Surgical Anatomy of the Forehead, Eyelids, and Midface for the Aesthetic Surgeon

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Key Points

- The eyes are a central feature of the face, and patients commonly present for aesthetic rejuvenation of the eyelids and surrounding areas.
- A detailed comprehension of forehead/eyebrow, eyelid and midface anatomy, and how these separate units interrelate with each other, is critical to successful aesthetic surgery of the upper face.
- Eyebrow position is maintained by a delicate balance of muscles which elevate the brow (frontalis muscle), and those that depress the brow (orbital orbicularis oculi, corrugators supercilii, procerus and depressor supracilii).
- Eyebrow lifts can be achieved surgically with variety of browlifting procedures, or chemically (along with treatment of dynamic rhytids) with selective chemodenervation.
- The eyelids are complex structures composed of multiple delicate layers. A comprehensive familiarity with their anatomy and function is essential for successful aesthetic and functional surgical outcomes.
- Involutional lower lid and midface changes lead to lower lid "bags," lid/cheek interface depressions (tear trough), and loss of malar projection. An understanding of these changes allows appropriate planning for surgical correction
- The temporal, zygomatic, and to a lesser degree, the buccal, branches of the facial nerve innervate the eyelids and periorbital region. It is important to understand the course of these nerves when performing surgery.

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2.1 Introduction

The expanding indications and array of procedures available to the aesthetic surgeon demand a thorough understanding and knowledge of the intricate anatomy of the face. Novel surgical approaches and evolving instrumentation offer tremendous opportunities to improve clinical and surgical skills and outcomes. An intimate appreciation of facial anatomy is critical in choosing and performing the appropriate surgical procedure. This chapter will review eyelid and periorbital facial anatomy essential to all aesthetic surgeons.

2.2 Facial Proportions

Evidence from historical texts and art dating back to the Renaissance period show that appreciation of ideal facial proportions has persisted for ages. Many regard the ideal face as five eye widths wide and eight eye widths high [1]. In a study examining North American Caucasians, the horizontal proportions were defined by the width of the nose, with one nose width equaling interorbital width or one fourth of the face width [2].

More recent studies have emphasized the importance of recognizing ethnic, gender, and age-related differences in facial proportions when performing aesthetic and reconstructive surgery. One guideline of beauty is "the golden ratio" introduced by Euclid approximately three centuries before Christ. The "golden ratio" (1:1.618), sometimes called "phi," is a ratio obtained when a line is divided into two unequal segments, where the ratio of the longer segment to the whole line is equal to the ratio of the shorter segment to the longer one. This ratio is naturally observed in both nature and the human body. This "golden ratio" was used to develop a "facial golden mask" [3]. Aesthetic surgeons can use the facial golden mask to represent idealized facial structures that are reported to remain consistent regardless of race or culture. The facial golden mask can be overlaid on standard

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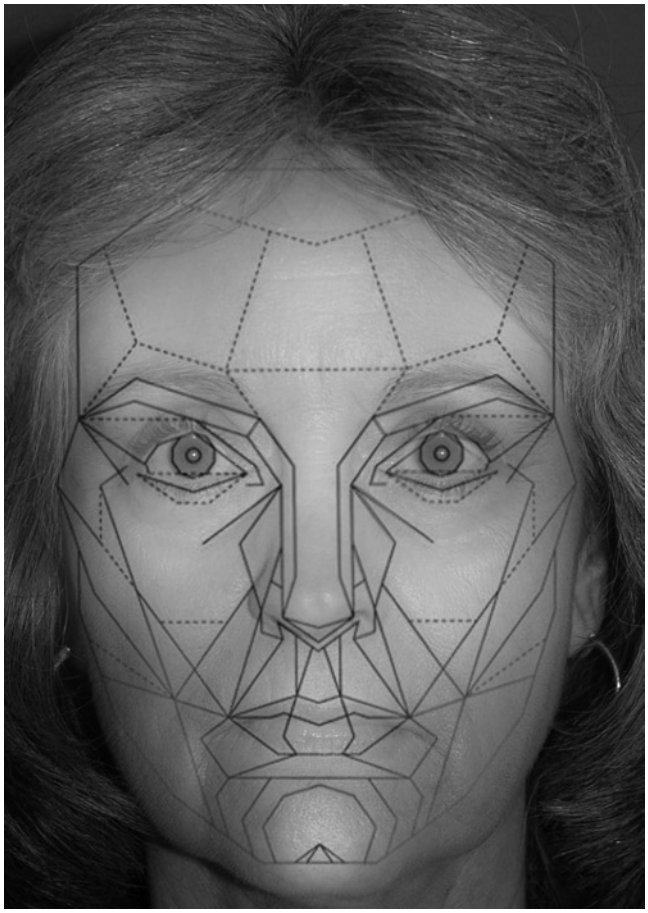


Fig. 2.1 A 55-year-old woman with the golden facial mask superimposed on a digital photograph

photographs and used as an analytical tool to recognize the balance and arrangement of facial structures based on soft tissues in pre- and postoperative patients [4] (Fig. 2.1).

2.3 Forehead

Since the upper face forms the platform for facial recognition, beauty, and age estimation, it is a focus of many patients seeking aesthetic facial surgery. The importance of the upper facial appearance was studied with eye tracking devices to determine which facial regions on a photograph were used by observers to gauge age and tiredness. By far, the periorbital areas were the most scrutinized by observers [5].

The forehead is composed of multiple layers, including skin, connective tissue, and muscle. The skin of the forehead is the thickest of the face and contains transverse oriented septae extending from the dermis to the frontalis muscle. These are thought to play a distinct role in the transverse forehead furrows that occur with aging. The vertically oriented frontalis muscle is the main retractor of the upper face whose primary function is to raise the forehead/eyebrows. Its fibers originate from the galea aponeurotica on the scalp and



Fig. 2.2 A 76-year-old woman with visually significant bilateral upper eyelid ptosis and compensatory contraction of the frontalis muscle

it inserts on the skin of the eyebrows and nose. The galea aponeurotica divides into a superficial layer, encompassing the frontalis muscle and a deep layer, which attaches to the supraorbital margin and merges into the postorbicular fascial plane at the upper eyelid [6]. It is common to see chronic contraction of the frontalis muscle with secondary horizontal forehead rhytids in patients with visually significant upper eyelid ptosis or dermatochalasis (Fig. 2.2).

The primary depressors of the forehead and eyebrows are the procerus, corrugator supercilii, orbicularis oculi, and depressor supracilii muscles (Fig. 2.3). The procerus is a small, triangular muscle that originates from the fascia of the nasal bone and inserts into the glabellar and forehead skin, between the paired bellies of the frontalis muscle. It draws the medial angle of the eyebrow downward and is responsible for the horizontal wrinkles seen over the nasal bridge.

Superior to the procerus is the corrugator supercilii muscle, which lies at the medial one-third of the orbicularis oculi muscle. It originates from the nasal process of the frontal bone and extends obliquely over the supraorbital rim where it interdigitates with fibers from the frontalis and orbicularis muscles and inserts into the deep surface of the skin. Its action is to pull the forehead and eyebrow in an inferomedial direction. Contraction of the corrugator causes vertical "frown lines" rhytids (glabellar folds) medial to the eyebrow. Aesthetic evaluation should include testing for corrugator function to detect the presence of dynamic rhytids. Chemodenervation of the corrugator and procerus muscles with botulinum toxin injections provide temporary yet powerful treatment for dynamic rhytids in this region (Fig. 2.4). The corrugator muscle is supplied by the temporal branch of the facial nerve, and the procerus is innervated by the buccal branch of the facial nerve (cranial nerve VII).

