The Modified Upper Lip Lift

Advanced Approach with Deep-Plane Release and Secure Suspension: 823-Patient Series

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KEYWORDS

• Modified upper lip lift • Philtrum • Reduction • Shortening • Augmentation

KEY POINTS

- Deep-plane release of the SMAS tissue in the upper lip permits a tension-free suspension to the ligaments at the nasal base.
- Preoperative incision and vector markings provide a map for proper skin redistribution.
- Suspension suturing of the deep lip tissue allows proper, tension-free, healing in a highly dynamic region.
- Immaculate closure is of utmost importance at the nasal base.
- Techniques crossing the nasal sill should be avoided.

INTRODUCTION

The Evolution of Lip Lifting

The upper lip lift has been performed for over 4 decades.[1] The modified upper lip lift takes established principles used elsewhere in facial surgery and applies them to upper lip rejuvenation to obtain superior results. Traditional lip lift techniques have been criticized and often avoided out of the fear of scarring. To avoid problems that can be encountered at the nasal base, surgeons have become increasingly creative with incision design, trying to maximize results and decrease complications. Unfortunately, few of these techniques have provided esthetically natural and reproducible results.

The bullhorn subnasal lip lift was one of the first acceptable techniques, as described in 1971 by Cardoso and Sperli.[1] Several renditions followed with the goal of reducing incision length, limiting scarring and enhancing the amount of lifting.[2–6] Unfortunately, most of these techniques have a tendency toward nasal base effacement and scarring that is difficult to repair according to the author's clinical experience (**Figs. 1–4**).

Our technique is based on the classic bullhorn incision with modifications that have made a significant improvement in results and consistency. Rather than focus on changes in incision design, the key to our procedure is a deeper and more extensive release of the upper lip and more definitive suspension. The modified upper lip lift is a centrally vectored deep-plane advancement flap focused on releasing tension in the skin and uniformly redistributing the skin once tethering is released. The preoperative radial vector markings designed and depicted by the author are essential to optimizing outcomes. We performed 823 upper lip lifts over the 4-year period from 01/01/2015 until

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Fig. 1. Atrophic scarring with nasal effacement following "Italian Lip Lift."

Fig. 3. Effacement of nasal base with labial skin pulled into the nose with loss of sill volume.

the date of this article 10/31/2018. Review of our results reveals consistent outcomes with few complications when using our technique for the modified upper lip lift.

PATIENT SELECTION

The modifications made to the bullhorn subnasal lip lift technique have allowed a significantly wider application of this procedure. Previously reserved primarily for elderly patients with light skin, this procedure can now be used on patients of a wide variety of ages, skin types, genders, and ethnicities. This procedure can also be used for patients with already adequate tooth show who wish to improve upper lip height, character, and volume. Even the most conservative upper lip lift can change the slope and vector of the vermillion and make the lip more receptive to filler augmentation (**Figs. 5–7**).

The most common presentations and complaints in the author's practice are shown in **Box 1**.

Patients often present with excess lip length and drooping, complaining of looking tired and aged. An elongated upper lip can lengthen the appearance of the entire midface. Lack of tooth show exaggerates the aged appearance and can dramatically diminish sensuality. As the lip lengthens, it also tends to display diminished function while losing character and definition of the Cupid's bow (**Figs. 8–10**).

In recent years, there has been an emergence of patients suffering the negative effects of fillers. Permanent fillers such as silicone, fat, and other polymers such as polymethylmethacrylate (PMMA) may cause perpetual damage to the upper lip because of expansion, thickening, and effacement. They may also dramatically inhibit lip function through muscular infiltration and/or edema. The upper lip lift cannot restore the lip to a normal state, but it can re-elevate the lip to a higher position with improved eversion and improve overall appearance (**Figs. 11** and **12**).

