7

Forehead rejuvenation

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SYNOPSIS

- Detailed knowledge of forehead anatomy is the basis for rejuvenation strategies of the forehead region.
- Eyebrow position is the net result of forces which depress the brow, forces which raise the brow and the structures which tether the eyebrow in place.
- Brow depression is caused by glabellar frown muscles, the orbicularis and gravity. Frontalis is the only effective brow elevator.
- Attractiveness of the periorbital region is intimately related to eyebrow shape and eyebrow position as it relates to the upper eyelid and the upper lid sulcus.
- Aging causes enlargement of the orbital aperture as well as changes in eyebrow shape. In a subset of individuals there is ptosis of the entire forehead complex.
- Key elements of forehead rejuvenation are the attenuation of frown muscle action and the repositioning of ptotic eyebrow elements. The lateral eyebrow is often the only portion requiring elevation.
- Forehead rejuvenation can be accomplished using a combination of surgical and non-surgical techniques.
- If surgical elevation of the brow complex fails early, it is usually due to lack of soft tissue release. If it fails late, is usually due to failure of fixation.
- Many methods of soft tissue fixation and bony fixation have been proven effective in maintaining the position of the surgically elevated brow.


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Introduction

The periorbital region is the most expressive part of the human face. The eyes are central, framed above by the eyebrows, and below by the cheek. Alteration in components of the orbital frame, as well as the eyelids themselves, will profoundly affect facial appearance. The aesthetic balance created by surgery can project strong human emotions, ranging from joy to sadness and from restfulness to fatigue.

In the younger individual, aesthetic alteration of the forehead is generally limited to the nonsurgical alleviation of glabellar frown lines and lateral orbital wrinkles. These issues are discussed in Chapters 3 and 4. Occasionally, surgery is indicated to change the basic shape of a youthful eyebrow. In the older individual, the forehead typically becomes ptotic laterally, while in the orbit, there is a relative loss of orbital fat together with an accumulation of loose eyelid skin. Understanding the interplay between these complex anatomical changes is critical in choosing an appropriate surgical strategy to rejuvenate the upper third of the face.

Anatomy

The frontal bone is crossed laterally by a curved ridge called the temporal crest (also called the temporal ridge or the superior temporal fusion line of the skull). This is a palpable landmark which separates the temporal fossa and the origin of the temporalis muscle from the forehead portion of the frontal bone ***(Fig. 7.1)***. It also marks a change in nomenclature as tissue planes transition from lateral to medial. The deep temporal fascia covering the temporalis muscle attaches along the temporal ridge and continues medially as the periosteum which covers the frontal bone. Similarly, the superficial temporal fascia (also known as the temporal parietal fascia) continues medially as the galea aponeurotica which encompasses the frontalis muscle.

The surgical significance of the temporal crest line is that all fascial layers are tethered to bone in a band approximately 5 mm wide immediately medial to the palpable ridge. This has been called the zone of fixation.[22,23] Where this zone approaches the orbital rim at its inferior end, the fascial attachment widens and becomes more dense, forming the orbital ligament ***(Fig. 7.2)***. All fascial attachments in this region must

History

The history of aesthetic brow surgery was thoroughly reviewed by Paul in 2001.[1]

The first description of brow elevation surgery was a publication by the French surgeon Passot in 1919.[2] His technique involved the removal of multiple small skin ellipses, positioning scars in the forehead crease lines and at the frontal hairline. In 1926, Hunt described what appears to have been a full anterior hairline incision for brow lifting access.[3] In 1931, Lexer published a combined forehead and open brow lift with a hairline incision,[4] and in 1933, Claoue published a similar extensive approach.[5] Interestingly, forehead lifting then fell into disfavor for several decades until 1962 when Gonzalez-Ulloa published in the English literature an open coronal brow lift combined with facelift.[6] Shortly thereafter, in Brazil, Vinas presented (1965)[7] and subsequently described (1976)[8] his advanced concepts of brow elevation. He suggested making a concerted effort to elevate the lateral portion of the brow. He also described a local method of direct brow lifting for certain patients. In 1984, Papillon and colleagues presented a subcutaneous dissection plane from the anterior hairline approach.[9] In 1989, Paul described a transblepharoplasty approach.[10]

The original description of endoscopic brow lifting is attributed to two surgeons, Isse and Vasconez, both of whom presented their method at different venues in 1992.[11,12] The first publication of this method was by Chajchir in 1993.[13]

In 1996, Knize published his "limited incision forehead lift",[14] using a short temple incision without endoscopic assist.

By 2003, a reduction in the number of endoscopic brow lifts being done was documented due to uncertainty over the stability of endoscopic brow lifting.[15] In the first part of the 21st century, other methods appeared to deal with lateral brow relapse.[16] Numerous reports demonstrated the success of endoscopic brow lifting using measurements from the brow to the pupil.[17–21]

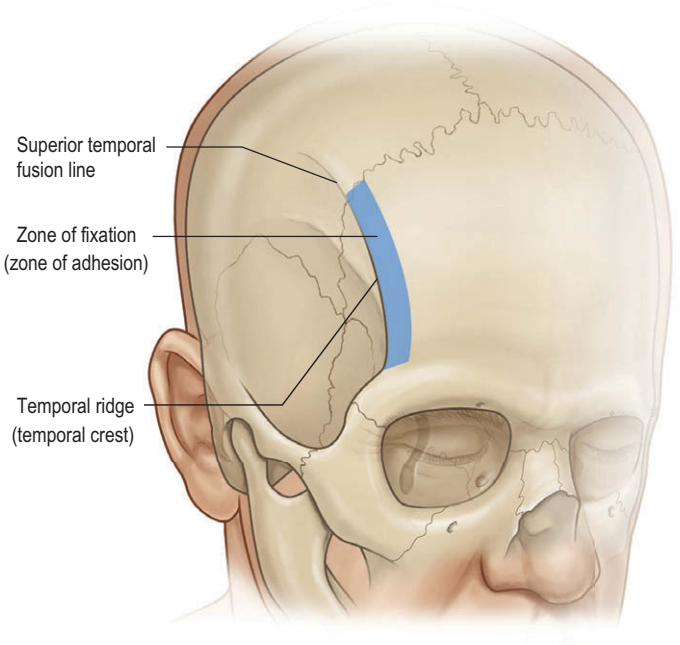

Fig. 7.1 Bony anatomy of the forehead and temporal fossa. The palpable temporal ridge separates the temporal fossa from the forehead. The zone of fixation (*aka* zone of adhesion, superior temporal septum) is a 5 mm wide band along the temporal ridge where all layers are bound down to periosteum.

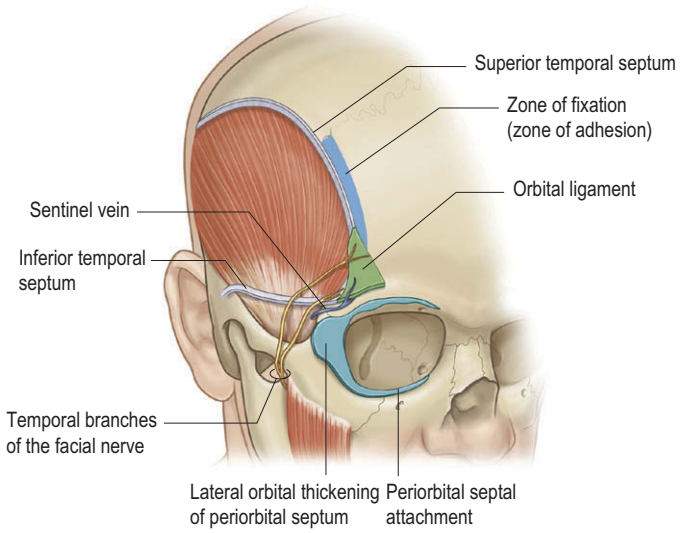

Fig. 7.2 Fascial attachments around the orbital rim. The inferior end of the zone of fixation is the orbital ligament. The lateral orbital thickening is a lateral extension of the septum which extends across the lateral orbital rim onto deep temporal fascia.

be released from bone when a full thickness forehead flap is being repositioned.

Some fascial structures in this area have been named by different authors, generating some confusion. The superior temporal septum[24] and the zone of adhesion[16] are alternate terms used to describe the zone of fixation. The temporal ligamentous adhesion[24] describes the lower portion of the zone of fixation and the orbital ligament. The inferior temporal septum[24] and the orbicularis-temporal ligament[25] both

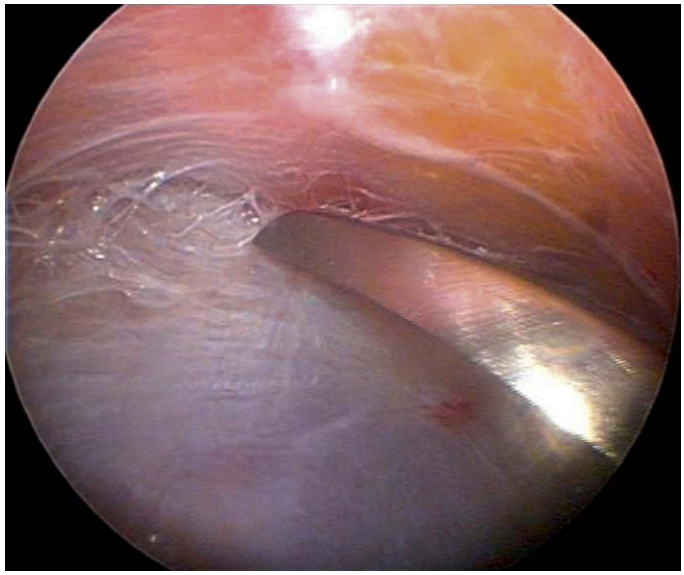

Fig. 7.3 Endoscopic view of the inferior temporal septum, right side.