The orbicularis oculi is divided into an orbital, preseptal, and pretarsal portions based on the anatomic structures that lie beneath (Fig. 2.3). The orbital fibers arise from the medial canthal tendon, arch along the orbital rim, and meet laterally

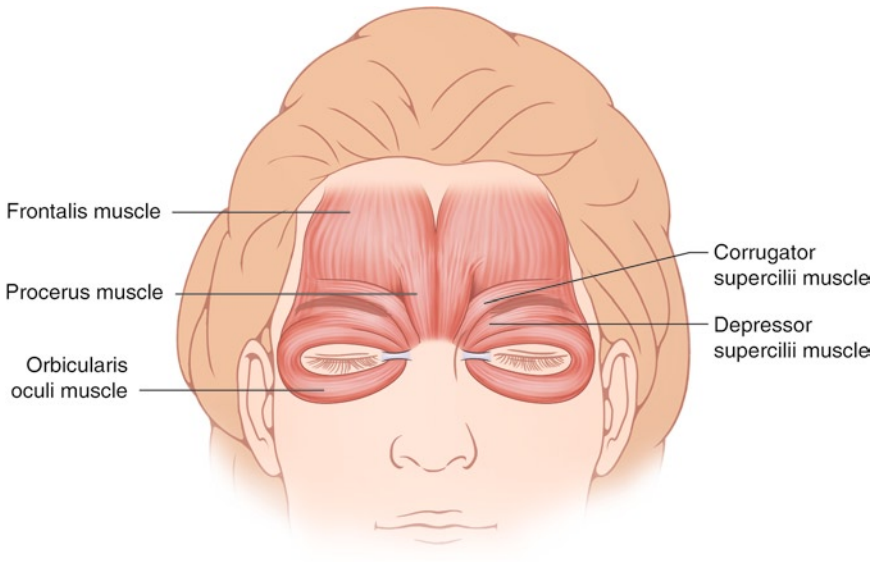


Fig. 2.3 Upper face retractors and depressors



Fig. 2.4 This patient desired nonsurgical treatment for her glabellar rhytids (*left*). Four weeks after botulinum injection, she was satisfied with resolution of her rhytids (*right*). Patient still has presence of static rhytids and may benefit from soft tissue fillers

at the zygoma. The preseptal fibers overlie the orbital septum, originate at the medial canthal tendon and meet laterally to contribute to the lateral palpebral raphe. The pretarsal fibers are firmly adhered to the tarsus and travel in an elliptical path around the palpebral fissure. Medially, the pretarsal orbicularis splits into superficial and deep heads. The superficial head (along with the preseptal and orbital orbicularis) originate above and below the anterior reflection of the medial canthal tendon. The deep head arises at the posterior lacrimal crest (posterior reflection of medial canthal tendon). Laterally, the pretarsal orbicularis also forms superficial and deep heads. The deep head contributes to the lateral canthal tendon which inserts 3 mm posterior to the orbital rim at Whitnall's tubercle.

The orbicularis muscle functions as a protractor of the eyelids (blinking, squinting and forceful eyelid closure), with its orbital component an accessory depressor of the forehead. The superior fibers of the orbicularis oculi (upper eyelid) are innervated by the temporal branch of the facial nerve, while the inferior fibers (lower eyelid) are innervated by the zygomatic branch. The orbital fibers of the orbicularis muscle interdigitate superiorly with the frontalis muscle fibers, pulling the skin of the forehead and eyelid downward, while elevating the cheek toward the eye from their inferior function, resulting in dynamic "crow's feet." With aging and thinning of the overlying dermis and fascia, static rhytids develop over time.

Finally, the depressor supercilii originates on the medial orbital rim, near the lacrimal sac and inserts on the medial aspect of the bony orbit, inferior to the corrugators supracilii [7]. It is also innervated by the temporal branch of the facial nerve, and acts as an accessory depressor of the medial eyebrow.

2.4 Eyebrows

The eyebrows serve as a foundation for the eyelids. Freund and Nolan reported a study showing that, in general, men have straighter eyebrows, remaining at the level of the superior orbital rim, while women tend to have a greater arc that



Fig. 2.5 Pre- and postoperative photographs of a 58-year-old patient after bilateral endoscopic eyebrow lift and upper eyelid blepharoplasty. Preoperatively, she had a flat brow with ptosis of the lateral tail (*left*). Postoperatively, a more youthful brow shape is achieved with the eyebrow apex located at the lateral limbus (*right*)

remains above the orbital rim, with the apex at the lateral limbus [8]. There is also a preference for a medial eyebrow below or at the supraorbital rim, with a shape that has a lateral slant in females [9]. A more contemporary assessment of favorable eyebrow shape, taking into account cultural preferences, indicates that a more lateral brow apex is preferable [10].

The orientation of eyebrow cilia is remarkably constant among individuals. Angular and lateralized cilia are much more abundant in the medial eyebrow, with decreasing degree as the eyebrow arcs laterally. The upper portion of the eyebrow contains cilia directed downward from the vertical plane, while in the lower portion they are directed upward from the vertical plane [11]. Incisions in the brow should to be beveled in the appropriate angle to preserve cilia.

With aging, the classical notion of eyebrow descent from the effects of gravity has been widely described. Recent studies, however, suggest that eyebrows can actually remain level or even elevate with age [12]. Some studies have shown a higher and more arched brow in older adults [13]. When eyebrow height in an older cohort was compared to a younger one, the older subjects had higher eyebrows and a flatter configuration, with the lateral and central regions having similar heights [12]. Lateral brow ptosis is more common due to lack of frontalis contraction in the lateral brow and also from gravitational pull from the heavy cheek and lateral facial tissues. Because of this, when rejuvenating the upper face, consideration should be given to selectively elevate the lateral brow, more than the nasal brow (Fig. 2.5).

Deep to the interdigitation of the frontalis/orbicularis muscles is a fibro-fatty layer termed the eyebrow fat pad, or retroorbicularis oculi fat pad (ROOF) (Fig. 2.6). The ROOF contributes to eyebrow volume and mobility of the lateral eyebrow and eyelid. However, in some individuals who have prominent eyebrow fullness, the ROOF can be debulked. The ROOF is continuous with the posterior orbicularis fascia in the eyelid [14].

There are variable amounts of eyebrow fat present among different ethnicities. Studies suggest that in the Asian eyelid, there is a more substantial fatty extension of the ROOF into the preseptal space, which has been denoted as "submuscular fibroadipose layer" or "preseptal fat pad" [15, 16]. The anatomic relationship of the ROOF and the eyelid must be remembered when operating on the eyelid, as the eyebrow fat can often be mistaken for preaponeurotic fat of the eyelid.

Treatment consideration – forehead and brow rejuvenation: Dynamic rhytids in the glabellar and lateral periorbital regions can be temporarily treated with chemodenervation. Surgically, eyebrow ptosis repair, either internally through a concurrent blepharoplasty incision or externally above the brow, can provide minimally invasive functional and aesthetic improvement. Finally, endoscopic or open coronal brow and forehead elevation is an excellent option for those seeking maximal yet more invasive rejuvenation.

2.5 Eyelid

2.5.1 Topography

The contour of the eyelid is highly dependent on gender, race, and age. The typical eyelid has a lateral canthus which is approximately 2 mm superior to the medial canthus. In Asians, this vertical elevation may be slightly higher, and is referred to as the "Mongoloid slant." The palpebral fissure in the adult averages 10–12 mm vertically, and 28–30 mm horizontally. In adults, about 1–2 mm of the superior cornea is covered by the upper eyelid margin and the apex of the upper lid margin is found nasal to a vertical line drawn through the center of the pupil.

The vertical palpebral fissure and position of the upper eyelid crease varies among different ethnic groups. This finding has important implications in both ptosis and upper eyelid blepharoplasty surgery. When eyelids of patients of African, Latino, and Asian ancestry were studied, all groups had a lower upper lid (relative ptosis) than Caucasian patients [17]. This was identified by measuring the margin reflex distance (MRD). This is the distance from the upper (MRD1) or lower (MRD2) lid margins to a light reflex in the center of the pupil created by shining a light at the patient's eyes. This is the best parameter of lid position (i.e., ptosis or lower lid

retraction), as it is unaffected by the position of its upper or lower lid counterpart.