Temporary injectables such as hyaluronic acid (HLA) dermal fillers may have negative short-term outcomes, as well as permanent sequelae. The most notorious of these fillers to have a problem is Juvderm XC. Due to it being hydrophilic from its high HLA concentration (24 mg/mL) and migratory in nature, it accounts for most problems seen with HLA products in my practice. The tissue integration and migration of this product can cause a spreading out of the filler in the subcutaneous

Fig. 2. Atrophic scarring with striations after vertical lifting with extended lateral incisions.

Fig. 4. Atrophic scarring and hypopigmentation following upper lip lift performed with high tension closure.

Fig. 5. Conservative excision on a patient with adequate tooth show improving lip accents.

Fig. 7. Conservative excision improving lip accent and appearance.

tissue of the lip, beyond the vermillion border where it was injected. The author has witnessed the persistence of Juvederm in reactive regions for over 8 years. Given the issues witnessed following injections of Juvederm XC, PMMA, silicone, and other polymers, the author has advised against their use in the lips. Fat injections in the lip may have similar consequences, and fat grafting should not be done without prejudice. These migratory, hydrophilic, and inflammatory fillers are most notably found within the 10-mm segment above the vermillion border months to years following injection (**Figs. 13–16**). They are quite noticeable on most patients, presenting with a bulge, whitish discoloration, simian upper lip convexity, and limitation in smile. Dissolving HLA filler above the vermillion border is easy to do and should be done before pursuing surgical intervention to increase precision and decrease postoperative inflammation.

Another presenting complaint is drooping or lengthening of the upper lip following surgical procedures such as rhinoplasty or orthognathic surgery. Rhinoplasty can have a clear and direct effect on the position of the upper lip. Maneuvers that deproject the nasal tip, such as transfixion incisions or dissection around the nasal base, can cause the lip to lower immediately or shortly after surgery. This can be prevented, reversed, or improved using a variety of resuspension techniques such as the "tongue-in-groove" maneuver, suspension to the nasal spine, or by performing an upper lip lift.

Another common presenting patient issue is asymmetry of the upper lip. Complaints typically include height disparities between Cupid's bow peaks, differences with smiling, and position of the oral commissures. Mild asymmetries at the Cupid's bow and along the adjacent vermillion may be improved in some cases, but more lateral or more significant asymmetries are typically beyond the scope of an upper lip lift (see **Fig. 16**). Most lateral lip asymmetries are a consequence of facial asymmetries, which are not amenable to improvement from a procedure done at the base of the nose.

Fig. 6. Lip eversion following modified upper lip lift providing improved vermillion vectoring and display.

Box 1
Common complaints

1. Chronically long or heavy upper lip
2. Poor tooth show/dental hooding
3. Over-filled lips/poor filler results
4. Filler complications
5. Postsurgical drooping (rhinoplasty/orthognathic)
6. Poorly defined or thin upper lip
7. Asymmetry
8. Buried or drooping corners of the mouth
9. Upper lip incompetence

Fig. 8. Cupid's bow definition and sensuality restored following modified upper lip lift.

SURGICAL TECHNIQUE

Dental and Facial Analysis

The threshold for patient candidacy is significantly lower when using the modified upper lip lift technique. The exceptions are patients in whom a lip lift would create imbalance or an exaggerated appearance. A familiarity with minimum and maximum excision amounts, as well as the necessary minimum height of lip to be left in situ is of great importance. However, the true art of lip lifting

Fig. 9. Youth and tooth show restored following modified upper lip lift.

Fig. 10. Cupid's bow definition tightened following modified upper lip lift.

Fig. 11. Modified upper lip lift combined with nasal base suspension and mucosal excision to improve silicone-caused deformities.

comes from a thorough facial analysis and an ability to “eyeball” what would look good.

Overall facial balance must be considered, comparing soft tissue proportions, as well as dental or skeletal predominance. A primary goal of the lip lift for most patients and practitioners is to increase the incisive tooth show. There is a tipping point that must be respected for each patient, where the sensuality and youthfulness gained from increased tooth show transitions to a toothy or skeletonized appearance with excessive excision. There are no measurements or strict

Fig. 12. Upper lip weighing down from fillers now re-suspended following modified upper lip lift.