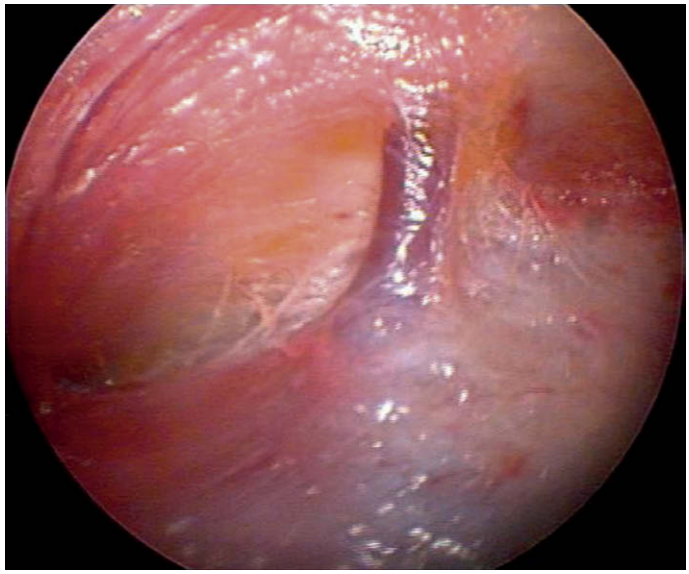

Fig. 7.4 Endoscopic view of the medial zygomaticotemporal vein (sentinel vein), right side.

describe the criss-crossing white fibers which loosely attach the superficial to the deep temporal fascia.

The inferior temporal septum is a useful landmark during endoscopic dissection from above, because it separates the safe upper zone containing no vital structures from the lower zone where facial nerve branches travel in the cavity's roof. The medial zygomatic temporal vein (sentinel vein) is also present in this lower zone, adjacent to the lateral orbital rim. The temporal branches pass immediately superior to this vein (***Figs 7.3, 7.4***).

Galea

Knize has described galeal anatomy in detail.[26] In the forehead, the galea aponeurotica splits into a superficial and deep

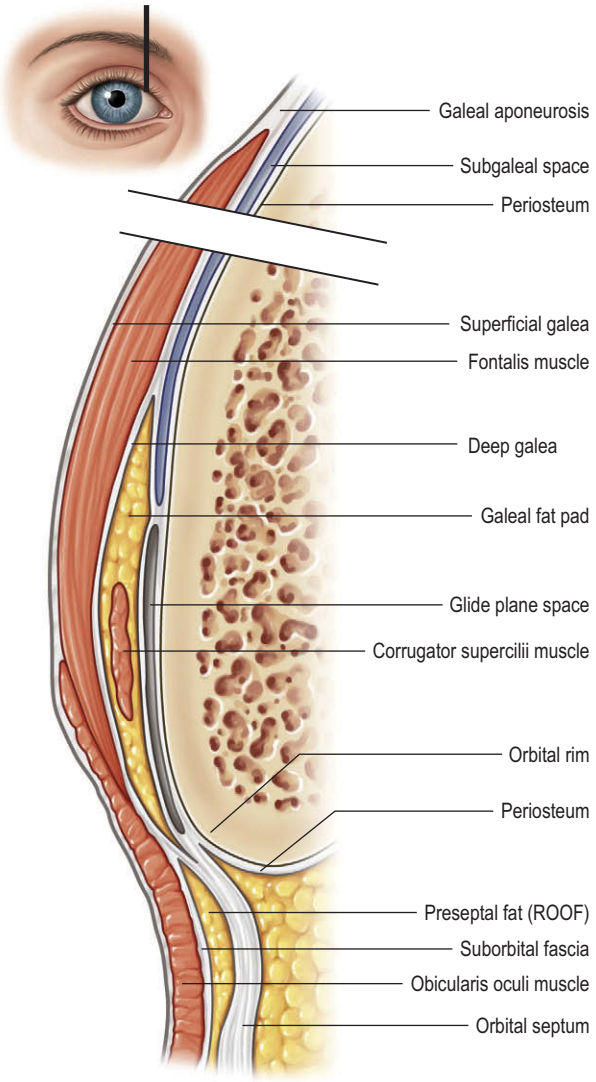

Fig. 7.5 Relationship of galea to surrounding tissue as it splits to encompass the frontalis muscle, the galeal fat pad, and the glide plane space. The corrugator supercilii traverses through the galeal fat pad as it courses from its deep bony origin to its superficial insertion in the orbicularis and dermis.

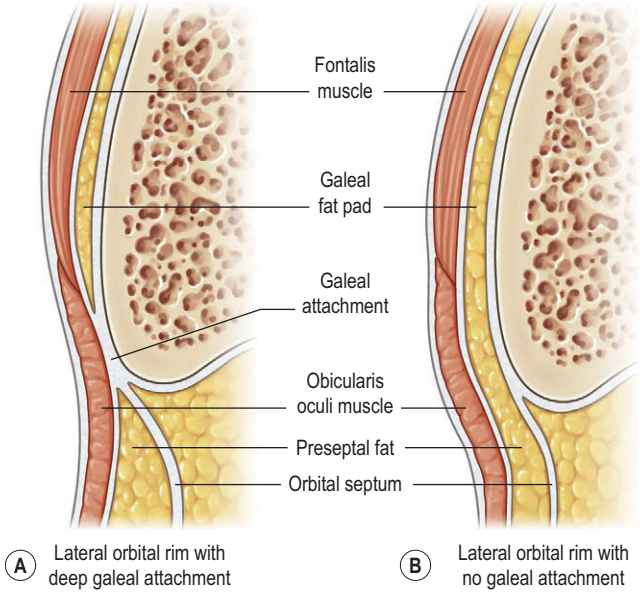

Fig. 7.6 Lateral orbital rim variation. On the left, galeal attachment tethers the overlying brow. On the right, the galeal fat pad is contiguous with retro orbicularis oculi fat, potentially making the lateral brow prone to ptosis.

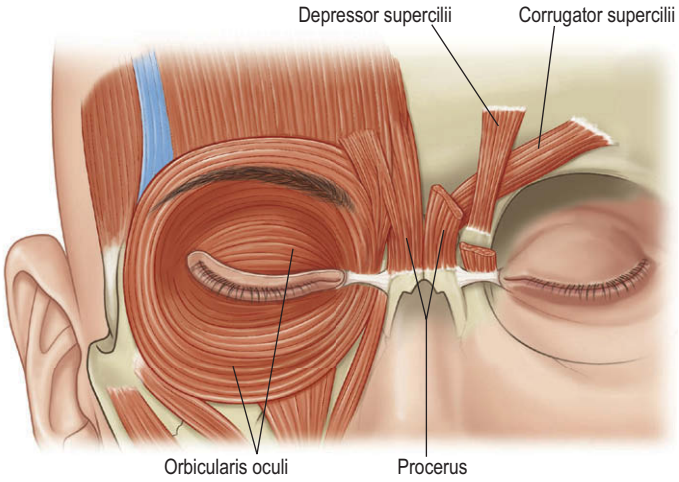

Fig. 7.7 Glabellar frown muscles.

layer encompassing the frontalis muscle (*Fig. 7.5*). Inferiorly, the deep galea layer separates further into three separate layers: one layer immediately deep to the frontalis forming the roof of the galeal fat pad, a second layer forming the floor of the galeal fat pad but not adherent to bone, and a third layer adherent to periosteum. The two deepest layers define the glide plane space between the galeal fat pad and the skull. Inferiorly, the septum orbitale divides orbital fat from PreSeptal fat (also known as retro orbicularis oculi fat or ROOF).

When the eyebrow is raised by frontalis contraction, the soft tissue slides over the glide plane space. The galeal fat pad extends across the entire width of the lower 2 cm of the forehead; medially it surrounds the supra orbital and supra trochlear nerves as well as portions of the frown musculature. The galeal fat pad is separated from the preseptal fat (ROOF) by a reflected layer of galea. Laterally, this separation is thought to be variable, with some individuals having a continuous layer of fat from galeal fat pad to the preseptal fat (*Fig. 7.6*).[26]

Muscle

Eyebrow level is the result of a balance between the muscular forces which elevate the brow, the muscular forces which depress the brow, and the universal depressor: gravity (*Fig. 7.7*).

Brow depressors in the glabella originate from bone medially, inserting into soft tissue. The procerus runs vertically, the depressor supercilii and orbicularis run obliquely, and the corrugator mostly runs transversely. The transverse corrugator

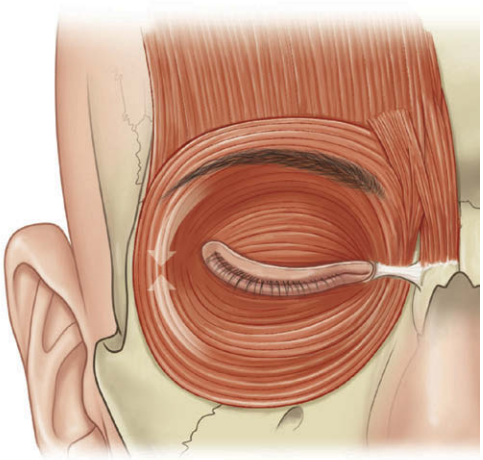

Fig. 7.8 Lateral orbicularis acts like a sphincter, depressing the lateral brow.

