5–25 units/mL) is injected, there is a greater possibility that the material will diffuse over a greater surface area. This diffusion of material may result in a broader area covered or may cause side effects (e.g., eyelid ptosis). Once the vial is diluted, Botox tends to gradually lose its efficacy, beginning at 12 h, although some surgeons claim that the diluted Botox retains efficacy for up to 1 month. The manufacturer recommends use of reconstituted Botox within 4 h. The volume and concentration of Botox injected depends on the area being treated. The dilution depends on what location is treated and the extent of muscle paralysis desired. Botox is manufactured as either 50 or 100 unit vials. Typically, 2.5 cc or 1.25 cc of saline is slowly added to the 100 units or 50-unit vial, respectively, providing 4 units/0.1 cc. The surgeon should use a tuberculin syringe with a 30-gauge needle for all injections. Do not use the same needle used to draw up the Botox solution, as it will be slightly dulled and more painful for the patient. Prior to and after injection, it may be beneficial to cool the treatment area with ice packs because some patients complain of brief, mild discomfort and stinging. Topical anesthesia may be used but is not necessary.

Injection Sites

Botulinum can be injected intramuscularly, subcutaneously, or intradermally. Most muscles of facial expression can be affected by the introduction of neuromodulators (Fig. 8.1) (Video 8.1). The most common cosmetic applications for Botox are the reduction of glabellar frown lines, crow's feet, and horizontal forehead lines [4]. Botox can also be used to treat facial asymmetry, chronic tension headaches, and hyperhydrosis.

The distribution of injection sites can be seen in Fig. 8.2. Glabellar frown line injections are placed above the medial brow (directly into the corrugator muscles) and between the brows (into