Fig. 13. Front view. Top photo demonstrating simian appearance and heaviness from Juvederm. Bottom photo after dissolver and lip lift.

Fig. 14. Corner view. Top photo demonstrating simian appearance and heaviness from Juvederm. Bottom photo after dissolver and lip lift.

guidelines that would indicate this level or point. A 3-mm tooth show on a patient with beautiful teeth and normal projection may be lovely, whereas the same amount of tooth show on a patient with a strong dental overjet (type II malocclusion), malocclusion, a gaunt facial appearance, or unappealing dentition may be excessive. Surprisingly, "gummy smiles" are rarely affected or exaggerated with the modified upper lip lift, likely because this technique has the ability to decrease the exertion or strain on the upper lip with smiling (**Fig. 17**).

Fig. 16. Mild asymmetries improved with an asymmetric lip lift. Normal healing in Asian skin types.

Fig. 15. Lateral view. Top photo demonstrating simian appearance, projection, and heaviness from Juvederm. Bottom photo after dissolver and lip lift.

Fig. 17. A more relaxed smile noted in the bottom photo after modified upper lip lift.

Excessive tooth show, maxillary-mandibular imbalance, or unappealing dentition should not preclude one from performing a lip lift. Either a conservative lip lift may be performed, in the 3- to 5-mm range of excision, or the patient may first be referred to a cosmetic dentist, orthognathic surgeon, or orthodontist.

Relative soft tissue balance is also important. We learn to begin by analyzing the horizontal fifth's and the vertical thirds of the face, but there are many variables affecting what we perceive as a pleasant harmony of the face. The proportions we see on patients with thick skin or a full-round face may be drastically different than that of a patient with a thin or delicate face. Rather than measure the proportions directly, the author recommends looking at the face as a whole and simply envisioning the changes to be made. The overall intent is to make the lip fit appropriately in relation to its surrounding structures, primarily the nose, cheeks, and chin. For example, a wide nasal base with fatty ala and flaring will not tolerate the appearance of a foreshortened upper lip.

Surgical Marking

The excision outline and radial reference markings designed by the author are the most crucial part of this procedure. The markings are based on the classic "bullhorn" lip lift. The excision and closure should be treated as a centrally vectored advancement flap. The markings are made in a step-wise and logical fashion to aid in the decision of the proper amount of upper lip excision and to make the design as symmetric possible.

1. The first step is to mark the upper incision (**Fig. 18**). This mark goes across the entire nasal base in the natural alar-facial and alar-labial crease. The lateral extent of this is where the alar-facial crease tapers and ends caudally toward the alar groove. The incision should not go past the superior or lateral extent of the well-demarcated crease, which may end on the inferior or lateral part of the ala. Extending an incision beyond this point may cause distortion and scarring of the crease or even create a pleat from the cheek to the nose and efface the natural upper lateral extent of the upper lip esthetic unit. The incision continues under the nose, making sure not to invade the nasal sill. In hypotrophic nasal sills, a healthy amount of tissue must deliberately be left in situ. Progressing centrally, the marking will reach a peak either at the superior extent of the philtral column or at the divergence of the medial crural footplate around the nasal spine. It is important to note that the line of the philtral column and this peak do not always align. Moving further centrally, the 2 paramedian peaks then transition into a dip at the junction of the lip to the base of the columella. This crease may be low and buried or high at the base of a rotated columella.
2. Two reference markings are made on each side, extending radially from the internal sill and the external rim. The height of excision is then demarcated (**Fig. 19**). The best starting point on most patients is on a horizontal crease or line that the author deems a "line of declaration." Most patients with an elongated lip have 1 or 2 horizontal creases that form in lines of tension during strained smiling. If this is not present, the next step would be to find an area of transition or inflexion on the upper lip following the base of the columella inferiorly. Most lips

Fig. 18. The first step in marking is to find the natural crease between the nose and lip. The lateral-most extent should be at the transition zone between a well-defined and blunted crease. Medially the peak occurs where the medial crural footplate diverges.