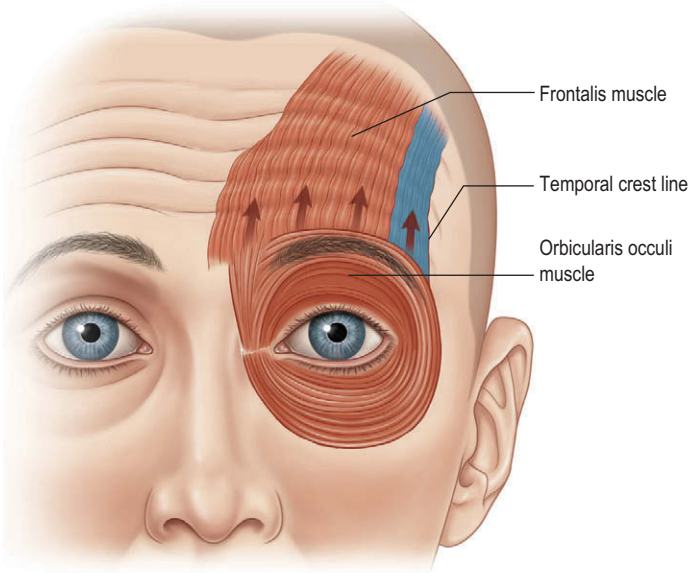

Fig. 7.9 Frontalis acts to raise the eyebrow complex. On contraction, most movement occurs in the lower third of the muscle, and action is strongest on the medial and central eyebrow.

supercilii is the largest and most powerful of these muscles. It originates from the orbital rim at its most supero-medial corner, with the large transverse head later passing through galeal fat becoming progressively more superficial until it interdigitates with the orbicularis and frontalis at a skin dimple which is visible when the patient frowns.[27]

The orbicularis encircles the orbit acting like a sphincter. Medially and laterally the orbicularis fibers run vertically and act to depress brow level. Laterally, orbicularis is the only muscle which depresses brow position ***(Figs 7.8, 7.9)***.

Frontalis is the only elevator of the brow. It originates from the galea aponeurotica superiorly, and interdigitates inferiorly with the orbicularis. Contraction raises this muscle mass, and in so doing, lifts the overlying skin which contains the eyebrow. Due to its deficiency laterally, the primary effect of frontalis contraction is on the medial and central portions of the eyebrow.

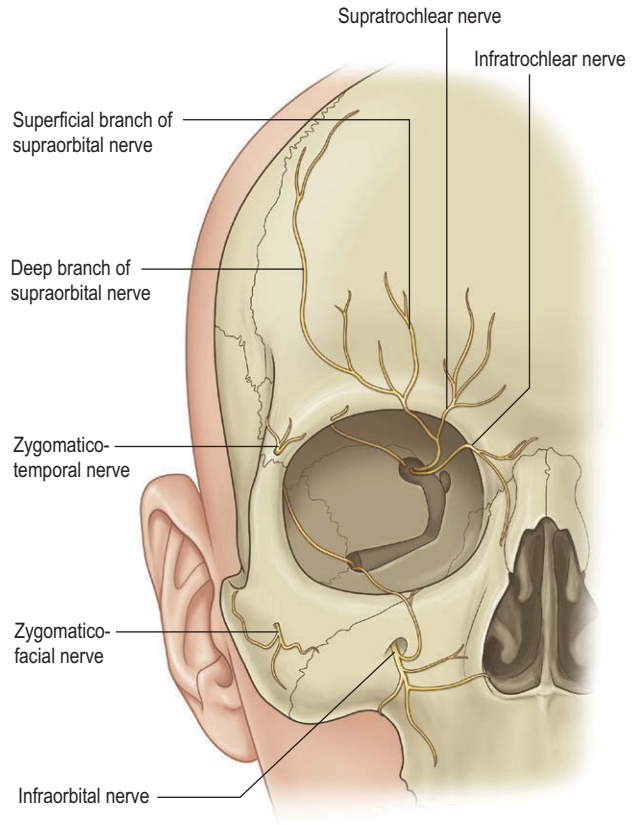

Fig. 7.10 Sensory nerves.

Sensory nerves

Innervation to the upper periorbita is supplied by the supraorbita and supratrochlear nerves, as well as two lesser nerves, the infratrochlear, and zygomaticotemporal ***(Fig. 7.10)***.

The infratrochlear nerve exits the orbit medially supplying sensation to the nasal dorsum and medial orbital rim. It is seldom damaged and rarely a cause of postoperative concern.

The zygomaticotemporal nerve exits posterior to the lateral orbital rim piercing the deep temporal fascia just inferior to the sentinel vein. In brow lifting, with complete release of the lateral orbital rim, it is often avulsed. Consequences of this are minimal and temporary.

The supratrochlear nerve usually exits the orbit superomedially although this is variable, and it occasionally will exit near the supraorbital nerve. It immediately divides into 4–6 branches which can pass superficial (anterior) to the corrugator, or more frequently, directly through the substance of the corrugator. These branches then become more superficial, innervating the central forehead.

The supraorbital nerve exits the superior orbit either through a notch in the rim, or through a foramen superior to the rim. Much variation occurs with foramina present about 20% of the time.[28] The location of the notch or foramen is between 16 and 42 mm from the midline, with a mean of 25 mm. A useful landmark for this is a palpable notch, or failing that, the mid-papillary line. When a foramen is present, it has been found as far as 19 mm above the rim. Because of such variation, blind dissection from above should be discontinued at least 2 cm above the orbital rim.

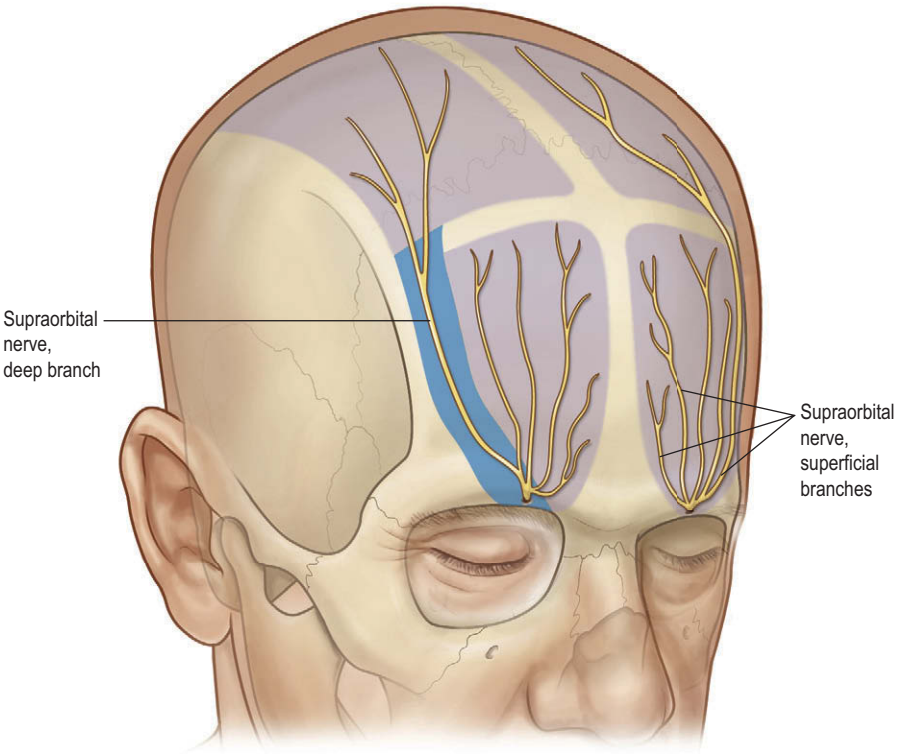

Fig. 7.11 The deep branch of the supraorbital nerve travels in a 1 cm wide band between 5 and 15 mm medial to the temporal ridge.

The supraorbital nerve immediately divides into two distinct segments: superficial and deep. The superficial branch pierces orbicularis and frontalis, dividing into several smaller branches which travel on the superficial surface of the frontalis to innervate the central forehead as far posteriorly as the first 2 cm. of hair. The rest of the scalp, as far back as the vertex, is innervated by the deep branch. The deep branch courses superiorly in a more lateral location, remaining between the periosteum and the deepest layer of galea. As it travels superiorly, it becomes more superficial, piercing frontalis to innervate the skin.

It is a double branch approximately 60% of the time.[29] An important fact during endoscopic brow lifting is that the deep branch runs in a 1 cm wide band, which is between 5 mm and 15 mm medial to the palpable temporal ridge (*Fig. 7.11*).