The upper eyelid crease (formed by attachments of the levator aponeurosis to the skin) in Caucasians is 7–8 mm above the lid margin in men and 10–12 mm in women. In Asians, the crease is lower and the upper sulcus more full. It has traditionally been thought that this occurs because the orbital septum and levator aponeurosis fuse lower on the lid, below the superior tarsal border. However, a recent study by Kakizaki et al. showed that this fusion occurred above the tarsal border [17]. In either case, the preaponeurotic fat pad (PFP) descends and prevents a higher insertion of the levator aponeurosis to the upper lid skin [18]. These variations result in an inferiorly positioned or absent upper eyelid crease in Asians.

The lower lid margin rests at the inferior limbus of the cornea, with a crease that is 2 mm below the lash line medially and 5 mm laterally. The nadir of the lower lid margin is slightly lateral to the center of the pupil.

2.5.2 Lamellae

The upper and lower eyelid layers are classically divided into the anterior, middle, and posterior lamellae. The skin and underlying orbicularis oculi muscle comprise the anterior lamella of the upper eyelid. The orbital septum forms the middle lamella, separating the true orbit from the eyelid. The posterior lamella is composed of the tarsal plate, eyelid retractors, and conjunctiva (Fig. 2.6).

Deep to the orbicularis muscle and above the tarsus is the fibrous orbital septum. The orbital septum originates from the arcus marginalis, a band of thickened periosteum at the superior orbital rim [19]. The anterior layer of the orbital septum fuses with the levator aponeurosis which forms extensions into the orbicularis muscle and skin to form the eyelid crease [20, 21]. If the septum is mistaken for the levator aponeurosis and advanced during ptosis repair, lagophthalmos and eyelid retraction may develop [22].

The upper eyelid fat is found posterior to the orbital septum and is divided into two components, the preaponeurotic fat pad (PFP) and the medial (or nasal) fat pad (Fig. 2.7). The PFP is found just anterior to the levator aponeurosis. The orbital lobe of the lacrimal gland, found laterally and posterior to the septum can be mistaken for the PFP and must be carefully identified and avoided in upper eyelid fat removal. The PFP is made up of fat encased in a thin membranous sac, the wall of which harbors small blood vessels and is innervated by terminal branches of the supraorbital nerve [23].

The nasal fat pad is surrounded by the medial horn of the levator aponeurosis and the tendon of the superior

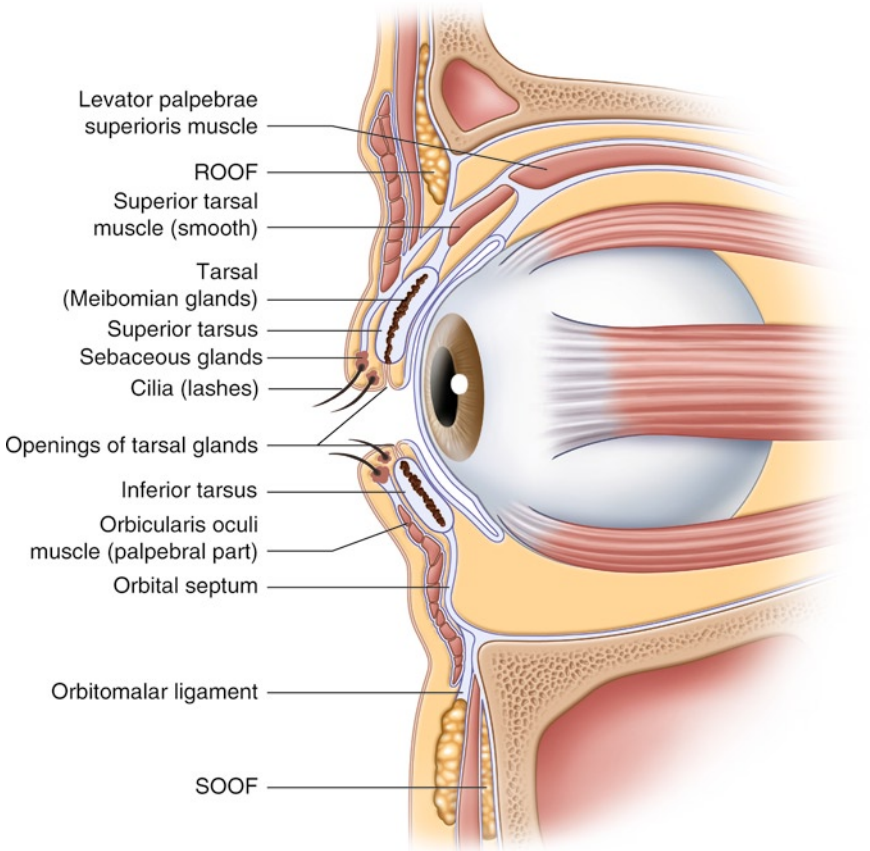


Fig. 2.6 The ROOF sits posterior to the orbital portion of the orbicularis oculi muscle

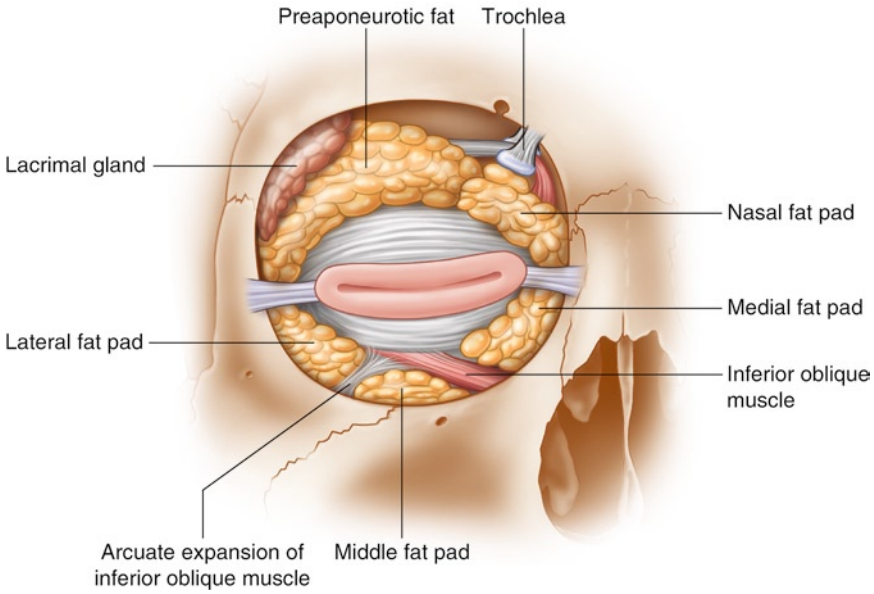


Fig. 2.7 Upper and lower eyelid fat pads

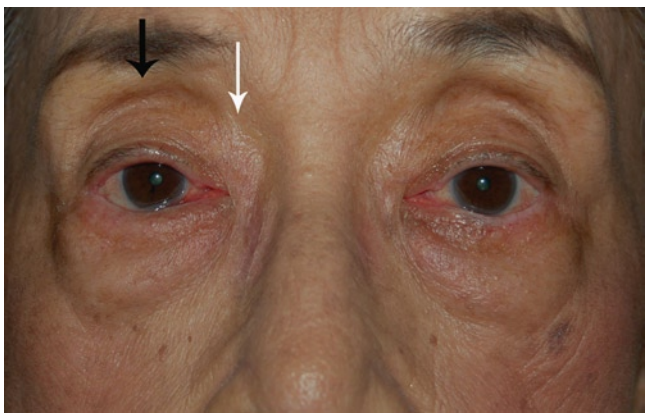


Fig. 2.8 This 72-year-old man has atrophy of the central fat pad (*black arrow*) with preservation of the nasal fat pad (*white arrow*)

oblique muscle. It is whiter than the PFP and noted to be similar in character to intraconal orbital fat [24]. The trochlea of the superior oblique muscle separates the nasal and PFP. During surgical procedures in this region, damage to this structure can result in strabismus, i.e., superior oblique palsy or Brown's syndrome [25]. During transconjunctival upper eyelid blepharoplasty, the nasal fat pad can be safely approached via the conjunctiva because it is not interrupted by the levator aponeurosis [26].

