
Forehead and Brow Rejuvenation

Erik A. Hoy, Benjamin Z. Phillips, and Patrick K. Sullivan

1 Introduction

The forehead is often the first element of the face to show aging [1, 2]. Since the hair-bearing eyebrow is the most obvious aspect of the forehead, procedures such as forehead lifts, foreheadplasty, etc., have been referred in general terms, simply as “browlifts” [2]. Gonzales-Ulloa first described resuspension of the brow region through a coronal approach in 1962 [3]. Subsequent authors have altered or refined his approach to this area. Procedures to address the prematurely aging brow are among the most commonly performed in plastic surgery. In 2008, surgeon members of the American Society of Plastic Surgeons (ASPS) performed over 42,000 surgical browlift procedures, and many of the 5 million cosmetic Botox treatments and nearly 1.6 million soft tissue filler procedures were directed at forehead rhytids and transverse brow or glabellar creases [4]. Recent trends toward minimally invasive procedures have led to the development of endoscopic and other limited-length incisional approaches.

2 Anatomy and Consequences of the Aging Process

2.1 Musculature

The motion of the brow is due in large part to the frontalis muscles, which are joined to the occipitalis by means of the galea aponeurotica. The frontalis is rare in that it is a skeletal muscle that does not originate from, nor insert into, the bone. The superior aspect of the frontalis muscles originates from

this sheet of connective tissue. The lower half of the muscle provides the majority of contraction and hence is responsible for the elevation of the brows. This contraction exerts tension across the orbicularis oculi muscle and subsequently on the skin of the lower brow. As this skin elevates, transverse folds form as the skin “accordions” upon itself. As Knize points out, the temporalis ends laterally at the superior temporal fusion line, which crosses the brow at the junction of the middle and lateral thirds [5]. Therefore the vertical vector is smallest on the lateral third of the brow, and this portion is also the first to descend with aging. Also, Knize points out that, in this lateral third, the orbicularis’ action on the brow is unopposed by the frontalis, hastening the development of ptosis in this area [5].

The orbicularis oculi muscles are brow depressors, acting against the pull of the inferior edge of the frontalis. Though these muscle fibers run at right angles to the frontalis for most of the brow’s length, their strong sphincteric function is a powerful brow depressor, and repeated contractions or hyperactive tone can result in periorbital rhytids, aka “crow’s feet.”

The procerus is an antagonist to the frontalis: it lowers the brow (and pulls the soft tissues of the upper nose superiorly). It originates on the superior aspect of the nasal bones and inserts bilaterally on the frontalis muscles. The medial brow is pulled inferiorly by activation of the procerus muscle, and over time a deep transverse crease may develop at the root of the nose.

The depressor supercilii muscles are another antagonist of the frontalis. They originate from the superior orbital rim, just above the attachment of the corrugators. They pass obliquely to insert on the dermis. The depressor supercilii’s contraction results in oblique skin creases at the medial aspect of the brow. They are not alone in this action; however, the corrugator’s oblique head and the medial orbicularis oppose the frontalis, depress the medial brow, and help create oblique skin creases.

The corrugator supercilii muscles, like the depressor supercilii, originate from the superior orbital rims, in this case the medial aspects, and pass medially to insert into the

E.A. Hoy, MD (✉)
Department of Plastic Surgery, Alpert Medical School
of Brown University, Providence, RI, USA
e-mail: erichoymd@gmail.com

B.Z. Phillips, MD • P.K. Sullivan, MD
Department of Plastic Surgery, Brown University,
Rhode Island Hospital, Providence, RI, USA

undersurface of the dermis. Their contraction pulls the brows medially, resulting in vertical glabellar creasing of the skin. Hyperactive corrugators result in deep creases that are difficult to address in vertical browlifting procedures alone, as the pull is along the axis of the crease and perpendicular to the muscle fibers responsible for it.