Motor nerves

The temporal branch of the facial nerve is the only motor nerve of concern in this area. Loss of this branch would result in a brow ptosis and asymmetry due to impaired frontalis action (*Fig. 7.12*). The anatomy of this nerve has been well described.[30–33]

The temporal branch enters the temporal fossa as multiple (2–4) fine branches which lie on the periosteum of the middle third of the zygomatic arch. Between 1.5 cm and 3.0 cm above the arch, these branches become more superficial, entering the superficial temporal fascia (temporoparietal fascia), traveling on to innervate the frontalis, superior orbicularis and glabellar muscles.[34]

A number of different landmarks are commonly used to predict the course of the temporal branches. These include:

1. The middle third of the palpable zygomatic arch
2. 1.5 cm lateral to the tail of the eyebrow

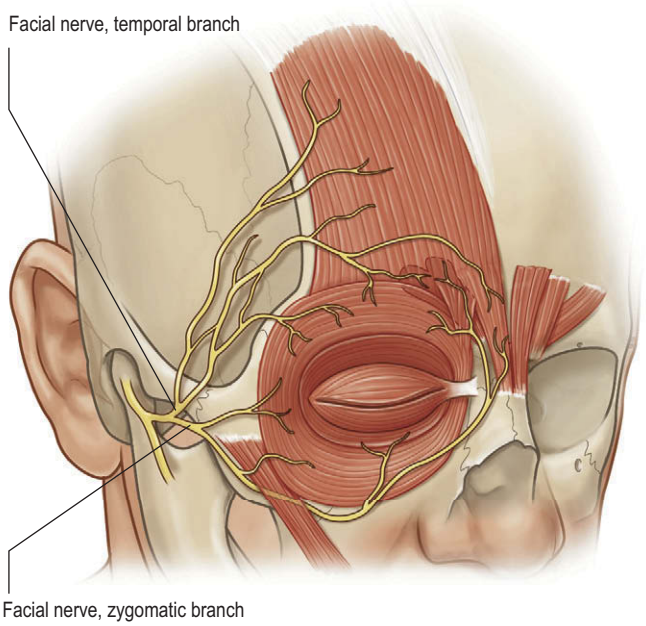

Fig. 7.12 Facial nerve branches in the periorbital region. Note the corrugator has dual innervation from the temporal branch and the zygomatic branch. The temporal branch crosses the middle third of the zygomatic arch as 2–4 branches.

3. Parallel and adjacent to the inferior temporal septum
4. Immediately superior to the sentinel vein (medial zygomaticotemporal vein).

In all forehead lift procedures, dissection planes are designed to protect the temporal branches. This can be done by staying deep to them, which requires dissecting directly on deep temporal fascia in the temple and in the subgaleal or

subperiosteal planes over the frontal bone. Alternatively, dissection can be kept superficial to the frontalis, the orbicularis, and the superficial temporal fascia.

Patient presentation

Forehead aging

Historically, the visible signs of forehead aging have been described in two ways. First, and most obvious are the furrows caused by the repetitive action of underlying muscles: transverse lines are due to the eyebrow lifting action of the frontalis, while glabellar frown lines are due to the corrugator, depressor supercilii, and the procerus. The corrugator, being the most transverse of these muscles causes vertical frown lines, the depressor supercilii, being oblique, causes oblique folds which cut across the orbital rim, and the vertically running procerus causes transverse lines at the radix (***Figs 7.13, 7.14***).

Second, it has been assumed that the forehead/eyebrow complex becomes ptotic with age, encroaching on the orbit, causing a pseudo-excess of upper eyelid skin. While consistent with the age-related ptosis of most other body parts, the facts are not so clear. Some studies actually suggest that eyebrows may rise with age, at least in the medial and central portions (***Figs 7.15, 7.16***).[35–37]

Logically, the medial and central eyebrows could rise over time through the action of frontalis. This may be caused by a subconscious reaction to excess upper lid skin or to early eyelid ptosis caused by senile levator disinsertion. Both phenomena will stimulate frontalis contraction to open the line of sight. Also at play is personal habit, exhibited by the brow elevation seen when most individuals are confronted with a mirror, or on facing a camera. Closing the eyes will usually, but not always, relax the frontalis, causing the eyebrows to drop. Frontalis paralysis due to facial nerve injury or botulinum toxin will always drop the level of the eyebrow, indicating that some resting tone is normal.

A final factor is the shape of the orbital aperture which appears to enlarge with age, the superomedial brow rising, and the inferolateral orbital rim dropping and receeding.[38,39] This could contribute to a rising medial brow, because of soft tissue attachment and the soft tissue support provided by the trunk of the supraorbital nerve (***Fig. 7.17***).

As described earlier, the level and shape of the eyebrow is the result of a balancing act between the many forces of brow depression and the only elevator, which is the frontalis muscle. The lateral portion of the brow is particularly sensitive to this interplay because frontalis action is attenuated laterally.[40] Against the unrelenting force of gravity and the lateral orbicularis oculi, the principle resistance to lateral brow decent is soft tissue attachment. This attachment is variable and may be absent, leaving the lateral brow free to move.[41] The result is often a gradual ptosis of the lateral third of the brow, relative to the medial brow. This effect will be accentuated if a patient also has a rising medial brow. The resulting downturned lateral brow imparts a look of sadness, tiredness and age.

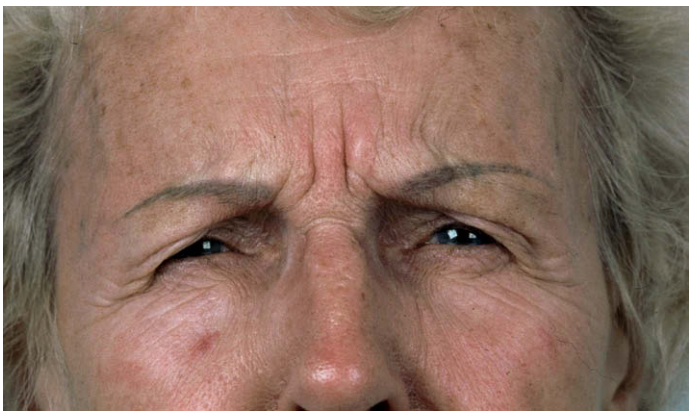

Fig. 7.13 Patient frowning. The paired vertical folds are caused by the corrugator supercilii and the transverse lines at the nasal radix are caused by the procerus. The paired oblique lines are caused by the depressor supercilii and the medial orbicularis oculi. Laterally the "crow's feet" lines are caused by the vertically running fibers of the orbicularis oculi.

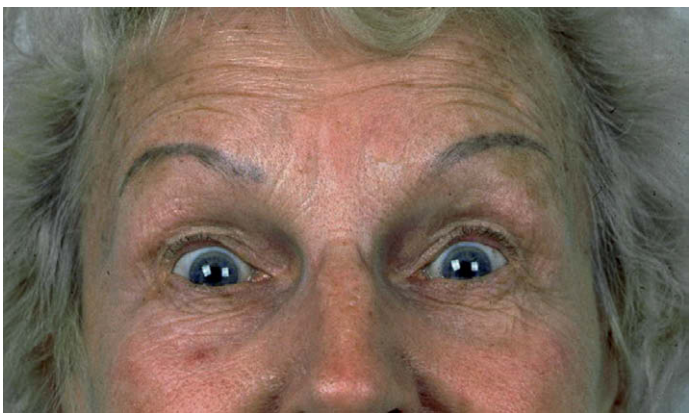

Fig. 7.14 Patient raising eyebrows. The transverse forehead lines are caused by the frontalis.

Fig. 7.15

Fig. 7.16 From age 25–50, photographs demonstrate a 3–4 mm rise in the medial and central brows.

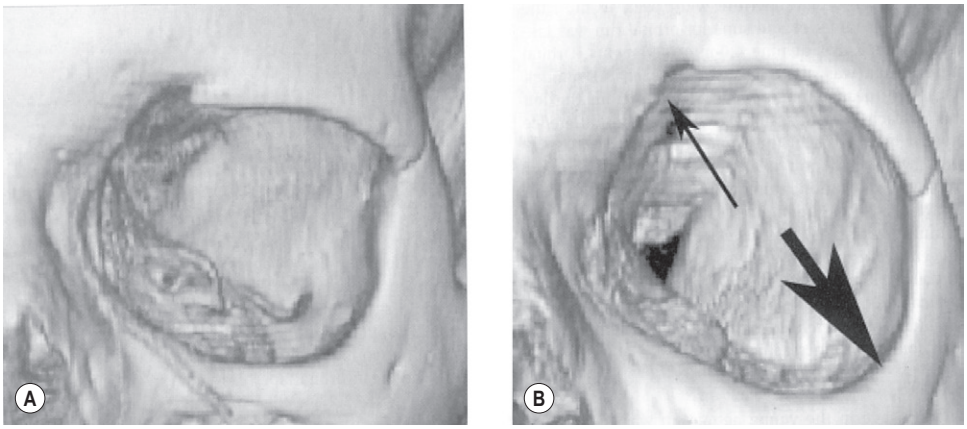

Fig. 7.17 Orbital changes with age: orbital volume expands, most marked superomedial and inferolateral. (With permission from Kahn DM, Shaw RB. Aging of the bony orbit. A three-dimensional computed tomographic study. Aesthet Surg J 2008; 28(3):258–264.)

Another effect of a dropping lateral brow is a bunching up or a pseudoexcess of lateral upper eyelid skin. In response to this, Flowers and Duval have described the phenomenon of compensated brow ptosis where patients subconsciously contract the frontalis to open their line of sight.[42] This further exacerbates the appearance of a downturned lateral brow.