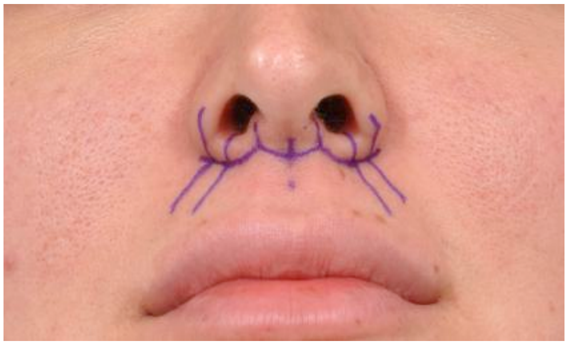

Fig. 19. Radial reference markings are made to aid even distribution and advancement of flaps from the internal sill following the curve of the lip outward as well as from the alar rim margin. The 2 paramedian peaks are marked along with the center of the columella. The ideal height is marked.

look maximally appealing if they begin with a vertical slope, transitioning anteriorly toward the vermillion like a ski ramp (Figs. 20 and 21). Once this point is chosen, the surgeon must determine the ideal location for the best looking lip with an incision that would yield the ideal excision for perfect tooth show. As a security measure, mark the minimum amount of remaining lip. For most patients, this would be around 11 mm as measured from the Cupid's bow peak superiorly while the lip is on stretch. Leaving less than 10 mm of residual upper lip height is not recommended.

The amount of expected tooth show gained from each excisional height is demonstrated in Table 1. These measurements should only serve as guidelines. The amount to be excised typically ranges between 4 and 11 mm, with most standard excisions ranging between 5 and 7 mm. Excisions aiming for notable tooth show are typically between 7 and 9 mm. An excision of over 11 mm is not advised, because this dramatically increases healing time and makes redistribution of skin difficult for the average patient. There are many variables that determine the actual changes in height including skin thickness, skin laxity, muscle function, and nasal base laxity. The lift obtained on patients with thinner upper lips tends to be more exaggerated than on those patients with thick or hyperelastic lips (see Table 1).

Fig. 20. The upper lip looks most pleasant with an immediate transition from vertical to sloped.

Once the excision height is marked, a caliper is used to measure the distance with the lip on stretch. The lower incision marking is then made using a caliper uniformly and in parallel to the upper incision, until the first of the lateral radial markings is encountered (Fig. 22). At this point, the dots are connected between the internal rim reference marking and the peak of the lateral upper incision. If there is a minor Cupid's bow asymmetry, this can be corrected at this stage, with an asymmetric excision. Lateral asymmetries cannot be corrected with a surgery centered at the base of the nose.

Once all the dots are connected, the remaining reference markings are drawn, totaling 9 lines. A vertical marking is placed on each incision peak and 1 in the center. Intermediate markings are then made between the peak marking and the internal rim marking (Fig. 23). These points serve as closure points for the deep suspension sutures as well as even centralized redistribution markings for the advancement of the lower flap.

Excision

The procedure is performed using local anesthesia and with the surgeon at the head of the bed. The lower incision is made first, with a 15 blade scalpel perpendicular to skin, extending to the junction of the fat and the muscle. The upper incision is then made parallel to the lower incision (Fig. 24). The skin and subcutaneous flap is then excised in a plane over the orbicularis, leaving a thin glossy layer of fat intact. This glossy layer is where most of the vasculature lays deep to the superficial muscular aponeurotic system (SMAS). The larger-caliber vessels in the field are the inferior alar arteries, which are buried under the ala and alar sill, running parallel to them (Fig. 25).