Treatment considerations – fat pad contouring in upper eyelid blepharoplasty: Korn et al. noted an abundance of adult stem cells derived from human orbital adipose tissue in the upper lid fat pads [27]. Although these cells were noted in both the nasal and PFP, there was two-fold higher staining of putative neural-crest stem cell markers in the nasal fat pad. A higher population of these cells in the nasal fat pad may explain the prominence of the nasal pad and atrophy of the PFP with aging. During fat removal in blepharoplasty, we recommend preservation of the PFP with conservative excision of the nasal fat pad if clinically indicated (Fig. 2.8).

2.5.3 Upper Eyelid Retractors

The levator palpebrae superioris (LPS) is the main retractor of the upper eyelid and arises from the orbital apex. The muscular portion is 40 mm in length with a terminal tendonous sheath that extends for about 14–20 mm, termed the levator aponeurosis (LA) [28]. The transition from muscle to tendon of the LPS is at the region of Whitnall's ligament. Whitnall's ligament, in concert with the intermuscular transverse ligament, may act to elevate the LPS like a pulley [29]. The central portion of the LA inserts onto the tarsal surface via elastic attachments. It also sends attachments to the orbicularis muscle and skin forming the eyelid crease (Fig. 2.6). With age, the LA may become attenuated or disinserted, compromising lid height, and leading to ptosis [30]. In thyroid-related orbitopathy, lid contour may change as the peak of the upper eyelid is situated laterally (temporal flare) [31] (Fig. 2.9).

Müller's muscle is an accessory retractor and is a smooth muscle that lies deep to the levator and firmly attaches to underlying conjunctiva near the superior margin of the tarsus [32]. It is innervated by the sympathetic nervous system and contraction causes approximately 2 mm of eyelid retraction. Aging causes thinning, fat deposition, and lengthening of Müller's muscle, which can be effectively resected for mild to moderate ptosis. Classically, topical phenylephrine is used as a diagnostic tool to determine if resection of Müller's



Fig. 2.9 A 47-year-old woman with thyroid related orbitopathy, exhibits lateral upper eyelid flare in both eyes



Fig. 2.10 This 26-year-old woman was initially referred for left upper eyelid ptosis. Examination revealed miosis of the left eye, with greater aniscoria in dim light. Horner's syndrome was confirmed with pharmacologic testing, and she was referred for systemic evaluation

muscle could correct the existing ptosis (see Chap. 13). There is now evidence that patients who are both positive and negative for this test may benefit from a Müllerectomy [33].

Clinical pearls: During ptosis evaluation, it is imperative to examine the pupils for anisocoria. Patients with ptosis and ipsilateral miosis must be evaluated for Horner's syndrome (Fig. 2.10). Whereas patients with ptosis and an ipsilaterally enlarged pupil, require evaluation for acute or chronic third nerve paresis.

2.5.4 Tarsus

The tarsus of the upper and lower eyelids have attachments to the periosteum of the orbital rim via the medial and lateral canthal tendons. The upper eyelid tarsal plate measures 10–12 mm vertically and tapers at the medial and lateral ends. The lower eyelid tarsal plate is 4 mm vertically and also taper at its medial and lateral ends. The tarsal plates are composed of dense connective tissue and function as rigid structural support to the eyelids. Both the medial and lateral canthal tendons secure the tarsus to their corresponding orbital rims. Medially the canthal tendon has a deep attachment to the posterior lacrimal crest and a superficial attachment to the anterior lacrimal crest. Laterally, the canthal tendon also has a deep attachment 3 mm posterior to the orbital rim of a Whitnall's tubercle. These posterior attachments are important in maintaining appropriate lid position and continuity with the globe. With age, stretching and attenuation of the canthal tendons can result in a variety of involutional eyelid malpositions (ectropion, entropion, retraction).

2.5.5 Lower Eyelid

The layered lamellae of the lower eyelid are analogous to those of the upper eyelid. The capsulopalpebral fascia (CF) and the inferior tarsal muscle make up the lower eyelid retractors. The CF and the inferior tarsal muscle are akin to the levator aponeurosis and Müller's muscle in the upper eyelid, respectively. The capsulopalpebral head originates from the fascia of the inferior rectus muscle, then envelopes the inferior oblique muscle to become the CF, inserting at the inferior tarsal border along with the orbital septum. The inferior tarsal muscle receives sympathetic innervation and is located posterior to the CF.

Until recently, it was thought that the lower eyelid retractors were a single layer consisting of the CF and inferior tarsal muscle [34]. Recent studies demonstrate that the lower lid retractors are actually made of two layers, which can be separated using either blunt or sharp dissection [35, 36]. The CF transmits forces exerted by the inferior rectus muscle on the lower lid. This intimate relationship can result in lower eyelid retraction after inferior rectus recession surgery (Fig. 2.11). The lower eyelid crease is formed by small fibers of the CF that attach to the skin-orbicularis complex just a few millimeters below the tarsus.

The position of the lower eyelid margin is highly dependent on the three-dimensional vector forces imposed by the lower eyelid retractors and the canthal ligaments. Mechanical and involutional forces from either acquired or developmental abnormalities may cause eyelid problems, such as entropion and ectropion. In lower eyelid entropion, upward forces cause internal rotation of the inferior tarsal plate, an observation seen more frequently in Asians because of more prominent adipose tissue [37]. On the other hand, Caucasians more frequently exhibit ectropion, possibly due to loss of soft tissue support and greater tendency for actinic changes in the skin. The posterior layer of the lower eyelid retractors has been shown to provide the vertical vector force of the eyelid and should be targeted during surgical correction of both eyelid ectropion and entropion [36].

The orbital septum of the lower eyelid arises as a fibrous extension of the arcus marginalis. The orbital septum fuses with the lower eyelid retractors below the tarsal plate. In Caucasians, this conjoined area begins 3–4 mm lower than it does in Asians. As a result of these anatomic differences,



Fig. 2.11 This patient initially presented with left hypertropia and right lower eyelid retraction (*left*). After right inferior rectus recession, his right lower eyelid retraction worsened (*center*). He had right lower eyelid retraction repair with posterior lamellar grafting with hard palate mucosa (*right*). This case demonstrates the intimate relationship between the inferior rectus muscle and the lower eyelid retractors

the length of unreinforced septum is about 12.3 mm in Asians and only 9.3 mm in Caucasians. Attenuation of the inferior orbital septum thereby allows anterior and superior extension of the lower eyelid fat pads in Asians, analogous to inferior extension of the same tissue in the upper eyelid [38].

There are three clinically apparent fat pads in the lower eyelid: the medial, central, and lateral fat pads. The belly of the inferior oblique muscle divides the medial and central fat pads, while its arcuate expansion separates the central and lateral fat pads. Anatomic variations do exist where only two compartments or a non-compartmentalized single fat pad is found. A pretarsal fat pad has also been described and is located at the lateral half of the tarsal plate, just superior to the lateral fat pad [39]. This pretarsal fat can contribute to the visible bulk of the eyelid below the eyelashes.