Many patients recognize these changes and treat themselves to eyebrow plucking, make-up or tattooing in order to make the lateral brow appear higher. Alternatively, they may seek blepharoplasty to deal with lateral soft tissue hooding, unaware that the ptotic lateral brow is the most significant factor. The unsuspecting surgeon who performs blepharoplasty in this circumstance will see the frontalis relax, unmasking the compensated brow ptosis, causing the medial and central brow to fall.

Aesthetics

Traditional teaching has been that the correct eyebrow position is at or above the supra orbital rim. While usually true, this axiom is overly simplistic, because eyebrow height is only one of many variables. In many individuals, the lateral brow becomes more ptotic than the medial brow, altering brow shape. Studies have demonstrated that our impression of people can be affected by altering the shape of their eyebrows, implying that the shape of the brow is more important than its absolute height.[43,44] Also, age related changes in eyebrow position do not occur in isolation. The upper lid sulcus may become more hollow as fat is lost, upper lid skin may become more redundant, and there may be a modest degree of senile eyelid ptosis. As mentioned earlier, reflex brow raising is often the result, with a rising medial brow in relation to the lateral brow ***(Fig 7.16)***.

Gunter observed that the eyebrow and naso-jugular fold create an oval shape, and that in an attractive eye, the pupil will lie at the equator of that oval ***(Fig. 7.18)***.[45] Applying this analysis is a useful exercise to determine if brow position is an issue ***(Fig. 7.19)***.

Ovals which are vertically wide look aged, while vertically narrow ovals look youthful.

There is an intimate relationship between eyebrow position and the eyelid. The ratio of the visible eyelid from the lashes to the palpebral fold should be one-third, and at most one half the distance from the lashes to the lower border of the

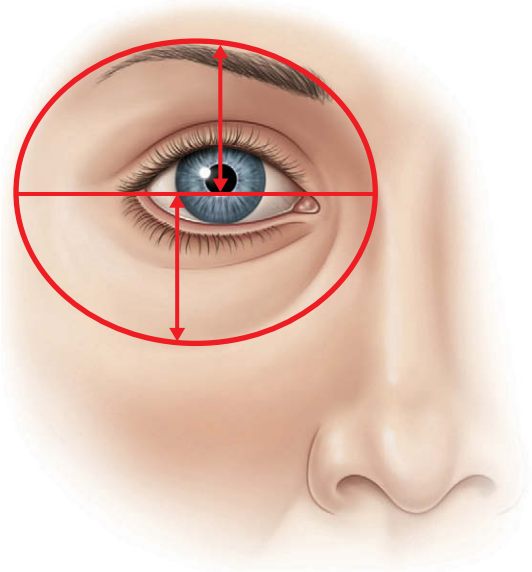

Fig. 7.18 An oval formed by the eyebrow above, and the nasojugular fold below, should have the pupil at its equator. (Adapted from: Gunter J, Antrobus S. Aesthetic analysis of the eyebrows. Plast Reconstr Surg 1997; 99:1808–1816.)

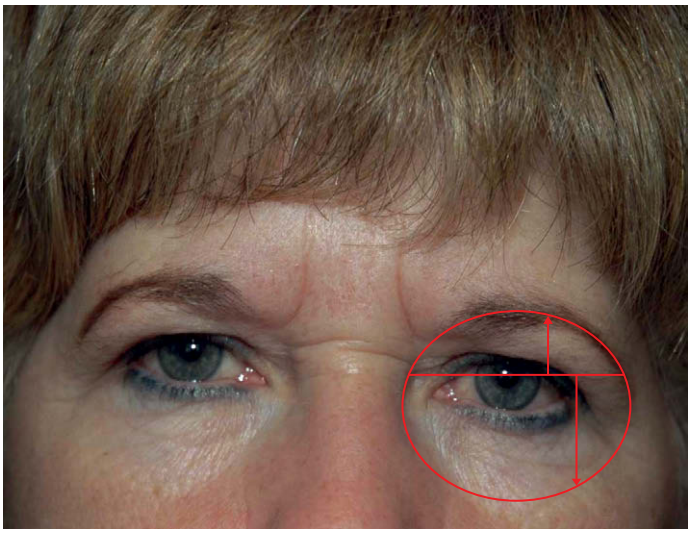

Fig. 7.19 On oval analysis of this case, the pupil lies above the natural equator of the oval. This confirms a low lying eyebrow plus or minus a low lying nasojugular fold.

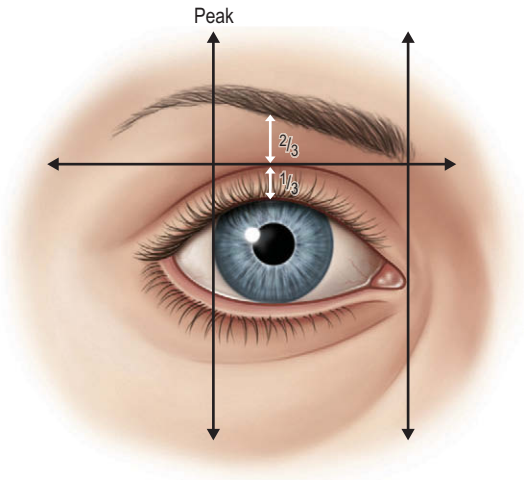

Fig. 7.20 The modern ideal brow/upper eyelid complex.

eyebrow (*Fig. 7.20*).[45] A number of different factors may change this ratio:

- Changing eyebrow height
- Lid ptosis or lid retraction
- Redundant upper eyelid soft tissue
- Loss of upper sulcus fat.

Any one of these issues can be treated independently or in conjunction with a brow lift. Brow repositioning is a powerful tool but it must be considered in the context of other possibilities such as ptosis repair, blepharoplasty, and fat grafting to the upper lid sulcus.

Individualization is a key component to any periorbital rejuvenation. Gender, ethnicity, eye prominence and overall facial proportions must be considered. For example, Oriental faces look attractive with higher eyebrows than would seem appropriate for the Caucasian face. Complicating matters, the "ideal" eyebrow has also changed over time. Renaissance painters tended to portray their subjects with normal eyebrows and relatively hollow upper sulci, while in the 1950s, eyebrows became very high and arched.[44] Individual variation aside, there are certain themes which define "the ideal eyebrow" (*Fig. 7.20*) in the era when this text is being written:

1. The medial eyebrow level should lie over the medial orbital rim
2. The medial border of the eyebrow should be vertically in line with the medial canthus
3. The eyebrow should rise gently, peaking slightly at least two-thirds of the way to its lateral end; typically this peak lies vertically above the lateral limbus
4. The lateral tail of the brow should be higher than the medial end
5. The male brow should be lower and less peaked.

Patient selection

Most patients are not aware of the many variables involved in periorbital rejuvenation, and they may not want the multiple procedures required to treat all of these components. For that reason, identifying the main component of every patient's periorbital aging is important. Old photographs are very helpful in determining which aging changes predominate. Such a review will also help to focus patients' perspectives on exactly how they have aged, and what, if any, rejuvenation they would like to undergo.

Assessment of the patient should be done with the patient's head in the vertical position; the patient will be sitting or standing. The following issues are evaluated: visual acuity; eyebrow and orbital symmetry; position of anterior hairline; thickness of scalp hair; transverse forehead lines; glabellar frown lines; thickness of eyebrow hair; eyebrow height; axis of the eyebrow (downward or upward lateral tilt); shape of the eyebrow (flat or peaked); passive and active eyebrow mobility, and the presence of old scars or tattoos. The upper eyelids should be assessed for soft tissue redundancy, for hollowness and for lid level (ptosis versus lid retraction). The patient should be examined with eyes open and eyes closed. With the eyes closed, the frontalis can usually be made to relax, revealing the true position and shape of the eyebrows. If the brow is held in this position when the patient opens their eyes, the eyebrow/eyelid relationship without frontalis effect will be revealed. The surgeon can then manually reposition the eyebrows, experimenting with various positions and different vectors of mobilization.

Patients may be a candidate to have their entire brow complex lifted, or more commonly to have only part of the eyebrow raised, thus improving eyebrow shape. Occasionally, this may involve raising the medial brow only, but most typically it involves raising the lateral third to half of the brow, with little or no lift of the medial portion. Weakening or eliminating the glabellar frown muscles is a useful parallel objective. Numerous methods are available, ranging from botulinum toxin, to surgical techniques which may weaken, or completely eliminate the glabellar frown muscles.

Surgical techniques

Surgical rejuvenation of the forehead has changed dramatically from the one-size-fits-all approach of an earlier era. As our understanding of anatomy and aging has improved, our available surgical techniques have also evolved. Alongside this evolution, the introduction of botulinum toxin for aesthetic indications has changed many of our fundamental concepts.

Open coronal approach

The coronal approach was long considered the "gold standard" against which other techniques must be measured. Many surgeons still consider it to be the most effective method for modification of the forehead. The principal advantage of this approach is the unparalleled surgical exposure which facilitates release and mobilization of brow soft tissues, as well as the modification of glabellar muscles under direct vision. Surgical results are stable, and long lasting.