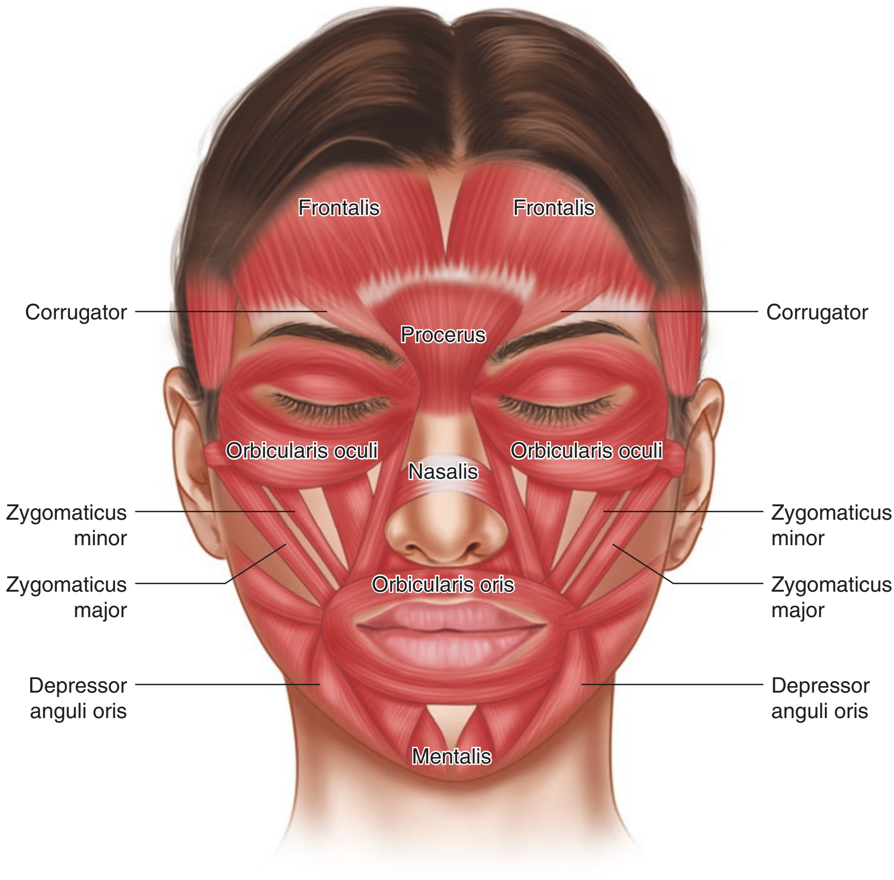


Fig. 8.1 Important muscles in the glabellar region

the procerus muscle) (Fig. 8.3). The dilution depends on the thickness of the muscle. Men usually require more units than women. In general, 2–5 units are administered at each injection site. Injections should be symmetrical to achieve a balanced look. For most patients, five injections of 4 units each (total 20 units) provide results with which patients are satisfied. Sometimes the corrugator muscles are injected too high superior to the brow, resulting in what it termed the "Spock" look, after the character in the original *Star Trek* television series. It is imperative to be very familiar with the forehead anatomy to avoid this unpleasant appearance.

When treating crow's feet, two or three injection sites lateral to the lateral orbital rim are used (2–5 units/site). The patient is asked to smile, and the center of the canthal creases is marked. The first injection is given at the canthal crease. The second and third injections are applied approximately 1 cm above and below the first. For most patients, 8–10 units per eye provide optimal results.

Treatment of forehead wrinkles can provide excellent results (Fig. 8.4). Several treatment methods exist, and the physician must determine which is best for a particular patient. One technique involves injections directly into a rhytid or just above and below a rhytid. This technique may be best suited for patients with a small number of rhytids or wrinkles localized to one small region, such as the central forehead only. A total of 4–6 injections (4 units/injection, 16–24 units total) should provide good results.

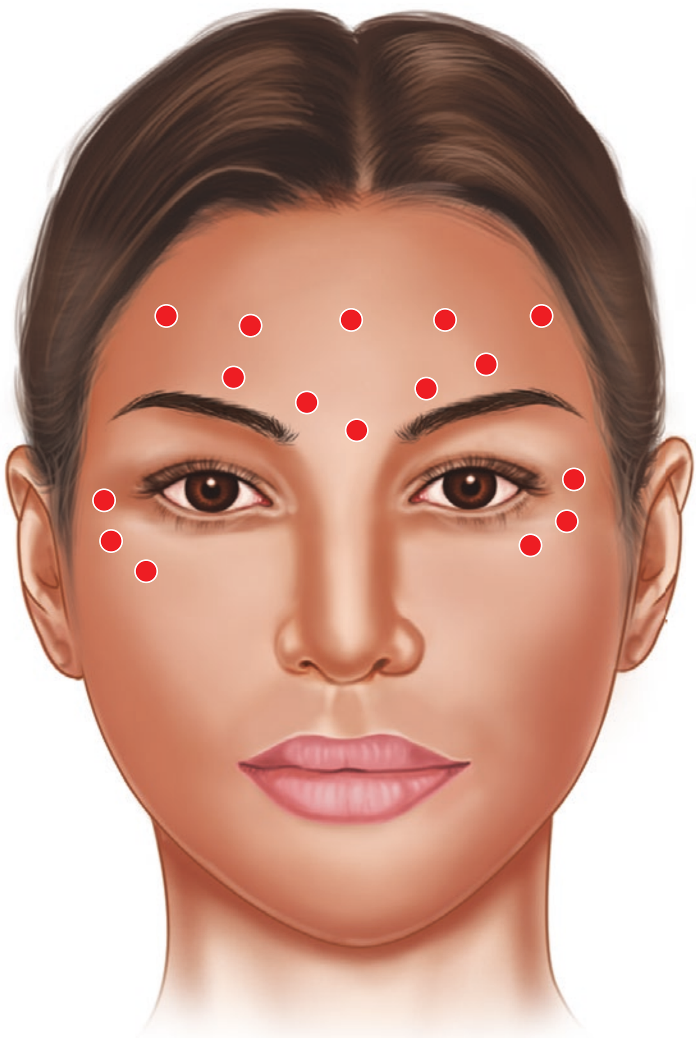


Fig. 8.2 Areas commonly treated with cosmetic Botox: transverse forehead rhytids (**a**); glabellar rhytids (**b**); Crow's feet (**c**)

For a patient with diffuse transverse forehead rhytids, a more generalized approach might suffice (Fig. 8.5). Usually five injections of 4 units/injection (20 units total) provide broad coverage. Each injection is given approximately halfway between the brow and hairline. The two medial injections are given along a vertical line through the medial edge of the eyebrow. The two lateral injections are given along a vertical line through the lateral canthus.