2.2 Motor Innervation

As in the rest of the face, the facial nerve (Cranial Nerve VII) is responsible for movement of the mimetic muscles of the forehead and brow. Specifically the frontal branch, as the most superior branch of the facial nerve, passes from its divergence from the main body of the nerve in the parotid and exits the gland superiorly between the deep and superficial lobes. The frontal branch courses from a point 5 mm below the tragus to a point 15 mm above the lateral brow. Over the zygomatic arch, it is found about 2.5 cm lateral to the lateral canthus, placing it halfway between the lateral canthus and the inferior helix where it is particularly vulnerable to careless dissection in browlift procedures [6]. Care must be taken to avoid any traction on this branch by tenting the skin and soft tissues over the elevator or scope during dissection from above in the plane of the deep temporal fascia.

2.3 Sensation

Sensory innervation to the brow is by means of branches from the V₁ distribution of the trigeminal nerve (Cranial Nerve V). Specifically, the paired supraorbital and supra-trochlear nerves supply the lateral and medial forehead, respectively. The supraorbital nerves exit from the supraorbital foramen an average distance from the midline of 2.42 ± 0.04 cm females and 2.56 ± 0.05 in males [7]. They then split into superficial and deep branches to supply the forehead. The deep division supplies the frontoparietal region and can be injured along its course from the main nerve trunk, where it runs superiorly between the galea and periosteum, pierces the galea 2–2.5 cm above the orbital rim, and continues superiorly within 1–2 cm of the temporal fusion plane. If this nerve branch is injured, it is often secondary to traction injury with the dissector or to transection by the coronal incision and results in paresthesia over the temporoparietal scalp. The superficial branch is shorter, more medial, and less often injured in browlifts. The superficial branch supplies the medial brow, medial forehead, and anterior hairline.

Attaining an aesthetic postoperative result depends on preoperative planning. An organized, logical analysis of the aged brow is of paramount importance. Understanding the patient's concern with their appearance, and matching

achievable results to realistic patient expectations, is the core of aesthetic surgery. As the evolution of procedures for forehead rejuvenation illustrates, this has not always been possible. Early attempts at forehead rejuvenation involved elevating the eyebrow as a single aesthetic unit. However, with refinements in analysis and techniques, the brow is now usually addressed in terms of the medial, middle, and lateral thirds. Often, the lateral third descends earliest and to a greater extent [1, 2, 8, 9]. This lateral third not coincidentally is the area that usually needs the majority of superior repositioning in the browlift.

3 The Ideals of the "Aesthetic Brow"

Multiple authors have studied the favorable brow position and orientation, including the work by Westmore [10], Cook et al. [11], Connell et al. [12], Matarasso and Terino [13], McKinney et al. [14], and Gunter and Antrobus [15]. Most authors acknowledge that the aesthetic ideal has changed over time. Westmore proposed that the aesthetic brow had the following attributes: a medial brow that began at the same vertical intercept as the medial canthus and ending laterally along an axis connecting the nasal ala with the lateral canthus and medial and lateral endpoints along the same horizontal axis with a peak directly above the lateral limb [10]. However, it is more aesthetically pleasing to most patients and surgeons to achieve a final brow orientation with a more elevated lateral third relative to the medial and middle thirds of the brow.

More recently, authors have tried to ascribe more quantitative attributes to the ideal brow [12–14]. Namely, the brow should begin medially directly at the caudal aspect of the superior orbital rim. The superior portion of the brow should be 1 cm superior to the orbital rim and 5–6 cm inferior to the hairline [16]. Additionally, the brow should be 1.6–2.5 cm above the eyelid crease. The superior peak of the brow should lie at the juncture of the middle and lateral thirds, lateral to the location described by Westmore.

More recently, Gunter and Antrobus reviewed pre- and postoperative photos of a cohort of his patients in his cosmetic practice and compared their brow position versus that of a number of fashion models in print magazines [15]. They found that the patients tended to have flatter brows that started medial to, peaked more lateral to, and ended more inferolaterally than those of the models studied [15]. They therefore refined the ideal brow to include the periorbital structures, since intuitively, more attractive periorbital anatomy either enhanced an attractive brow or helped to compensate for the less attractive one. By their specifications, the brow should lie along a slightly inclining axis when viewed from medial to lateral. The remaining findings, which will not be discussed further here, were an upper lid which

overlies the iris 1–2 mm, a more vertically orientation of the medial upper lid versus the lateral aspect, an upper lid crease which parallels the lash line and does not extend toward the midline beyond the medial canthus nor laterally beyond the lateral orbital rim, no or minimal scleral show below the iris, and finally, a smoothly arcing lower lid with the meniscus at the lateral limbus [15].