Dissection

Once the excision is performed, the labial flap is then elevated in a deep sub-SMAS plane. This

Fig. 21. The upper lip convexity in the before photo causes an aged, simian appearance.

dissection releases the labial SMAS from the underlying orbicularis oris. The extent of this dissection is at the discretion of the surgeon, as more extensive dissection may mitigate tension but also causes a dramatic increase in postoperative swelling. Taller excisions typically require a greater degree of release, as do patients who require release and rolling of the lateral vermillion to avoid a subsequent corner lift. The average patient will require release in the deep plane half-way down the central philtrum. Full central dissection is avoided because of possible effacement of the Cupid's bow (**Figs. 26** and **27**). Laterally, the dissection is carried as far out as necessary to obtain a palpable release of the labial flap that would allow a minimal tension closure. For most patients the dissection approaches or extends to the vermillion anywhere lateral to the philtral columns and stops just before the nasolabial fold. Care must be taken to stay in a directly sub-SMAS plane to avoid excessive bleeding or damage to any of the labial elevator complex. Careful hemostasis must be achieved, preferably with a bipolar cautery (**Fig. 28**). Although a hematoma is not typically a risk in classic lip lifts, it is a consideration with a modified upper lip lift given the extensive dissection and dead space created.

Table 1
Estimated lift based on excision height—variable

Excision (mm)	3	4	5	6	7	8	9	10	11
Tooth show (mm)	0	0–1	1–2	2–3	2–4	3–5	4–6	5–7	6–8

Suspension and Closure

The mistake made by most practitioners is performing a simple dermal closure. As we have learned from endoscopic brow lifting and advanced forms of face lifting, the best lift is achieved by performing adequate release of tethering and then by suspension of dense tissue upward to a fixed location. When this is performed in the upper lip, the released skin/SMAS flap is then able to roll over and redistribute tension above the contracted orbicularis.

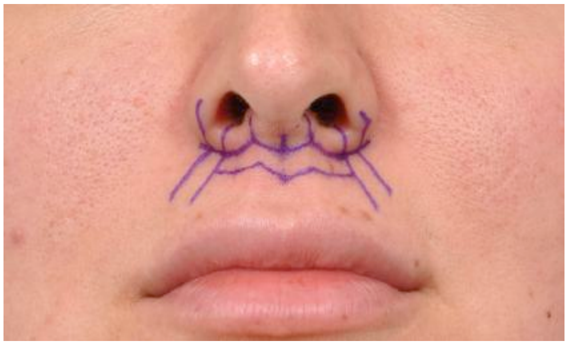

Fig. 22. Castro-Viejo angles caliper is used to mark the height of excision with the lip on stretch. Equal heights are marked between the internal sill reference markings.

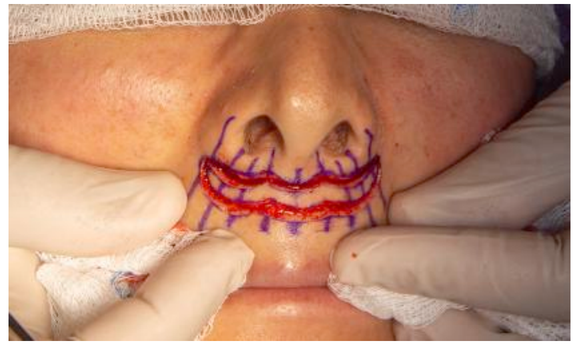

Fig. 24. Perpendicular incisions are made through the skin, fat, and SMAS to the level of the orbicularis layer. Upper and lower incisions are made in parallel to aide in proper approximation.

The dermis at the base of the nose is not firmly attached. The periosteum or overlying pyriform ligament are the only firm structures that can provide a strong base for suspension. Suturing to the periostium produces an over exaggerated tacking of the labial flap. The pyriform ligament is a dense network of fibrous tissue overlying the periosteum that spans the pyriform aperture and is perfect for engagement of suspensory sutures.[7]

A 5-0 PDS suture on a P-3 needle is used at each of the central 7 reference markings. The needle is passed into the junction of the nasal and oral musculature and then carried deep to grab the pyriform ligament but not the periosteum. The needle exits deep to the alar dermis with care not to incorporate the dermis (**Fig. 29**). The needle is then passed inferiorly through the SMAS on the underside of the labial flap (**Fig. 30**). The SMAS of the upper lip is a discrete tissue layer with substantial strength that is located just deep to the reticular dermis.[8,9]