At therapeutic doses, the initial effect of Botox for all these locations can occur 2–3 days after injection. Maximal weakness occurs within 1 week. In general, the smaller the dose of Botox, the longer it takes to see the results. The effects usually last 3–5 months in patients who undergo the treatment for cosmetic purposes. Patients can be reexamined 1–2 weeks after the initial treatment; if additional injections are necessary, they may be provided during this time. Repeat injections are given every 3–6 months.

One must be aware that Botox does have immunogenic properties. For neurologic patients,

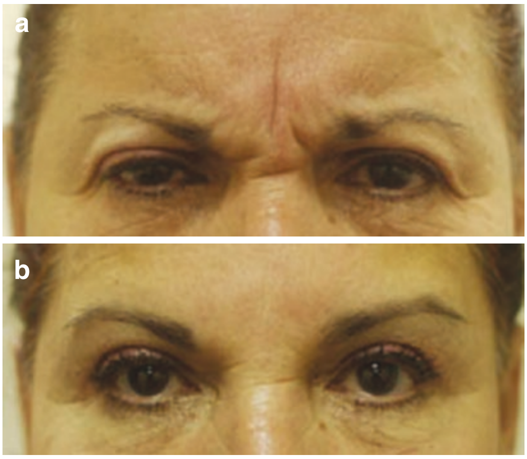


Fig. 8.3 (**a**), Before Botox. (**b**), 18 units Botox in glabellar region

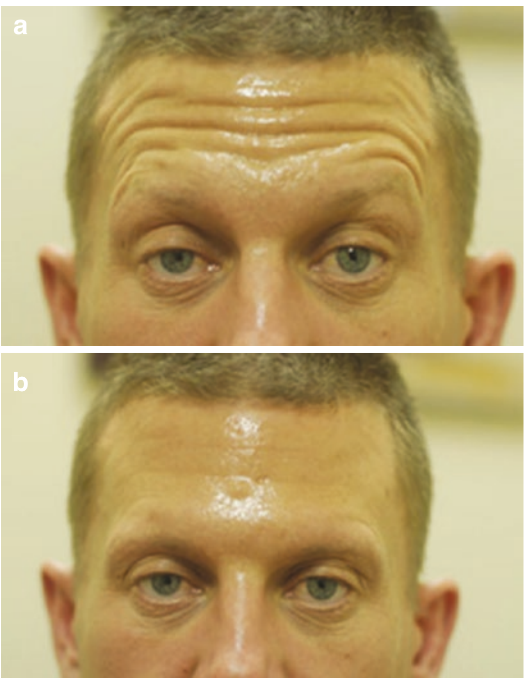


Fig. 8.4 (**a**), Before Botox brow lift. (**b**), 8 units per side lateral orbicularis muscle