A cautionary note should be mentioned here: these “ideal” brow concerns are for the female patient. The male eyebrow has been less studied [17] and has several key differences. First of all, the male brow should lie at the level of the superior orbital rim and is less arching than the female brow. Still, the peak should lie at the junction of the two lateral thirds.

Unlike other areas of the face, bony changes play little if any role in aging of the forehead and brow. That being said, there is a spectrum of orbital rim anatomy seen in patients, as Barton points out in his book [2]. The superior orbital rim may take the form of a gradual transition from orbital roof to inferior brow, with its details masked by profuse orbital and periorbital fat. Alternatively, some patients may have a more severe appearance of their superior orbital rim, relatively devoid of upper lid and periorbital fat to disguise the bony anatomy [2]. Whatever the configuration, in terms of bony anatomy, what one sees is what one gets: bony anatomy is rarely changed in forehead rejuvenation, though volume restoration in the form of autologous tissue transfers such as fat grafting has been used to good effect by the senior author.

Increasing laxity and ptosis of the soft tissues of the brow are responsible for the stigmata of aging in this area. Since the descent of the brow is a soft tissue process, attempts at rejuvenation involve release, redraping, and resuspension of these tissues, with occasional resection of excess skin. Difficulty in obtaining precise control of the medial, middle, and lateral thirds of the brow spurred further studies into the anatomy of this area.

The senior author recently published his work in dissecting 24 hemi-foreheads, with close attention to the ligamentous attachments of the brow [18]. Notable findings included multiple ligamentous structures analogous to the suspensory ligaments of the mid- and lower face. In the subperiosteal plane, a superomedial ligamentous attachment was found to originate on average 10.8 mm above the supraorbital rim and 13 mm from the midline. Also in the subperiosteal plane, a ligamentous attachment originated an average of 10.3 mm above the supraorbital rim and 23 mm from the midline (Figs. 1 and 2). Though these attachments appeared to serve a similar purpose to those of the midface, the ligamentous thickenings of the forehead are broad based. They continued from the bone, pierced the periosteum, and inserted into the frontalis muscle and the tightly adherent overlying skin. Also dissected out was a long and broad ligamentous structure which extended from the lateral aspect of the supraorbital rim and extended laterally to the superior aspect of the lateral orbital rim. This structure

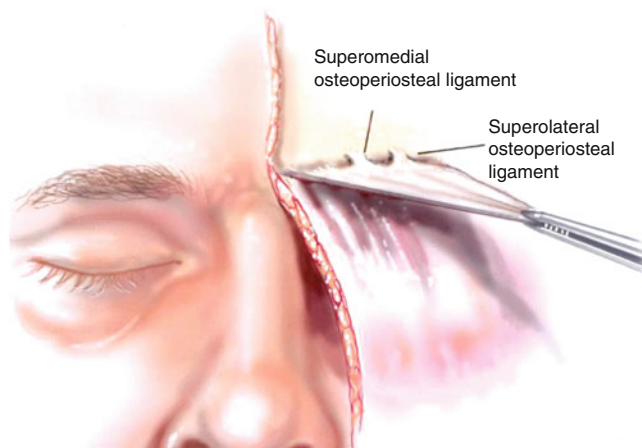


Fig. 1 Superomedial and superolateral ligamentous attachments of the brow shown in the subperiosteal space. The superomedial structures average 10.8 mm above the supraorbital rim and 13 mm from the midline. The superolateral structure averages 10.3 mm above the supraorbital rim and 23 mm from the midline