Lockwood's ligament is the primary suspensory ligament in the lower eyelid. It can be divided into an inferior ligament (which supports the eyelid retractors), the main ligament, and an arcuate expansion. The main ligament inserts onto Whitnall's tubercle at the lateral orbital wall, approximately 11 mm below the frontozygomatic suture [40]. Lockwood's ligament acts as one of the suspensory support systems of the inferior orbit [41]. The arcuate expansion divides the central and lateral fat pads of the lower eyelid.

Clinical pearls: One of the dreaded complications after lower eyelid blepharoplasty is lower eyelid retraction. Both anterior lamellar shortening and middle or posterior lamellar cicatrices can cause retraction. Spacer grafts may be necessary for posterior lamellar shortening. If minimal anterior lamellar deficiency coexists with middle or posterior lamellar scarring, a cheek or midface lift may be simultaneously performed to recruit anterior lamellar tissue. Severe cases of anterior lamellar deficiency resulting in eyelid marginal ectropion and keratinization of the palpebral conjunctiva require a full-thickness skin graft.

2.6 Midface

Aging of the midface is associated with descent of soft tissue, demarcation of the nasojugal and nasolabial folds, deflation of the facial soft tissues, and loss of bone. These varied structural age-related midface changes make comprehensive rejuvenation challenging.



Fig. 2.12 A 61-year man with midface ptosis exhibiting an obliquely oriented "Y," formed by the palpebromalar groove superolaterally, the nasojugal groove medially, and the midcheek furrow/groove inferolaterally (*right*)

2.6.1 Topography

The term "midface" is a defined region demarcated superiorly from an imaginary line between the medial and lateral canthi, and inferiorly from an imaginary line between the inferior border of the tragal cartilage to just below the oral commissure.

In youth, the midface has a uniformly rounded fullness. With age, it tends to assume an obliquely oriented "Y," formed by the palpebromalar groove superolaterally, the nasojugal groove medially, and the midcheek furrow/groove inferolaterally [42] (Fig. 2.12). Loss of the maxillary projection (bone) below the orbit is a major contributor to laxity and descent of the medial cheek soft tissue. Some studies have advocated augmentation of the infraorbital rim with alloplastic implants to provide convexity to this region [43]. Schematically, the prominent, youthful midface can be viewed as a "base up triangle," with the cheeks forming the base. With age, midface ptosis and lower face jowls transform the triangle to a base down configuration (Fig. 2.13).

2.6.2 Soft Tissue Lamellae

The soft tissues of the face can be categorically divided into five concentric layers: (1) skin, (2) subcutaneous layer, (3) musculoaponeurotic layer, (4) loose areolar tissue, and (5) periosteum and deep fascia [44].

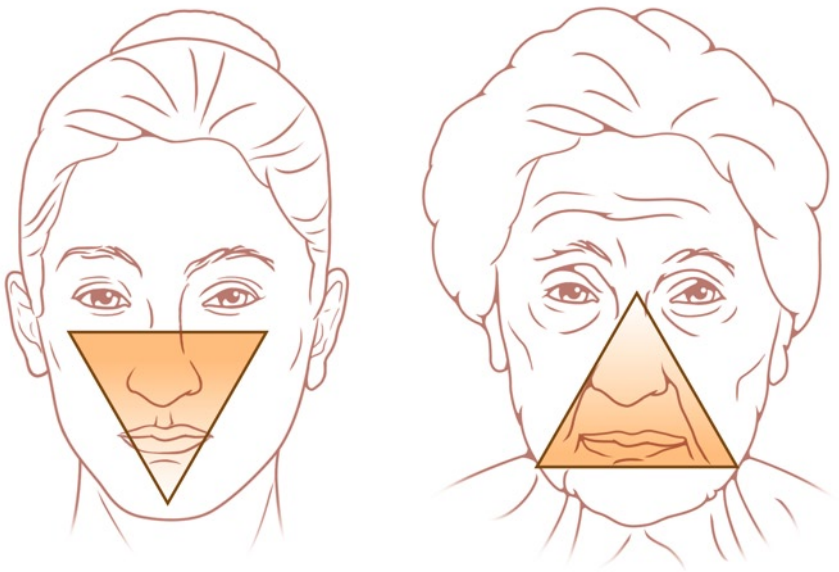


Fig. 2.13 In youth, the lower face has a base up triangle (*left*). However, with aging changes, the lower face takes on a base down triangular configuration (*right*)

The musculoaponeurotic layer, termed the superficial musculoaponeurotic system (SMAS), is firmly attached to the skin by retinacular cutis fibers within the subcutaneous layer. The SMAS has only limited attachments to the underlying bony skeleton, likely contributing to its inferior descent seen with aging [45]. The SMAS spreads out in a fanlike fashion and functions to transmit and distribute the facial muscle contractions to the skin. The fibrous network of the SMAS invests the orbicularis oculi and attaches to the orbital rim via the orbitomalar ligament (OML) [46]. With age, the elastin fibers of the SMAS degenerate, leading to descent of the SMAS and development of senile facial changes, such as malar festoons, eyelid ectropion, and orbital fat prolapse [17].

The areolar layer lies posterior to the SMAS and is composed of ligaments anchoring the overlying soft tissue to the facial bones [47]. With aging, these areas without deep attachments become distended and appear as bulges on the surface. In contrast, areas firmly attached to the dermis resist this distention and result in cutaneous grooves or folds.

2.6.3 Nasojugal Groove

The nasojugal groove, also known as the "tear trough" or medial lid-cheek junction, becomes more visible with age. This region is a natural depression, extending inferolaterally from the medial canthus to the midpupillary line [48].

With age-related midface descent, atrophy of skin and soft tissue, the tear trough is accentuated as thin eyelid tissue overlies the inferior orbital rim. In addition, elongation of the area between the OML and the eyelid margin leads to prolapse of orbital fat over the inferior orbital rim. The increased visibility of this region adds to the formation of "eyelid bags" and often motivates patients to seek periorbital aesthetic surgery.

Clinical pearls: Filler injection to restore volume to the tear trough has gained popularity as a nonsurgical alternative to lower lid blepharoplasty. However, the long-term efficacy of these materials has not been well studied. In a study by Donath, an 85% average maintenance effect of augmentation was noted at 15 months [49]. One patient, at 23 months, had a 73% volume retention. Limited soft tissue movement (facial dynamics) in this area compared to other facial sites, may explain the longer retention of hyaluronic acid fillers in the tear trough as compared to other facial areas.

2.6.4 Malar Region

The malar segment is a triangular region between the lid-cheek junction and the nasolabial region. This area of the midface is formed superiorly by the OML along the inferior orbital rim, the zygomatic ligaments laterally, and a transverse line from the zygomatic ligaments through the zygomaticus muscles. The zygomaticus minor and major muscles, which appear clinically as one complex, draw the mouth superolaterally, as exemplified in smiling. Since the facial nerve courses deep to the plane of the zygomaticus major, it provides a reliable guide to dissection into the medial portion of the face.