The technique involves an incision over the top of the head, classically about 6–8 cm behind the anterior hairline, although this incision can be placed almost anywhere in the hair-bearing scalp (*Fig. 7.21*). An incision as far back as the vertex

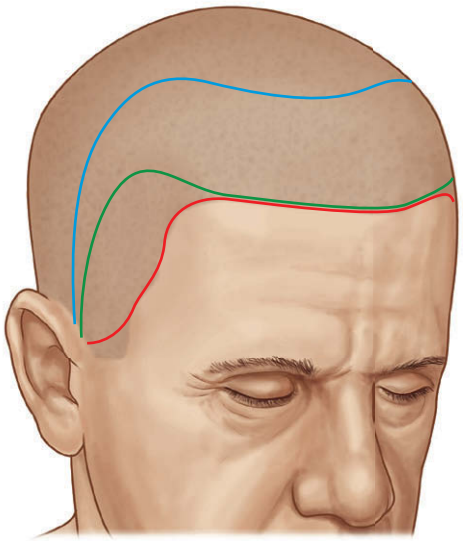

Fig. 7.21 Coronal and anterior hairline approaches.

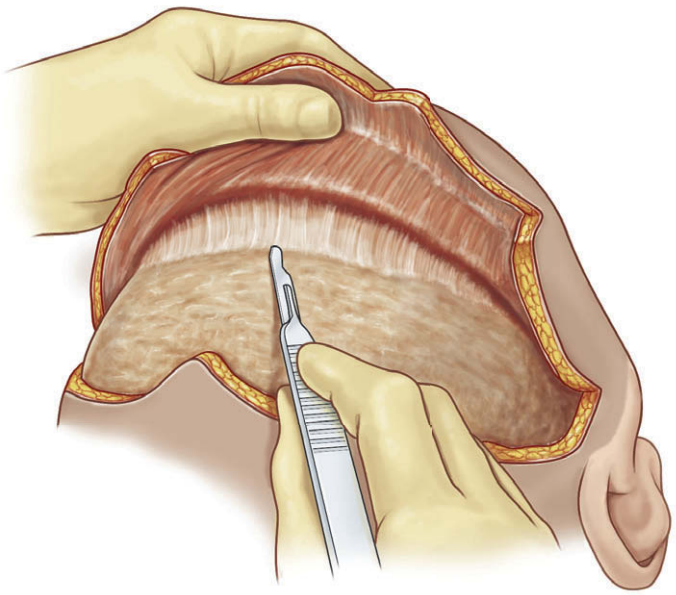

Fig. 7.22 Open coronal flap dissection shown in the subgaleal plane.

will be at the watershed between posterior and anterior running sensory nerves, thus reducing scalp numbness. However, a more anterior incision involves less scalp dissection, better visibility, and a closer point of traction on the eyebrows ***(Figs 7.21–7.23)***.

The incision is made full-thickness down to periosteum, and the anterior flap can then be raised in either the subperiosteal, or more commonly, the subgaleal plane. Under direct vision, the flap is elevated down to the orbital rim. If glabellar muscles are to be exposed, the galea must be breached on its deep surface, entering the galeal fat pad for access to the muscles ***(Fig. 7.22)***. The frown muscles, corrugator, depressor supercillii and procerus can be removed or weakened as necessary ***(Fig. 7.23)***. Typically, resection of the corrugator requires dissection of the supratrochlear nerve branches which course through the substance of this muscle. It is often advantageous

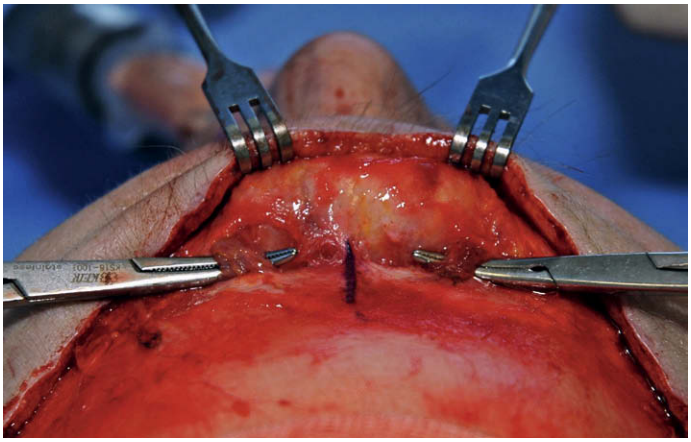

Fig. 7.23 Coronal approach showing corrugator muscles.

to leave some galeal attachment medially to prevent overelevation of the medial scalp. Otherwise, for proper brow elevation, there must be a thorough release of the galeal attachments along the central and lateral orbital rims. The zone of fixation will be released as dissection progresses laterally over the deep temporal fascia. The trunk of the supraorbital nerve is identified and preserved. To reposition the brows, the flap is drawn supero-laterally, and a full-thickness strip of scalp is excised. Laterally, scalp excision will range from 1 to 3 cm, but centrally, little or no scalp is excised. The scalp is closed directly, approximating galea and skin. Although deeper fixation can be added, the classic open coronal lift relies on scalp excision alone to maintain brow position.

Disadvantages of the open coronal approach include scalp numbness, which may be permanent, a long scar, disruption of hair follicles, and scalp dysesthesia. Inevitably, the anterior hairline will be raised and some hair-bearing scalp will be sacrificed. This technique should be used cautiously or not at all in patients with a high anterior hairline, with thin hair, or in patients who may eventually lose their hair.

Anterior hairline approach

This incision is usually placed along the anterior hairline, until it reaches the hairline laterally, where it transitions into the hair-bearing temporal scalp. Alternatively, it can follow the hairline over its entire extent ***(Fig. 7.21)***. Certain technical details help minimize scar visibility. These include placing the incision within or just posterior to the fine hair of the anterior hairline, and beveling the incision parallel to the hair follicles. Alternatively, the principle of cutting across the hair follicles may be used in order to promote growth of hairs through the resulting scar.[46] The incision, when made as a slightly wavy line, tends to create a less visible scar. Skin tension is minimized by approximating the galea, and doing a meticulous skin closure.

From the anterior hairline incision, dissection of the forehead flap can be done in one of three different planes: subperiosteal, subgaleal, and subcutaneous. Regardless of the plane being used, the anterior hairline approach offers the same advantage as the coronal approach, namely excellent surgical exposure, without the disadvantage of moving the anterior

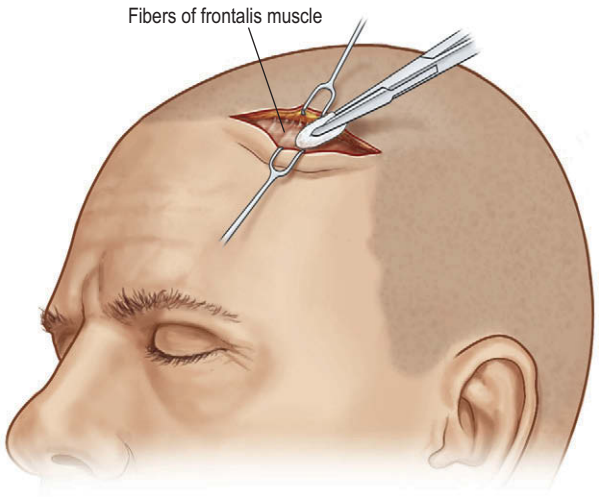

Fig. 7.24 Limited hairline subcutaneous approach.

Fig. 7.25 Anterior hairline incision to lower the anterior hairline.

Fig. 7.26 Hairline lowering.

hairline posteriorly. In addition, there are two unique advantages.

Because there is no undermining of hair follicles, the surgeon has the option of a subcutaneous dissection plane which is done on the superficial surface of the frontalis muscle. This allows brow elevation without the need to divide any sensory nerves, and also provides a potential effacement of deep transverse forehead lines. A popular modification of this method is a short incision in the widow's peak, which is used to target only the lateral brow ***(Fig. 7.24)***.[47]

The anterior hairline approach can also be used to lower an excessively high anterior hairline or to lower overly high eyebrows. These problems may be congenital but often are the result of previous brow lift surgery. Hairline lowering involves a posterior dissection past the vertex of the skull, in order to extensively mobilize the scalp. Releasing incisions are made in the galea, and the scalp is advanced, utilizing bony fixation to maintain the new hairline position ***(Figs 7.25, 7.26)***. If the anterior approach is used to lower the eyebrows, bony fixation is done at the supraorbital rim ***(Figs 7.25, 7.26)***.[48–50]

The main disadvantage of the anterior hairline incision is the presence of a permanent scar along the anterior hairline. In addition, if the scalp incision is full-thickness, the resulting scalp denervation will be worse than with the coronal approach because the posterior running sensory nerves are transected closer to their origin. Lastly, a full dissection of forehead skin may compromise cutaneous blood flow leading to partial skin necrosis.

Endoscopic approach

More than any other innovation, the introduction of endoscopy to facial aesthetic surgery stimulated the quest for better understanding of forehead and temple anatomy. Basic anatomic principles are integral to the theory of endoscopic brow lifting. Laterally, brow lifting is accomplished by releasing all galeal attachments and relying on some method of mechanical fixation to maintain the scalp in a higher position. Medially, brow lifting happens passively by removing muscular depressors, and allowing the frontalis to lift unopposed.

The principle advantages of the endoscopic brow lift are a very good surgical exposure, magnification of the surgeon's view, and short, undetectable incisions. In addition, the scalp denervation associated with the open coronal approach is largely avoided ***(Fig. 7.27)***.