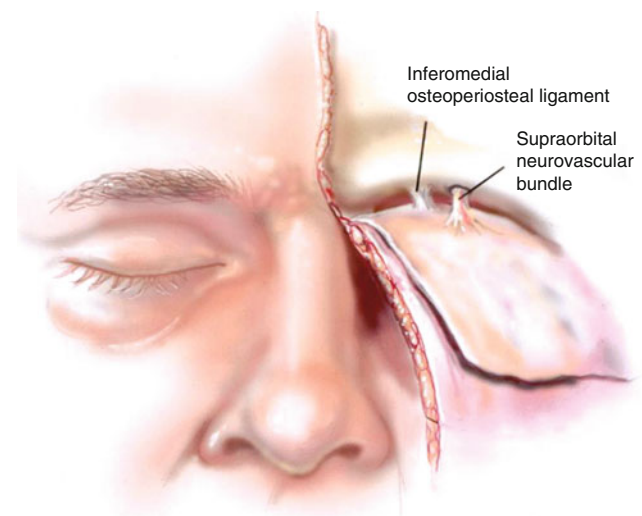


Fig. 2 The inferomedial ligamentous attachment is at the level of the orbital rim and averages 2.6 mm from the midline just medial to the supraorbital neurovascular bundle

was inserted to the superficial temporal fascia, as described by Knize [19, 20]. Without release of this structure in its entirety, the lateral brow cannot be optimally elevated. The short and stout fibers of the retinaculum cutis help secure the skin tightly to the frontalis muscle, and in dissection, no definite ligamentous attachments were encountered.

4 Preoperative Planning

The interrelations between development of brow ptosis and changes in the upper eyelid are notoriously misunderstood by patients presenting for rejuvenation of the upper third of

the face. In addition to a systematic approach to presurgical examination of these patients, a series of photos and an exam in front of a large mirror are vital in evaluating and instructing prospective patients in what to expect from their browlift procedure. Preoperative photographs should include the standard anterior-posterior, oblique, and lateral views, as well as close-up views of the periorbital area in repose with eyes open and closed, smiling, with eyes tightly closed, and with full corrugator/procerus and frontalis muscle contractions. These views, along with a dynamic exam in front of a large mirror, should help educate the patient and surgeon about what features of aging are present and which procedures are indicated. These images should be printed and readily available during the surgical procedure for easy reference, as the facial anatomy is easily distorted in the supine position. As always, the patient is examined again on the day of surgery, in the preoperative area, and after observing the brow in motion and at rest, the transverse brow and glabellar creases are marked. Preoperative markings are also placed if a blepharoplasty is planned. Typically, coronal, limited-length, or endoscopic access incisions are marked on the operating table.

5 Patient Selection: Indications

While the indications for forehead lift and browlift, plus the possible need for upper blepharoplasty, are concepts that are sometimes poorly understood by patients, they are relatively straightforward. These include ptosis of the eyebrows, especially when portions of the eyebrow skin descend below the superior orbital rim and thus give the impression of excess upper eyelid skin. This may occur as a normal consequence of the aging process, but is often seen with bilateral or one-sided frontalis dysfunction, as in the case of Bell's palsy. These processes differ in regard to the appearance of the forehead skin, with natural aging and normal frontalis function resulting in transverse skin rhytids, whereas the paretic brow is typically ptotic but without wrinkling due to decreased frontalis tone. Repetitive contraction of the corrugator muscles, procerus, and orbicularis oculi muscles can lead to vertical or transverse glabellar creases, and "crow's feet," respectively. When mild, these conditions can be treated with Botox for improved contour and symmetry [21]. Moderately deep creases may be addressed with a variety of alloplastic filler materials, which are not addressed in this chapter. However, deep creases and skin excess are best dealt with surgically by means of browlift, with or without denervation of the muscles of the brow and resection of the procerus and corrugator muscles [22]. While the use of chemical denervation with Botox and soft tissue augmentation with non-autologous fillers will not be discussed in further detail here, the reader is referred to an excellent article on the topic

[23]. It is the senior author's preference to reestablish soft tissue volume in the brow with autologous fat grafting, where indicated. Results with and without this adjunctive procedure are presented below.