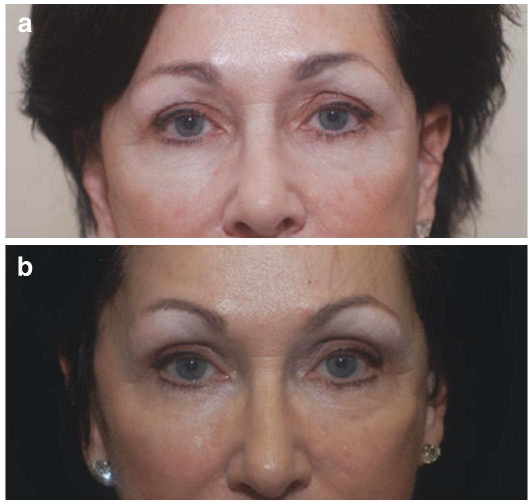


Fig. 8.5 (**a**), Before Botox to forehead rhytids. (**b**), 40 units Botox

it has been estimated that nearly one-third of treatment failures are due to antibody formation [5]. Failure is rarely seen in blepharospasm patients because such a low dose is administered. Patients at risk of developing antibodies are those given the toxin at doses of more than 100 units per session, booster injections within 30 days of initial injection, or injection into the systemic circulation. For these reasons, it is probably best to give patients the lowest possible dose needed to achieve the desired effect. Higher doses do not result in a better or longer-lasting effect and may predispose to antibody formation.

Other sites for injections are: **Brow Lifting** using the superolateral fibers of the Orbicularis Oculi Muscle, 2–4 units per side; **Bunny Lines** (Nasalis Muscle) where 2–4 units are injected in to the upper nasalis; **Gummy Smile** (Levator Labii superioris aleque nasi [LLSAN] Muscle): 1–2 units per side; **Perioral Lines** (Smokers Lines—Orbicularis Oris Muscle): 1 unit injected per lip line just above the vermilion border in area of muscle contraction; **Square jaw** (Masseter Muscles): 15–20 units per side; **Chin Dimples** (pebbled chin, orange peel chin—Mentalis Muscle): 3–5 units per mentalis band; **Downturned lips at the sides** (Depressor Anguli Oris [DAO] Muscle): 2 units are injected directly into the DAO on each side; **Vertical Neck lines** (Platysmal bands of the Platysma Muscle): 4–5 units per site, not to exceed over 25–30 units total for each session to avoid dysphagia.

Contraindication

Botox is contraindicated in patients who are known to be hypersensitive to the ingredients including human albumin and saline, those with muscular or neurologic diseases such as myasthenia gravis or amyotrophic lateral sclerosis, and pregnant women. Aminoglycosides are a relative contraindication because they interfere with neuromuscular transmission and potentiate the effects of Botox.

Complications

Botox can diffuse if injected improperly to non-targeted muscles resulting in an undesirable result. These side effects can be avoided by carefully targeting the injection and by using concentrated doses of botulinum toxin to limit its diffusion. Although adverse reactions and complications are uncommon and reversible, they must be disclosed to the patients. Such effects include ptosis, ectropion, tearing, keratitis, and rarely entropion and diplopia. The injected volume should be minimal to reduce the risk of ptosis. Some claim that the injected areas should not be manipulated for several hours after injection so Botox can bind to its receptors. The patient should remain vertical for 2–3 h to reduce the risk of ptosis. If ptosis does occur, Aproclonidine (Iopodine) 0.5% can be administered to help with the ptosis until the Botox wears off. The median lethal human dose (LD_{50}) of botulinum is 1.3–2.1 ng/kg intravenously or intramuscularly and 10–13 ng/kg when inhaled.

Conclusion

The usage of neuromodulators has caused a paradigm shift in the field of medicine, especially plastic surgery. This is still a medical drug and should be handled as such. It is imperative for the injector to not only have a solid understanding of facial anatomy and musculature, but also the ability to establish a trustworthy dialogue with patients for realistic expectations including the risks complications and benefits of this miraculous drug.

References

1. Carruthers A, Carruthers J. Aesthetic botulinum A toxin in the mid and local face and neck. Dermatol Surg. 2003;29:468–76.
2. Scott AB. Botulinum toxin injection of eye muscles to correct strabismus. Trans Am Ophthalmol Soc. 1981;79:734–70.
3. Schantz EJ, Johnson EA. Properties and use of botulinum toxin and other microbial neurotoxins in medicine. Micobiol Rev. 1992;56(1):80–99.
4. Myint S. Nonsurgical peri-orbital rejuvenation. New York: Springer; 2014.
5. Torres S, Hamilton M, Sanches E, Starovatova P, Gubanova E, Reshetnikova T. Neutralizing antibodies to botulinum neurotoxin type A in aesthetic medicine: five case reports. Clin Cosmet Investig Dermatol. 2013;7:11–7.