Access for the procedure is through 3–5 small (1–2 cm) incisions placed within the hair-bearing scalp. Forehead flap dissection is done to the same extent as with the open coronal lift. Medial to the zone of fixation, the dissection plane can be subgaleal, or the more popular subperiosteal approach. Flap dissection can be done blindly at first, but is completed under endoscopic control when approaching the orbital rim in order to avoid damaging the supraorbital nerve. Lateral to the zone of fixation, dissection is done against the deep temporal fascia, with the inferior temporal septum and the sentinel vein used as landmarks for the position of the overlying temporal nerve branches. The medial and lateral dissection pockets are then joined by going from lateral to medial. Soft tissue attachments along the lateral orbital rim and the supraorbital rim are then visualized and released. Dissection down the lateral orbital rim may be preperiosteal or subperiosteal. The supraorbital nerve is visualized during orbital rim release. If glabellar musculature is to be removed, the supratrochlear nerves are visualized as they pass through the substance of the corrugator

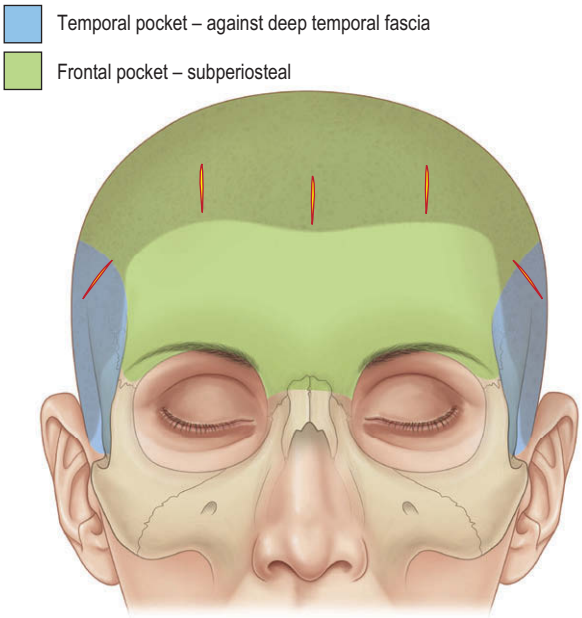

Fig. 7.27 Five port endoscopic approach.

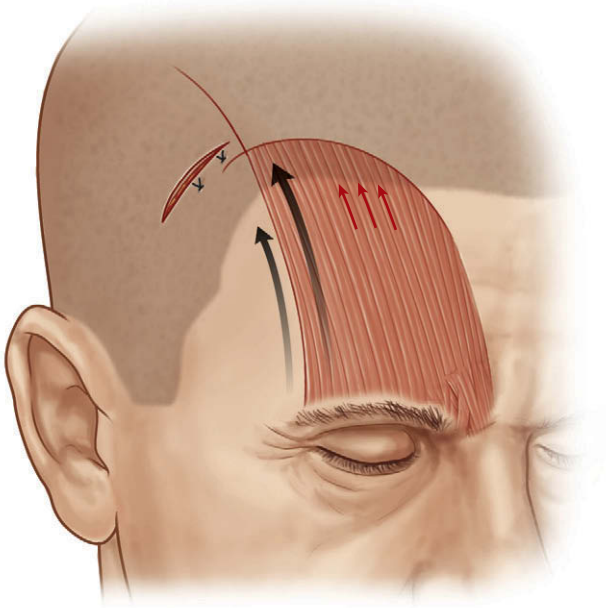

Fig. 7.28 Temple approach.

supercilii. Care is taken to avoid excessive release of the flap medially to prevent over-elevation medially and to avoid separation of the eyebrows. Once dissected, the forehead flap is drawn superiorly and somewhat laterally. Specific vectors have been described in this regard,[51] but the surgeon can make an artistic decision during preoperative planning, with appropriate vectors customized for each individual patient. While some authors have suggested that no fixation is necessary,[17] two methods of fixation are usually employed: suture fixation in the lateral dissection pocket from the superficial to the deep temporal fascia, and bony fixation in the medial dissection pocket. In an attempt to make the operation more predictable, a wide variety of fixation devices and techniques have been described.[52]

The main disadvantages of endoscopic brow lifting are: the technical demands of using endoscopic equipment, the potential of overly elevating or separating the medial eyebrows, and some uncertainty about maintaining adequate fixation.[15]

Temple approach

A temple approach involves a full-thickness scalp incision in the temple, lateral to the temporal crest line.[53] Knize improved and popularized this approach with dissection on the deep temporal fascia, releasing of the lateral orbital rim, the supraorbital rim, and the zone of fixation with using an endoscope (*Fig. 7.28*).[14] After flap mobilization, fixation is done with sutures between the superficial and deep temporal fascia. If surgical modification of glabellar frown muscle modification is desired, a transpalpebral approach can be used.

Disadvantages of this method include limited visibility of the central and medial supraorbital rim, and the fact that the fixation vector applied to the lateral eyebrow is oblique, rather than vertical, which may be inappropriate for some patients (*Fig. 7.28*).

Transpalpebral approach – muscle modification

Using the upper lid blepharoplasty approach, the glabellar frown muscles can be approached directly.[54,55] This is an excellent method to attenuate glabellar frown lines in patients who do not require a forehead lift. It can also be used as an adjunct to the patient undergoing an isolated elevation of the lateral third of the brow. The advantage of this method is a hidden incision, which may be used for two purposes, blepharoplasty and frown muscle ablation.

Through an upper blepharoplasty incision, dissection proceeds superiorly deep to the orbicularis oculi, but superficial to the orbital septum. Over the supraorbital rim, the transverse running fibers of the corrugator supercilii will be found. The muscle becomes more superficial as it coursed laterally through the galeal fat pad, eventually combining with the orbicularis oculi and the lower frontalis. The muscle can be removed, although care must be taken to protect supra trochlear nerve branches which travel through the substance of the muscle or around its inferior border. Medially in the wound, the depressor supercilii can be seen coursing almost vertically, and the orbicularis oculi courses obliquely. Portions of these muscles are removed. The procerus can be transected by dissecting across the root of the nose.

The main disadvantages of this approach include potential damage to sensory nerves (supraorbital and supratrochlear), and increased bruising and edema compared to an isolated upper lid blepharoplasty (*Fig. 7.29*).

Lateral brow approach

Video 1

The lateral brow approach utilizes a more medial incision than the temple approach. Its location is based on the observation that the most effective vector for lateral brow lifting seems to be directly along the temporal crest line (*Fig. 7.30*).

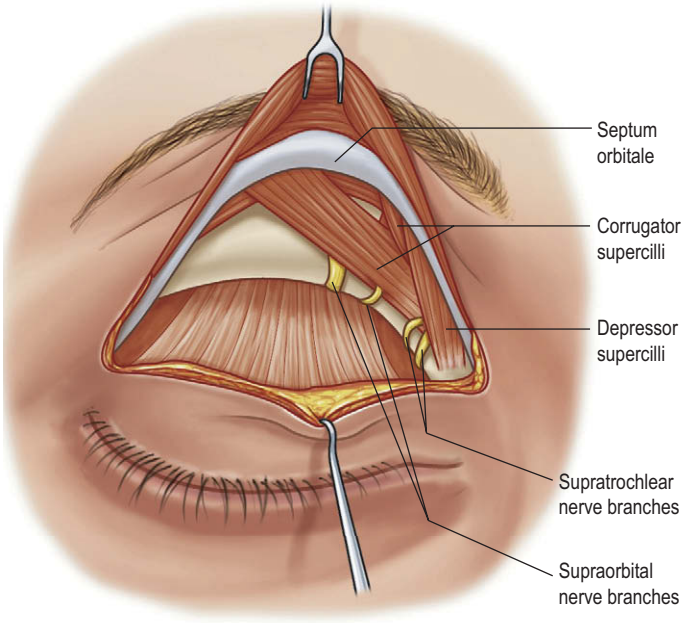

Fig. 7.29 Transpalpebral exposure of the frown musculature.

Fig. 7.30 Preoperative marking for modified lateral brow lift. The planned vector of pull is marked. Laterally, the purple dashed lines mark the expected course of the facial nerve temporal branches. The purple dot represents the sentinel vein. The curved purple line marks the temporal crest line which is accentuated when the patient clenches her teeth, contracting the temporalis. Medial to the crest line, the black cross hatched band is the expected course of the deep branch of the supraorbital nerve, in purple. The corrugator supercilii, depressor supercilii and procerus are marked in black.

A variety of fixation methods can then be used including simple scalp excision, deep temporal sutures, or fixation to bone.[56] The modified lateral brow lift is a hybrid procedure utilizing a 5–6 cm incision in the scalp, approximately 1 cm behind the hairline.[16] Because the desired vector is directly along the course of the deep branch of the supraorbital nerve, this procedure is designed to be nerve sparing. Orbital rim release can be done with or without an endoscope. A full-thickness excision of scalp is done (like an open coronal lift), but nerve branches are preserved as a neurovascular bundle. Fixation is accomplished with deep temporal sutures and by

Fig. 7.31 The neurovascular bundle of the deep branch of the supraorbital nerve. The subperiosteal pocket has been developed medially and the temporal pocket against the deep temporal fascia has been developed laterally. The two pockets are joined along the temporal crest line. When the lateral brow is raised, the neurovascular bundle will telescope up under the scalp closure.

galeal closure. The main advantages of this method are those of the endoscopic approach, plus the same strength of fixation provided by a coronal lift. The main disadvantage, compared with the pure endoscopic approach, is a slightly longer incision (*Fig. 7.31*).