6 Aging of the Brow and Periorbital

As alluded to above, it is sometimes difficult to discern where the aged brow ends and where the aging upper lid begins. Often, one element is the key feature of the aging process and is compensated by another – and one or both need to be dealt with to effectively rejuvenate the face's upper third. As brow skin descends and abuts and then displaces upper eyelid skin, the patient may unconsciously develop visual field limitations superiorly. To counteract this, they will activate the fibers of the frontalis muscle to elevate the brows when the eye is open, thereby lifting some of this soft tissue excess out of the upper visual field. The result is a ptotic upper lid which may or may not be adequately compensated by brow elevation and a high-arched and superiorly displaced hair-bearing brow. Transverse rhytids are also common in this case of increased tone of the frontalis muscle.

An important principle of rejuvenation of the upper third of the face is this: if both of these areas are problems which are not addressed, the patient will be unhappy with their postoperative appearance. This must be borne in mind whenever a patient states, "I just want my eyes done" or "I just want my eyebrows lifted." The patient may not realize the full extent of their upper lid ptosis because of a compensatory elevation of the brow. Showing such a patient their appearance in repose can help illustrate the actual anatomy in the area, without distorting input from the frontalis. However, if this relationship is not appreciated by the patient and surgeon prior to blepharoplasty, the brows will descend postoperatively, when this compensatory mechanism is no longer needed. Despite the upper lid skin excision, a descending brow can offset the rejuvenative effects of the upper blepharoplasty. Understanding the anatomy of the brow and the etiology of the aging process is vital in achieving the desired results in foreheadplasty and browlift.

7 Objectives

As with much of aesthetic surgery, the aims in rejuvenative procedures for the brow are simple, and the difficulty lies in their implementation. The main goal is to restore a more youthful appearance to the brow region, without "overplaying the hand" and conveying an overly lifted appearance. As Barton states in his book, while the depressed brow is unaesthetic, it is natural. The elevated brow is a postsurgical look

[2]. The goal is to elevate the elements of the brow smoothly and to the correct extent. As discussed above, the lateral brow typically needs to be lifted more than the remainder of the brow. In most patients, the medial brow needs little if any elevation. Elevation of the medial brow conveys a “surprised look” [24]. In lifting and redraping the brow, transverse lines should be softened, and if necessary autologous or off-the-shelf fillers can be employed to fill deeper creases. Hair follicle concentration and thickness should be preserved, and the hairline location should be either preserved or lifted to a minor extent. If indicated, an upper blepharoplasty should be performed to excise excess upper eyelid skin prior to redraping of the brow. Whenever possible, the tenets detailed above for the aesthetic brow should be the goal. That being said, however, the appearance of the row and upper lids can vary greatly between individuals and should be tailored to best suit the patient.

8 Approaches

1962	Gonzales-Ulloa	Coronal incision for forehead/browlift [3]
1978	Ortiz-Monasterio	Combined rhytidectomy and coronal browlift procedures [25]
1994	Vasconez	Endoscopic approach to browlift [26]
1996	Knize	Limited incision technique for browlift [5, 27]

Gonzales-Ulloa first described the coronal approach in an isolated procedure for elevation of the forehead and brows. Ortiz-Monasterio then incorporated this as an element of his rhytidectomy technique in 1974, and many others followed suit. Two variations on this long coronal incision have become commonplace, the standard coronal incision with curvilinear deviations such that the incision is always 6–7 cm posterior to the hairline and a modified anterior hairline incision. This modified anterior hairline incision is located more posterior along the desired vectors of the temporal lift. This incision is the senior author’s preference in those patients with a relatively high hairline or anteriorly thinning hair. However, either approach results in a rather long scar, across the whole of the temporo-occipital scalp.

The next major advance in surgical approaches arrived with the advent of endoscopy in plastic surgery. Knize further refined these approaches with a limited scar technique for brow, temporal, and upper eyelid rejuvenation. These minimally invasive techniques are, in most cases, equally potent in terms of brow elevation versus the coronal approach, with a reduced incidence of scalp paresthesias or alopecia. Though fewer surgeons are relying on the coronal approach, it is still the technique used by most plastic surgeons despite these shortcomings. We present the senior author’s preferred approach to endoscopic brow rejuvenation,

with long-term results, and detail the limited situations in which a short scar is employed. Because of the power of the endoscopic lift, and the well-hidden scars, coronal incisions are very seldom needed.