9 Soft Tissue Augmentation

Shoib Myint

History

There has been a tremendous paradigm shift taking place in plastic surgery toward nonsurgical modalities in facial rejuvenation. This evolution accelerated over the last 5 years owing to the increasing demand from patients desiring less downtime and faster recovery. We have only begun to scratch the surface of what the future holds in less invasive techniques for not only the face but also the rest of the body. History has taught us to be cautious in rapidly introducing agents to fill facial defects. The search for that perfect filler would adequately fill the correct volume, be safe and biocompatible, nonteratogenic, noncarcinogenic, cause no infection, require no skin testing, and fully reversible. From the first filler agent, paraffin, to chemical agents in the early 1800s, to fat transplants in the late 1800s, the search for that perfect filler material was beginning to take shape. In the mid-twentieth century the advent of silicone changed the industry, only to be later banned due to its complications. The 1970s saw bovine collagen as the savior for facial augmentation. It ran a wonderful course until the game changer in 2006 when the FDA approved Hyaluronic acid fillers, which revolutionized the world of nonsurgical facial rejuvenation. Since then many different types of fillers have emerged on the market, and many more are on the horizon. More recently, PRP, or Plasma Rich Protein has taken the market by storm not only as filler, but also as a facial skin enhancer by attracting growth factors and stem cells.

Types of Fillers

There are two broad categories of fillers: Temporary and Permanent.

Some of the more common temporary fillers are **hyaluronic acid**, which includes Juvederm (Allergan, Irvine, CA), Belotero (Merz Aesthetics, San Mateo, CA), and Restylane/Perlane (Medicis Aesthetics, Scottsdale, AZ etc.). The **calcium hydroxyapatite** fillers include Radiesse (Merz Aesthetics, San Mateo, CA), and the **collagen stimulators** include Sculptra (Sanofi Aventis, Bridgewater, NJ). Permanent fillers are not as common as the temporary ones, and include **polymethylmethacrylates** such as Artefill and Artecoll (Suneva Medical, San Diego, CA). Each filler has its unique physical

Electronic Supplementary Material The online version of this chapter (doi:10.1007/978-3-319-67331-8_9) contains supplementary material, which is available to authorized users.

S. Myint, DO, FAACS, FAOCO
Ophthalmology, Myint Center for Eye and Facial Plastic Surgery, Nevada Eye Physicians, UNLV School of Medicine, 2598 Windmill Parkway, Henderson, NV 89074, USA
e-mail: shoibmyint@gmail.com

G.J. Gladstone et al. (eds.), *Oculoplastic Surgery Atlas*, https://doi.org/10.1007/978-3-319-67331-8_9

properties that lend themselves to specific outcomes in individual patients. It is very important for the injector to understand the unique physical properties of the different types of fillers prior to deciding which filler is best for the patient.

There are two concepts that predict the lifting capacity of fillers: G prime (elasticity) and Viscosity [1]. The G prime or elasticity describes how the filler is able to retain its shape when a force is applied. High G primes allow for more contour stability and lifts tissues better. Fillers with lower G primes are softer and spread through tissues easer. For deeper areas, a higher G prime is a better choice due to the amount of movement and need for contouring. For tear troughs, a lower G prime may be better suited. Another property measured for filler is the viscous nature of the filler. The viscosity is related to the flow of the filler and how spreadable the filler is. A higher viscosity filler is able to keep its shape better while lower viscosity filler will conform to the underlying tissues better.