On the deep surface of the orbicularis muscle, at the superior border of the malar region, lies a significant layer of fat overlying the periosteum, termed the suborbicularis oculi fat (SOOF). It has been shown that the SOOF is actually a continuation from the ROOF superiorly [42]. In one study, the SOOF was shown to have two distinct areas, termed the lateral and medial suborbicularis oculi fat [50]. In addition, Rohrich describes a third, distinct fat pad, the deep cheek fat, which is found medial to the medial suborbicularis oculi fat. Since there can be differential loss and preservation of the

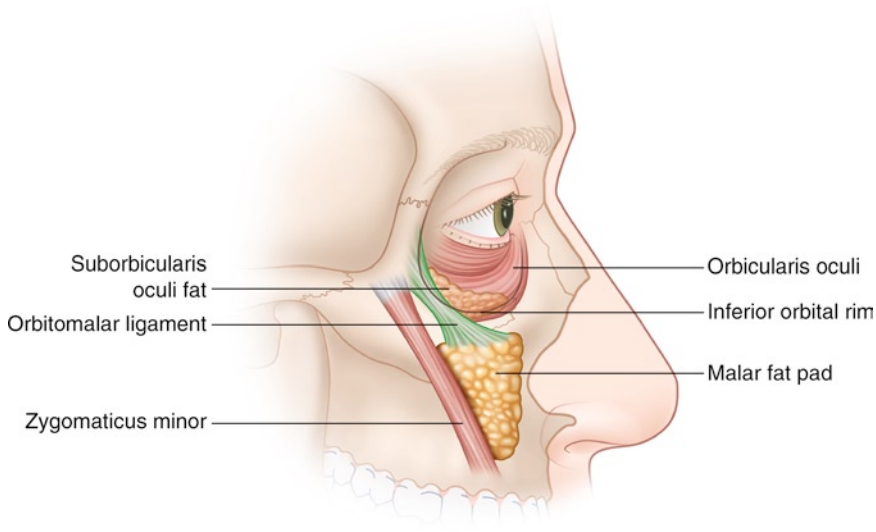


Fig. 2.14 With aging, there is laxity of the orbitomalar ligament (*green*), leading to inferior descent of the SOOF and skeletonization of the inferior orbital rim



Fig. 2.15 A 56-year-old patient with superior sulcus hollowing, double convex deformity of lower eyelids, and unmasking of the inferior orbital rim (*left*). She had upper and lower eyelid blepharoplasty along with resuspension of the orbitomalar ligament and elevation of the SOOF (*right*). Note the elevation of her midface and softening of the nasojugal groove

three fat compartments, any facial rejuvenation procedure should aim to treat only the deficient regions, and targeted soft tissue augmentation is ideal for this purpose.

The SOOF has variable thickness, being most prominent in the central and lateral malar region. Medially, the SOOF engulfs the mimetic muscles and lies superficial to the periosteum. Many theorize that loss and/or ptosis of the SOOF and its adjacent deep fat compartments, in combination with the attenuation and relaxation of connective tissue, contributes to "malar bags" associated with aging [51, 52]. In severe cases, the "double convexity" deformity is noted. In this case, the prolapsed orbital fat is the superior convexity, below which is the concavity caused by the deflated skeletonized inferior orbital rim. The inferior convexity is defined by the malar mound.

The role of the SMAS, OML, and SOOF should be understood to access anatomic changes that occur in the lower eyelid. Inferior descent of the SMAS and SOOF contributes to unmasking of the inferior orbital rim (Fig. 2.14). Concurrent lengthening of the OML can result in apparent vertical elongation of the lower eyelid. In these cases, SOOF lifting and anatomic reconstitution of the OML should be considered [53].

Clinical pearls: Resuspension of the SOOF with the OML, in conjunction with lower eyelid blepharoplasty, provide powerful elevation and support for the entire midface [47] (Fig. 2.15).

2.6.5 Nasolabial Region

The nasolabial region of the midface is trapezoidal in shape, encompassing the side of the nose between the malar segment and lip, and continuing as the lower cheek beyond the oral commissure. It can be divided into two segments, an upper and lower segment. The upper segment overlies the maxilla and the levator labii superioris and levator labii superioris alaequae nasi, two mimetic muscles involved in raising the upper lip. The lower segment of the nasolabial region forms the roof of the oral cavity and is predominantly mobile. Its lateral segment, however, is directly fixed with strong

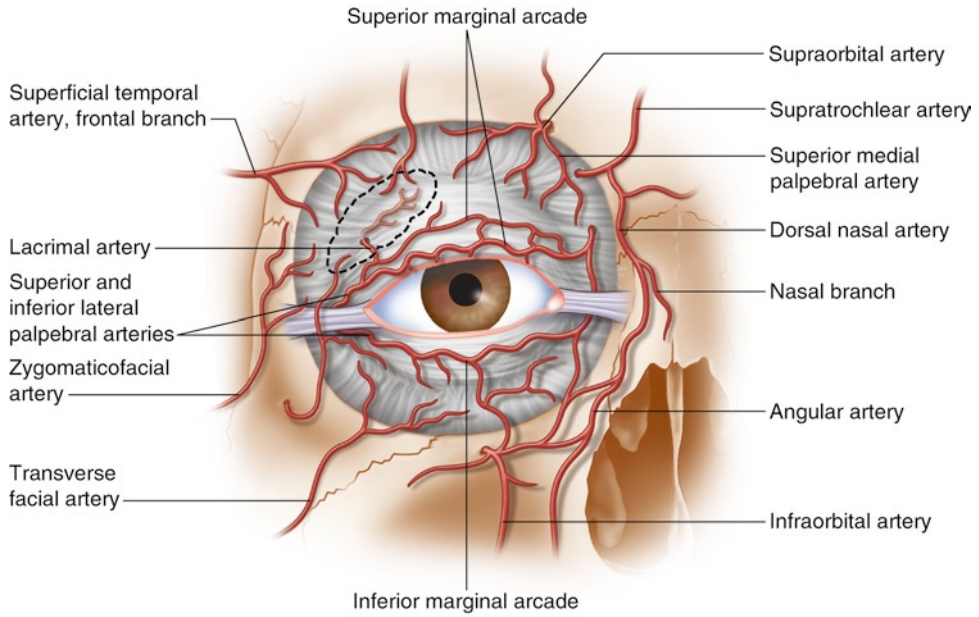


Fig. 2.16 Eyelid vasculature

ligamentous attachments to the zygoma and has additional support from the upper masseteric ligaments.

The subcutaneous layer in the nasolabial region is composed of thicker and more mobile fat termed the "malar fat pad" [54]. In older individuals, laxity of suspensory attachment of the nasolabial area by the zygomatic ligaments, leads to loss of the youthful, rounded fullness. In addition, as the lateral portion of the nasolabial region in the midface disinserts from the bony girdle beneath, hollowing of the midcheek also become prominent.

2.7 Facial Vasculature, Innervation, and Lymphatic Drainage

The internal and external carotid arteries provide the blood supply to the face. The superficial temporal artery and the terminal branch of the external carotid artery, supplies the lateral forehead and eyebrow. The medial forehead is supplied by terminal branches of the ophthalmic artery, including the supraorbital and supratrochlear arteries.

The upper eyelid is supplied by the marginal and peripheral arcades from the ophthalmic artery [55] (Fig. 2.16). Terminal branches of the ophthalmic and facial arteries provide additional vasculature to the medial eyelid. The angular artery, the terminal branch of the facial artery, lies about 6–8 mm medial to the medial canthus and 5 mm anterior to the lacrimal sac.

Clinical pearls: When grafting fat in the periorbital region, care must be taken to inject the fat while withdrawing the needle or cannula. Fat emboli injected into the arterial system anywhere in the face, can lead to end organ infarction [56].

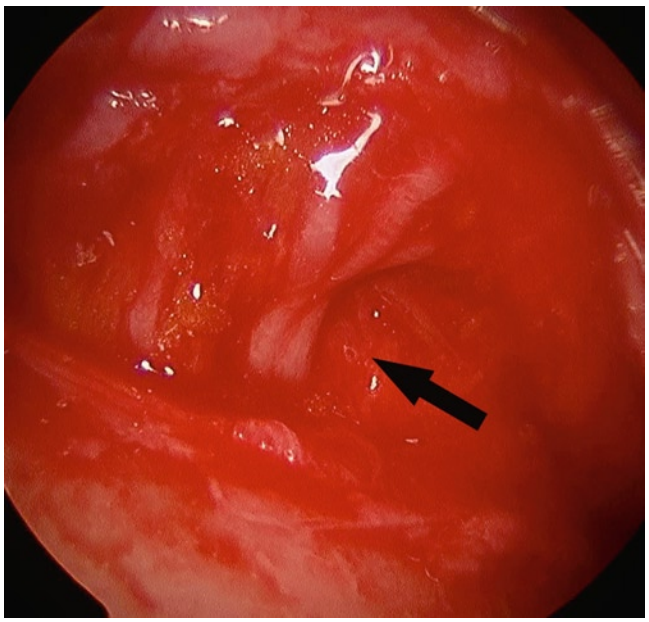


Fig. 2.17 During endoscopic browlift procedures, the supraorbital neurovascular bundle (*arrow*) must be preserved

The trigeminal nerve (cranial nerve V) provides sensation to the face. The brow receives sensory innervation from the ophthalmic division of the nerve (V1). The supratrochlear nerve conveys sensation to the bridge of the nose and medial part of the upper eyelid and forehead. The supraorbital neurovascular bundle exits the orbit through a notch or foramen in the superior orbital rim and provides sensation to the rest of the forehead and scalp. Care must be taken to preserve the supraorbital neurovascular bundle during endoscopic forehead surgery [57] (Fig. 2.17).