9 Operative Technique

In the senior author’s clinical cases, the results of this anatomical study of the ligamentous attachment positions are applied to preserve them with both open and endoscopic approaches. After the initial incisions are made 2 cm posterior to the hairline, dissection is performed inferiorly in the supra-periosteal plane toward the supraorbital region. Care is taken to preserve the medial brow retaining structures. Dissection then proceeds from lateral to medial across the superior orbital rim. The lateral retinacular ligament is released lateral to the supraorbital nerve, avoiding any traction on the nerve. Adequate exposure for resection of the medial corrugators and procerus muscles is obtained by dissecting a central tunnel between the two superomedial retaining structures. Preserving these medial retaining structures allows the surgeon to control the position of the lateral brow while helping to prevent over-elevation or lateral spreading of the medial brow in both endoscopic and open procedures. This is one element in preventing the “surprised look” in these patients.

Once the dissection is completed, the process of brow elevation and suspension can begin. Osteal tunnels are created with a small drill, which provide strong cleats through which to pass the suture. In this way, implanted materials such as screws, posts, or anchors which could become palpable are avoided. The suspensory sutures consist of permanent (4-0) nylon sutures in the deep dermal plane. Three passes of the suture are made through the deep dermis, aponeurotic tissues, and galea for each point of fixation. Using a rocking motion, the first tie is placed so that the knot will not slip as subsequent throws are placed. Care must be taken to avoid placing too much tension on these sutures when tying.

10 Closure

The closure of the endoscopic or limited-length incisions within the hair is accomplished with a skin stapler. These incisions are everted properly, and the scars heal well with the advantages of ease of removal and without the need to tie or remove sutures among the hair follicles. Incisions that must be located nearer to the hairline, and in thinner hair by necessity, are closed with running 5-0 nylon sutures and W-plasty for camouflage of the healed scar.

Fig. 3 Preoperative (a–c) and postoperative (d–f) photographs of a patient who underwent endoscopic forehead rejuvenation. Facial and neck rejuvenation was performed with upper lid blepharoplasty. Forehead and glabellar rhytids were addressed. The medial retaining ligamentous attachments were left intact to control the position of the medial brow



11 Peri- and Postoperative Care

Postoperative care of the patient begins on the operating table after the browlift procedure. First, emergence from sedation should be smooth, with good communication between the surgeon and anesthesiologist, and without hypertension, coughing, or gagging. With intraoperative careful attention to hemostasis and postoperative strict adherence to activity instructions, the incidence of hematoma should be rare. As with rhytidectomy, patients should be instructed to sleep with their head elevated and their neck extended slightly. The senior author also instructs his patients to place a wedge beneath the head when sleeping. NSAIDs and anticoagulants should be held for at least a week after brow rejuvenation. Finally, ensuring good communication between the surgeon and patient throughout the process increases cooperation and helps to achieve better outcomes.

12 Avoidance of Complications

Complication rates for brow rejuvenative procedures are similar to those seen after rhytidectomy. Fortunately, in our experience, they have been rare. Though postoperative hematomas do occasionally occur, we are extremely cautious about bleeding and make absolutely certain the field is dry before closure. The complications, though infrequent, should be recognized early and treated. This includes draining hematomas as soon as they are recognized. Seromas have not been encountered, but would also be treated with drainage or aspiration. Infection is treated with intravenous antibiotic coverage for skin flora and drainage if necessary. We use perioperative antibiotics routinely and have not had infections as a problem. Lastly, necrosis of the brow is exceedingly rare, but would be managed with topical antibiotics to prevent superinfection.

13 Results/Cases

Preoperative (Fig. 3a–c) and postoperative (Fig. 3d–f) anterior and right lateral oblique photographs of a patient who underwent endoscopic forehead rejuvenation. Facial and neck rejuvenation was also performed with upper lid blepharoplasty. Forehead and glabellar rhytids were addressed. The medial retaining ligamentous attachments were left intact to control the position of the medial brow.

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