Hyaluronic Acid

Hyaluronic Acid (HA) fillers are the most popular soft tissue fillers used in the United States. It is a naturally occurring glycosaminoglycan that is a major component of all connective tissue. HA is a non-animal product, so there is no chance for any adverse immunologic reaction, which is why patients don't need pre-injection allergic testing. Hyaluronic acid is very important for skin hydration, so the loss of HA with age can result in reduced dermal thickness, increased skin wrinkling, and folding. One big advantage of hyaluronic acid properties is that it can be reversed within 12–24 h following injection of the enzyme hyaluronidase. For areas where more volume is desired, such as the buccal cheek area, a higher G prime and viscosity product such as Juvederm has shown to be more beneficial. However, in the infraorbital tear trough, a thinner product such as Belotero or Restylane is preferred. If placed too superficially under the eyes, HA can result in a tyndall effect in which the optical scatter of the HA and fluid reflects blue light. Only Belotero, with a cohesive polydensified matrix property, has the least chance of developing a Tyndall effect. Regardless of the product used it is recommended to place the product supraperiosteal in the tear trough to avoid visible contour irregularities (Figs. 9.1, 9.2 and 9.3).

Calcium Hydroxyapatite

Radiesse has calcium hydroxyapatite (CaHA) microspheres suspended in a sodium carboxy methylcellulose gel carrier. It is more effective in

Fig. 9.1 Cannula cheek lift with Juvederm Voluma, cannnula tear trough with Belotero

Fig. 9.2 Cannula tear trough with Restylane

Fig. 9.3 Cannula cheeks lift Radiesse

treating deep lines and furrows. This product can last between 6 and 12 months. It is FDA-approved for the correction of moderate-to-severe facial folds and wrinkles, as well as lipodystrophy. CaHA is wonderful in filling over bony prominences such as the malar area in patients with thicker skin. Placing this filler in the tear trough area is *not* recommended.

Collagen Stimulators

Poly-L-lactic Acid (PLLA) such as Sculptra is a product that stimulates collagen growth and allows for subtle and progressive augmentation. It can cause, rarely, nodules and granulomas. This product is primarily for patients requesting global facial volumization where autologous fat is not available. It can last from 12–18 months following a series of three treatments.

Permanent Fillers

Polymethylmethacrylate (PMMA) is non-resorbable. It has microspheres composed of 3.5% bovine collagen, 0.3% lidocaine hydrochloride, 2.7% phosphate buffer, and 0.9% sodium chloride. Its main indication is the correction of nasolabial folds. Because of its bovine collagen component, patients need skin testing. This filler is not reversible like the HA fillers, and this must therefore be taken into consideration when discussing with patients during the reinjection consultation.

Injection

The use of blunt-tip cannulas instead of needles for injecting fillers is a method utilized by injectors to allow for immediate results with minimal morbidity (Video 9.1). Using the cannulas, the provider is able to place the fillers deep to avoid the ecchymosis discomfort and edema often associated with treatments that are more superficial. The cannulas also allow the injector to dissect underlying soft tissue to select a precise plane for product placement. One important fact in using a blunt-tipped cannula instead of a sharp needle is that it reduces the chance of inadvertent intravascular injection, which could be disastrous [2]. It should be noted that there is a moderate learning curve to overcome when using the cannulas. Once placed, the filler can then be massaged into place. A blunt-tip cannula requires more injecting force than a needle tip, and the pressure may be discomforting to the patient. Once the correct location and plane for filler placement is identified, the cannula is kept moving back and forth in a fanning fashion during a slow injection. This assists in smooth and even deposition of the product. The level of the injection is predicated on the area and the result desired. Around the eyes and cheeks, the fillers should be placed submuscular/preperiosteal for a nicer, softer contour.

Complications

There is a direct correlation between the speed of injections and the number of complications; it is therefore essential to decrease the speed at all cost. The overall safety profile of soft tissue filler injections is excellent, but complications *can* occur. Minor complications of facial fillers include pain, edema, and erythema. These complications are typically transient and resolve within a week without any sequelae. More serious complications may include scars, infections, granulomas, persistent lumps, visible palsy, vascular occlusion, and blindness. By understanding the anatomy and the materials being injected, it is possible to decrease the probability of a complication and to mitigate the outcome should one occur. Patients are warned to avoid nonsteroidal anti-inflammatory medications, aspirin, vitamin C, and omega supplements. It is recommended to sleep with the treated area elevated for 1–2 nights after injections. Ice to treated areas will reduce swelling/edema and trauma.