Direct suprabrow approach

Because the eyebrow is a cutaneous structure, the most effective method to lift it would theoretically be a subcutaneous approach done adjacent to the eyebrow itself. This simple technique was described almost a century ago. An excision of full-thickness skin is done along the upper margin of the eyebrow, or alternatively within a deep forehead crease. On closure, there is initially a 1:1 relationship between the amount of skin removed and brow elevation, but the surgeon should plan for a 50% relapse in the first few months following the procedure. The closer the incision is to the eyebrow, the less will be the relapse. The principle advantages of this technique are: the surgery is easy; it is well tolerated by the patient; there is no scalp denervation; there is no risk to motor nerves, and the result is relatively predictable.

The principle disadvantages of this method are the visible scar it creates and that fact that over time, brow depressing forces will once again stretch out the skin, causing a recurrence of brow ptosis. Certain individuals, especially older men with deep forehead creases, or thick eyebrows may be good candidates for this procedure, which can easily be repeated if necessary.

Transpalpebral browpexy

During upper lid blepharoplasty, the ptotic lateral brow can be addressed through the same upper lid incision.[57,58] The lateral portion of the superior orbital rim is easily exposed, and dissection proceeds superiorly over the frontal bone, superficial to the periosteum. Dissection should continue for 2–4 cm above the orbital rim, or at least 1 cm above the level

of planned fixation. Several sutures are then used to tether the mobilized brow in a more superior position, fixating the underside of the orbicularis to the periosteum. Alternate methods of fixation to bone can also be used. Overly tight sutures must be avoided because of suture dimpling in the eyebrow. A more modest pexy is achieved if the cut edge of orbicularis oculi is simply suture to the orbital rim, with no superior dissection at all.[59] Advantages of transpalpebral browpexy are the ease of the procedure and a hidden scar. The principle disadvantage is the limited effect achieved and questionable longevity.

Suture suspension browpexy

A number of methods have been developed to elevate the brow only using sutures, with no dissection at all. Methods include barbed sutures or suture loops which are placed blindly through subcutaneous tunnels. The obvious advantage of these methods is extreme simplicity and relative safety, while the principle drawback is their limited effect, and poor longevity.[60]

Postoperative care

Postoperative care for minor brow procedures is limited to head elevation, cold packs, ointment application, and analgesics.

More extensive procedures (e.g., open coronal lift, endoscopic lift) will require dressings and the possibility of drains for 24 h. Use of bupivacaine to block the supraorbital and supratrochlear nerves is very helpful in decreasing the incidence of postoperative headache. Patients can shower after 48 h, with scalp suture removal in 7–10 days.

After initial healing, measures can be adopted to prevent relapse of lateral brow ptosis. The use of botulinum toxin in the lateral orbicularis is helpful, as is the use of sunglasses and sun avoidance to prevent squinting in the first postoperative month.

Outcomes and complications

The surgical result of forehead rejuvenation depends on the type of deformity, the procedure done and the quality of its execution.

Lesser procedures generally produce lesser results, but for the individual patient with appropriate expectations, this may be adequate.

More involved procedures afford the opportunity for greater anatomic intervention, more dramatic results and potentially greater longevity. However, as our understanding of the aging brow has progressed, it is clear that brow ptosis is not as significant a factor as was once thought, and therefore, overly aggressive surgery can produce an exaggerated, un-aesthetic result. Historically, the main problems encountered by surgeons performing browlift procedures have been aesthetic – in some cases overdoing the surgery and in other cases, failing to achieve a predictable long term result.

Every patient presents with a different set of challenges, the most important of which is to first make a proper aesthetic diagnosis. Once the decision has been made to raise all or part of the brow complex, a myriad number of surgical procedures are available. No one method can be considered best, but rather, the surgical procedures must be chosen based on the individual patient's needs. In addition, every surgeon will have greater comfort with some procedures compared with others, and it is incumbent on surgeons to carefully analyze their results in order to give patients a realistic idea of what can be expected.

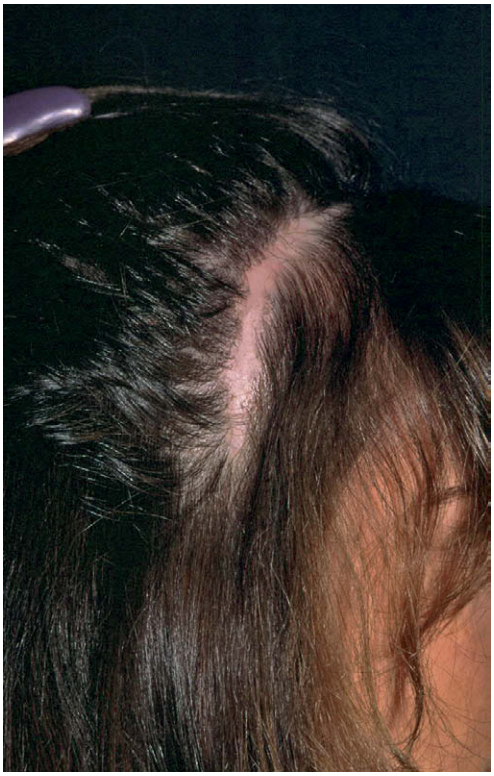

Fig. 7.32 Scar alopecia after coronal brow lift.

In addition to the aesthetic issues mentioned above, surgical complications of brow rejuvenation include scar alopecia, hematomas, infections, contour deformities, and nerve damage (***Fig. 7.32***).

Significant problems with brow positioning and shape may be treated with secondary procedures. Alopecia due to hair follicle damage may be temporary, but if permanent can be treated with scar excision or hair grafting.

Hematomas are uncommon, but if they occur, are treated with drainage. Infections are rare, consistently reported at less than 1%, and are treated with wound care and appropriate antibiotics.[18] Contour deformities can occur in areas of muscle excision; these problems are ideally prevented by the intraoperative utilization of filling material such as fat or temporal fascia. If identified late, similar tissue can be added at a separate procedure.

Sensory nerve damage is a common problem, and is universal with some types of procedures. With coronal incisions, all posterior running sensory nerves are routinely transected. The resulting scalp denervation will extend to the vertex, but will gradually improve, sometimes over several years. With limited incisions, sensory nerves may be traumatized

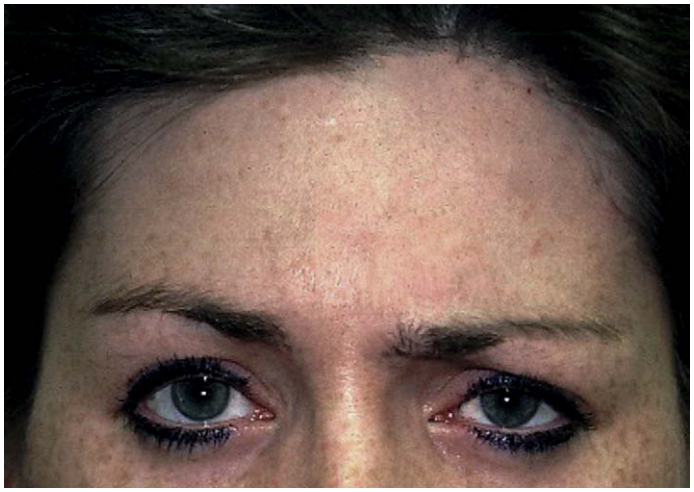

Fig. 7.33 Temporary neurapraxia of left temporal branch after coronal brow lift.

Fig. 7.34 Over elevated medial brow after endoscopic brow lift.

due to traction, cautery, or instrumentation. Temporary neurapraxia of the supratrochlear nerves after frown muscle ablation is almost universal, with sensory return typically appearing by 2–3 weeks. Similarly, temporary neurapraxia of the supraorbital rim is very common after a thorough release of the supraorbital rim.

The only motor nerve in the forehead is the temporal branch of the facial nerve, and damage to this nerve is the most worrisome complication. Temporary neurapraxias are relatively common, but permanent damage to the temporal branch is fortunately very rare. Should a neurapraxia develop, watchful waiting is a must ***(Fig. 7.33)***.

Secondary procedures

As mentioned above, minor issues such as areas of alopecia and contour deformities in the glabella, can be treated with simple procedures.

The most common reason for revision surgery after brow surgery is to correct aesthetic deformities. Not infrequently, overly aggressive brow lift surgery can create an unaesthetic eyebrow shape, most frequently an over-elevation of the medial brow ***(Fig. 7.34)***.

Minimal deformities can be corrected with botulinum toxin in the central frontalis. If the medial brow has been aesthetically over-elevated, but the lateral brow remains unelevated, the lateral brow can be elevated as a separate maneuver.

Alternatively, the medial brow can be lowered, a procedure which involves a full release of the scalp's attachment to the underlying skull, lowering of the medial brow, and bone anchoring to the medial orbital rim.[50]

If there is simply a loss of effect from brow lift surgery, the situation can often be resolved to the patient's satisfaction with a conservative upper lid blepharoplasty. However, if the loss of effect is significant, repeat brow lifting may be necessary, preferably using a different technique and a different dissection plane.

In the case of a temporal branch palsy which does not improve with time, treatment options include applying botulinum toxin to the normal side, or alternatively, performing another brow lift on the affected side.

Access the complete references list online at **http://www.expertconsult.com**

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