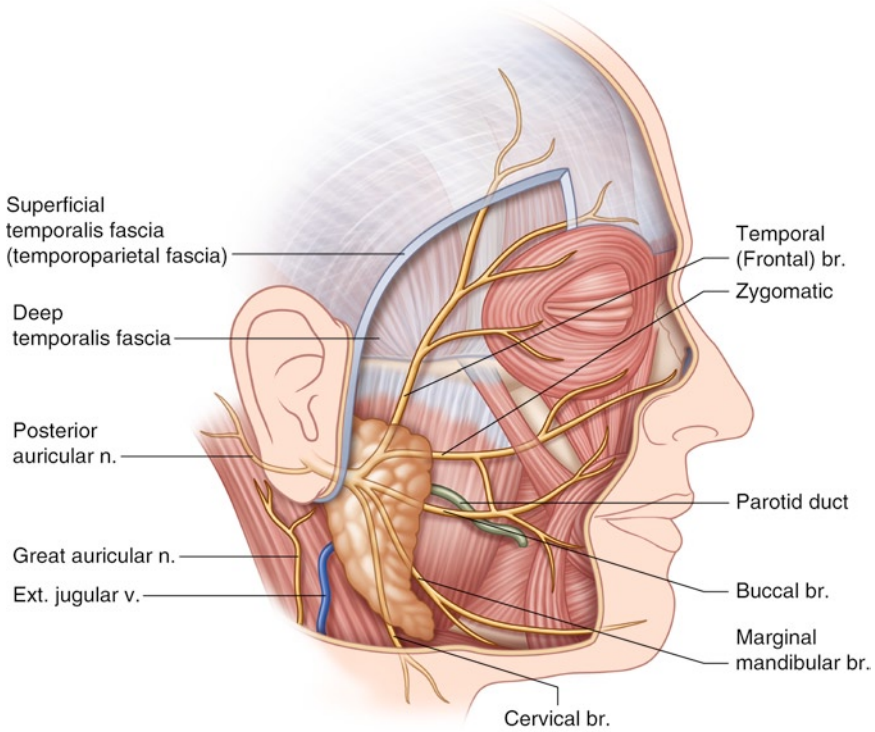


Fig. 2.18 The course of the facial nerve. In the temporal region, the facial nerve is found within the superficial temporalis fascia, and superficial to the deep temporalis fascia

Sensory innervation to the skin overlying the malar region is provided by the maxillary branch (V2) of the trigeminal nerve. It innervates the lower eyelid, cheek, side of the nose, nasal vestibule, and the skin and mucosa of the upper lip. Subperiosteal midface cheek lifts may injure the infraorbital nerve resulting in hypesthesia of the maxillary region.

Facial motor function is provided by the facial nerve (cranial nerve VII) and the oculomotor nerve (cranial nerve III – eyelid elevation) (Fig. 2.18). CNVII divides into its major trunks within the parotid gland. The superior division of CNVII innervates the upper eyelids via its temporal (frontal) branch, and the lower lids via its zygomatic and buccal branches [58]. In the temporal region, branches of the temporal nerve are found in the deep portion of the superficial temporal fascia (Fig. 2.18). During manipulation in this region, dissection must be deep to this layer (on top of the deep temporal fascia) to protect the nerve [59]. In addition to the upper eyelids (orbicularis muscle), the temporal branch also innervates the frontalis muscle, the corrugator muscle, the depressor supercilii muscle, and the anterior and superior auricular muscles.

In the lower face, the branches of the facial nerve are deep to the SMAS and become superficial medial to the masseter muscle. Because of its location, dissection during rhytidectomy must be performed superficial to the SMAS to avoid injury to the nerve.

The face has a rich lymphatic drainage system. The eyelids drain into the preauricular and submandibular lymph nodes; the midface drains to the submental and submandibular nodes; and the lateral face drains to the preauricular and retroauricular nodes. Disruption of the lymphatics during aesthetic surgical procedures can lead to prolonged lymphadenopathy and chemosis.

2.8 Conclusion

A sound anatomic approach to surgery remains the basis for all successful cosmetic and reconstructive procedures. This is especially true is regards to surgery on the eyelids and adjacent areas. The forehead/eyebrows and the upper lids, and the lower lids and midface act and function as a continuum. Understanding the clinical, surgical, and functional anatomy of how these structures interrelate is essential to attaining successful outcomes to surgery. In addition to relevant anatomic knowledge, it is imperative to be cognizant of the important changes associated with aging in order to effectively rejuvenate this area of the face. Only with mastery of these two principals can the aesthetic surgeon provide the best care for patients.

References

1. Tolleth H. Concepts for the plastic surgeon from art and sculpture. Clin Plastic Surg. 1987;14(4):585–98.
2. Farkas LG, Hreczko TA, et al. Vertical and horizontal proportions of the face in young adult North American Caucasians: revision of neoclassical canons. Plast Reconstr Surg. 1985;73:328–37.