If lumps or bumps cannot be massaged away after 7–10 days, it is possible to inject the enzyme hyaluronidase. It is also possible to remove fillers by using a 26-gauge needle or an 11 blade.

Granulomas are more commonly seen with nonhyaluronic acid-based products such as silicone, poly-L-lactic acid, and polymethylmethacrylate. The microspheres they produce can be extremely difficult to treat. Treatment with hyaluronidase, collagenase, and steroids has helped these granulomas. In some cases, surgical removal is a viable option. When the granulomas undergo delayed inflammation, treatment with oral antibiotics may help. Vascular compromise is dangerous and has a 0.05% chance of happening [3]. Injection in the temporal fossa should be done at the periosteal plane to avoid injury to the superficial temporal artery. Injections into the forehead should be in the deep planes to avoid the superficial vessels. The glabellar area is a danger zone. Any filler must be superficially injected to avoid vascular occlusion and necrosis of the supraorbital and supratrochlear arteries. Other danger zones include the angular artery at the base of the nasal labial fold and the superficial labial artery at the corner of the mouth. Rarely, reactivation of herpetic eruptions and localized bacterial infection may occur in susceptible patients. These patients should be promptly and aggressively treated with antivirals and local wound care. Any early skin blanching or dusky or purple color must be considered to be impending skin necrosis until proven otherwise. This complication has been reported in association with all types of filler, with an estimated incidence of 0.001% [4].

Intravascular injection of filler agents may lead to embolic events with irreversible loss of vision or cerebrovascular injury [5]. The mechanism of this adverse event is the retrograde propulsion of injected material into the ophthalmic or retinal arteries via the supratrochlear, angular, or dorsal nasal arteries during glabellar or nasolabial area injections, followed by arterial occlusion. Any patient who experiences a decline in visual acuity or ocular pain after injection should be considered to have experienced this complication until proven otherwise. Immediate ophthalmologic evaluation with a retina specialist and brain MRI are indicated. Theoretically, treatments should be aimed at rapidly reducing intraocular pressure in order to dislodge the embolus to a more downstream location. Aspiration prior to injection should be practiced to rule out intravascular placement of the needle or cannula. Blunt, flexible needles and cannulas are preferred to their sharp counterparts. Importantly, the volume of filler injection should be limited, the pace of the injection should be slow, and the pressure used to inject the substance should be low.

Summary

The introduction of nonsurgical modalities for facial rejuvenation has allowed for less downtime, less morbidity and faster recovery for patients. Filler augmentation is one modality, which has changed the way surgeons approach volume loss. It is very important for the injector to not only understand facial anatomy in detail, but also to understand the dynamics and properties of the different types of fillers available. Appreciating their characteristics and the injection techniques are critical factors in the avoidance of serious complications. Above all, as with any procedure, discussion with the patient of all the risks and complications of filler augmentation should occur during the preinjection consultation.

References

1. Sundaram H, Flynn T, Cassuto D, Lorenc ZP. New and emerging concepts in soft tissue fillers. Dermatol Surg. 2012;11(8 suppl):S12–24. discussion s25.
2. Myint SA. Nonsurgical periorbital rejuvenation. New York: Springer; 2013.
3. Rzany B, Cartier H, Kestemont P, Trevidic P, Sattler G, Kerrouche N, et al. Full face rejuvenation using a range of hyaluronic acid fillers: efficacy, safety, and patient satisfaction over 6 months. Dermatol Surg. 2012;38(7pt2):1153–61.
4. Dyan SH, Arkins JP, Mathison C. Management of impending necrosis associated with soft tissue filler injections. J Drugs Dermatol. 2011;10(9):1007–12.
5. Carruthers JD, Fagien S, Rohrich RJ, Weinkle S, Carruthers A. Blindness caused by cosmetic filler injections: a review of cause and therapy. Plast Reconstr Surg. 2014;134(6):1197–201.

Index

G.J. Gladstone et al. (eds.), *Oculoplastic Surgery Atlas*, https://doi.org/10.1007/978-3-319-67331-8