3. Marquardt SR, Stephen R. Marquardt on the Golden Decagon and human facial beauty. Interview by Dr. Gottlieb. J Clin Orthodont. 2002;36:339–47.
4. Lee JH, Kim TG, Park GW, Kim YH. Cumulative frequency distribution in East Asian facial widths using the facial golden mask. J Craniofac Surg. 2009;20(5):1378–82.
5. Nguyen HT, Isaacowitz DM, Rubin PA. Age- and fatigue-related markers of human faces: an eye-tracking study. Ophthalmology. 2009;116(2):355–60. (The visual cues of facial aging and mood are noted by observers in periorbital areas).
6. Lemke B, Stasior OG. The anatomy of eyebrow ptosis. Arch Ophthalmol. 1982;100:981–6.
7. Cook Jr BE, Lucarelli MJ, Lemke BN. Depressor supercilii muscle: anatomy, histology, and cosmetic implications. Ophthal Plast Reconstr Surg. 2001;17(6):404–11.
8. Freund RM, Nolan III WB. Correlation between brow lift outcomes and aesthetic ideals for eyebrow height and shape in females. Plast Reconstr Surg. 1996;97:1343–8.
9. Westmore M. Facial cosmetics in conjunction with surgery. Paper presented at the Aesthetic Plastic Surgical Society Meeting, Vancouver, BC, May 1974.
10. Biller JA, Kim DW. A contemporary assessment of facial aesthetic preferences. Arch Facial Plast Surg. 2009;11(2):91–7.
11. Lemke BN, Stasior OG. Eyebrow incision making. Adv Ophthalmic Plast Reconstr Surg. 1983;2:19–23.
12. Matros E, Garcia JA, Yaremchuk MJ. Changes in eyebrow position and shape with aging. Plast Reconstr Surg. 2009;124(4): 1296–301.
13. Ramirez OM. Subperiosteal brow lifts without fixation. Plast Reconstr Surg. 2004;114:1604–5.
14. Putterman AM, Urist MJ. Surgical anatomy of the orbital septum. Ann Ophthalmol. 1974;6:290–4.
15. Meyer DR, Linberg JV, et al. Anatomy of the orbital septum and associated eyelid connective tissues. Ophthal Plast Reconstr Surg. 1991;7:104–13.
16. Seiff SR, Seiff BD. Anatomy of the Asian eyelid. Facial Plast Surg Clin North Am. 2007;15(3):309–14.
17. Kakizaki H, Leibovitch I, Selva D, et al. Orbital septum attachment on the levator aponeurosis in Asians: in vivo and cadaver study. Ophthalmology. 2009;116(10):2031–5.
18. Chen WP. Asian blepharoplasty: update on anatomy and techniques. Ophthal Plast Reconstr Surg. 1987;3(3):135–40.
19. Jordan DR, Anderson RL. Surgical anatomy of the ocular adnexa: a clinical approach. Ophthalmology Monograph 9. San Francisco: American Academy of Ophthalmology; 1996: p. 16, 17, 26.
20. Malik KJ, Lee MS, et al. Lash ptosis in congenital and acquired blepharoptosis. Arch Ophthalmol. 2007;125:1613–5.
21. Murchison AP, Sires BA, Jian-Amadi A. Margin reflex distance in different ethnic groups. Arch Facial Plast Surg. 2009;11(5):303–5.
22. Tarbet KJ, Lemke BN. Clinical anatomy of the upper face. Int Ophthalmol Clin. 1997 Summer;37(3):11–28.
23. Persichetti P, Lella FD, et al. Adipose compartments of the upper eyelid: anatomy applied to blepharoplasty. Plast Reconstr Surg. 2004;113:373–8.
24. Johnston MC, Noden DM, Hazelton RD, et al. Origins of avian ocular and periocular tissues. Exp Eye Res. 1979;29:27–43.
25. Neely KA, Ernest JT, et al. Combined superior oblique paresis and Brown's syndrome after blepharoplasty. Am J Ophthalmol. 1990;109(3):347–9.
26. Gausas RE. Advances in applied anatomy of the eyelid and orbit. Curr Opin Ophthalmol. 2004;15:422–5.
27. Korn BS, Kikkawa DO, Hicok KC. Identification and characterization of adult stem cells from human orbital adipose tissue. Ophthal Plast Reconstr Surg. 2009;25:27–32.
28. Most SP, Mobley SR, et al. Anatomy of the eyelids. Facial Plast Surg Clin North Am. 2005;13:487–92.
29. Ettl A, Priglinger S, et al. Functional anatomy of the levator palpebrae superioris muscle and its connective tissue system. Br J Ophthalmol. 1996;80:702–7.
30. Karesh JW. Diagnosis and management of acquired blepharoptosis and dermatochalasis. Facial Plast Surg. 1994;10(2):185–201.
31. Kakizaki H. Modified marginal myotomy for thyroid-related upper eyelid retraction. Eur J Plast Surg. 2008;31:9–13.
32. Kakizaki H, Zako M, et al. The levator aponeurosis consists of two layers that include smooth muscle. Ophthal Plast Reconstr Surg. 2005;21:379–82.
33. Baldwin HC, Bhagey J, et al. Open sky Müller muscle-conjunctival resection in phenylephrine test-negative blepharoptosis patients. Ophthal Plast Reconstr Surg. 2001;21:276–80.
34. Hawes MJ, Dortzbach RK. The microscopic anatomy of the lower eyelid retractors. Arch Ophthalmol. 1982;100:1313–8.
35. Kakizaki H, Zhao J, et al. The lower eyelid retractor consists of definite double layers. Ophthalmology. 2006;113:2346–50.
36. Kakizaki H, Malhotra R, et al. Lower eyelid anatomy: an update. Ann Plast Surg. 2009;63(3):344–51.
37. Carter SR, Chang J, et al. Involutional entropion and ectropion of the Asian lower eyelid. Ophthal Plast Reconstr Surg. 2000;16:45–9.
38. Kakizaki H, Jinsong Z, et al. Microscopic anatomy of the Asian lower eyelids. Ophthal Plast Reconstr Surg. 2006;22:430–3.
39. Hwang K, Joong Kim D, Chung RS. Pretarsal fat compartment in the lower eyelid. Clin Anat. 2001;14(3):179–83.
40. Lockwood CB. The anatomy of the muscles, ligaments, and fasciae of the orbit, including an account of the capsule of Tenon, the cheek ligaments of the recti, and of the suspensory ligament of the eye. J Anat Physiol. 1885;20:1–25.
41. Camirind A, Doucet J, et al. Anatomy, pathophysiology, and prevention of senile enophthalmia and associated herniated lower eyelid fat pads. Plast Reconstr Surg. 1997;100:1535–46.
42. Mendelson BC, Jacobson SR. Surgical anatomy of the midcheek: facial layers, spaces, and the midcheek segments. Clin Plast Surg. 2008;35:395–404.
43. Yaremchuk MJ, Kahn DM. Periorbital skeletal augmentation to improve blepharoplasty and midface results. Plast Reconstr Surg. 2009;124(6):2151–60.
44. Yousif NJ, Mendelson BC. Anatomy of the midface. Clin Plast Surg. 1995;22(2):227–40.
45. Haddock NT, Saadeh PB, et al. The tear trough and lid/cheek junction: anatomy and implications for surgical correction. Plast Reconstr Surg. 2009;123:1332–40.
46. Ghassemi A, Prescher A, et al. Anatomy of the SMAS revisited. Aesth Plast Surg. 2003;27:258–64.
47. Furnas DW. The retaining ligaments of the cheek. Plast Reconstr Surg. 1989;83(1):11–6.
48. Mendelson BC, Muzaffar AR, Adams WP. Surgical anatomy of the midcheek and malar mounds. Plast Reconstr Surg. 2002;110:885–96.
49. Donath AS, Glasgold RA, Meier J, Glasgold MJ. Quantitative evaluation of volume augmentation in the tear trough with a hyaluronic acid-based filler: a three-dimensional analysis. Plast Reconstr Surg. 2010;125(5):1515–22. (The authors highlight the longer than expected duration of hyaluronic acid filler augmentation in the tear trough.)
50. Rohrich RJ, Arbique GM, et al. The anatomy of suborbicularis fat: implications for periorbital rejuvenation. Plast Reconstr Surg. 2009;124(3):946–51.
51. Kikkawa DO, Lemke BN, et al. Relations of the SMAS to the orbit characterization of the orbitomalar ligament. Ophthal Plast Reconstr Surg. 1996;12(2):77–8.
52. Lucarelli MJ, Khwarg SI, et al. The anatomy of midfacial ptosis. Ophthal Plast Reconstr Surg. 2000;16(1):7–22.
53. Korn BS, Kikkawa DO, Cohen SR. Transcutaneous lower eyelid blepharoplasty with orbitomalar suspension: retrospective review of 212 consecutive cases. Plast Reconstr Surg. 2009;125(1): 315–23.

54. Owsley JQ, Fiala TG. Update: lifting the malar fat pad for correction of prominent nasolabial folds. Plast Reconstr Surg. 1997;100(3):715–22.
55. Kawai K, Imanishi N, et al. Arterial anatomic features of the upper palpebra. Plast Reconstr Surg. 2004;113:479–84.
56. Park SH, Sun HJ, Choi KS. Sudden unilateral visual loss after autologous fat injection into the nasolabial fold. Clin Ophthalmol. 2008;2(3):679–83.
57. Knize DM. Anatomic concepts for brow lift procedures. Plast Reconstr Surg. 2009;124:2118–26.
58. Davis RA, Anson BJ, et al. Surgical anatomy of the facial nerve and parotid gland based upon a study of 350 cervicofacial halves. Surg Gynecol Obstet. 1956;102:385.
59. Ramirez OM. Why I prefer the endoscopic forehead lift. Plast Reconstr Surg. 1997;100(4):1033–9; discussion 1043–46.

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