Suturing to the SMAS instead of the dermis allows the skin to approximate without tension or dimpling. This provides a major advantage by pushing the dermal edges together. The incision is closed sequentially from central to lateral (**Fig. 31**). Once the knots are tied, the skin edges should be closely approximated. At the lateral-most reference marking, a 4-0 Vicryl on a PS-2 needle is passed from inside the pyriform coming out radially to grab the SMAS, and then returned back into the nose to complete a mattress suture (**Fig. 32**). The inferior alar artery should be identified and avoided, if possible. The skin is then reapproximated with a plethora of vertical mattress and interrupted 6-0 nylon sutures, with the end point being resolution of any step-offs from the lower to upper skin flaps (**Figs. 33** and **34**). This area is unforgiving and meticulous suturing technique is required.

POSTOPERATIVE COURSE

Postoperative Care

The incisions must be kept moist with ointment at all times in the first several weeks. Patients are given a surgical mask to so they do not feel self-

Fig. 23. The remainder of the inferior marking is made by tapering from the internal sill markings upward. The corresponding reference markings are made, as well as 2 intermediate reference markings to total 9 markings.

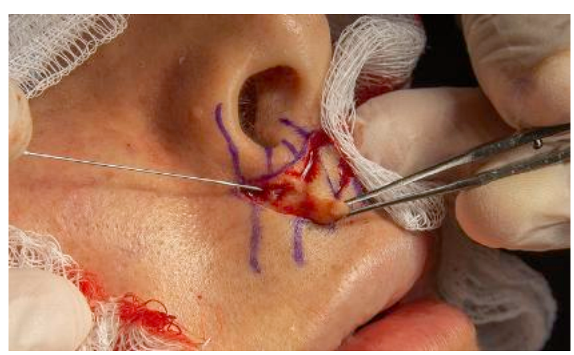

Fig. 25. The marked skin, fat, and SMAS are excised leaving a thin, glossy fat layer intact to avoid damage of vessels and the inferior alar artery marked in the photo.

Fig. 26. Deep-plane/sub-SMAS elevation is performed directly over the muscle layer.

Fig. 28. Hemostasis is obtained using bipolar electrocautery to minimize risk of hematoma.

conscious. Sutures are typically removed partially at day 3 and completely at day 5 (**Fig. 35**). Taping is neither affective nor necessary. Patients are forewarned that swelling may appear extreme and that the appearance of the lip typically takes 3 months to return to normal. Relative to others, this technique produces significantly more swelling in this area because of the disruption of bilateral lymphatic drainage pathways as well as muscle trauma causing a postoperative myositis. The stiffness and swelling in the first 3 months may benefit incisional healing by limiting movement at the incision line. Patients are seen at 3-week intervals for reassurance and potential injection of 5-fluorouracil 50mg/cc into a firm orbicularis patch. The nasal base is also quite responsive to fractionated CO_2 laser, should that be required. Most patients receive this routinely at 60 and 120 days at a low setting.

Potential Sequelae

The most commonly encountered sequelae of an upper lip lift are scarring and widening of the nasal base. For this reason, most practitioners who perform the lip lift procedure do so on elderly patients with light skin. Issues can arise with any technique. However, when using the bullhorn incision, even if unsightly scarring occurs, it can most often be easily and significantly improved with scar modulation therapies. Off-label use of 5-fluorouracil 50mg/cc can help flatten hypertrophic incisions. CO_2 laser can improve hypertrophic, atrophic, and other types of scarring.

Alternative techniques that involve more complex types of incisions, such as the philtral stretching variations of the upper lip lift, L-shaped philtrum lift, extended incision lip lift, Greenwald incision, double duck suspension, and the Italian technique, may result in greater amounts of scarring and changes to the nasal base that are difficult to reverse. Atrophic scarring is quite common, as well as skeletonization or effacement of the nasal base. Incisions extending into the nasal sill inherently cut away healthy mass and volume at the nasal base while advancing the skin of the lip inside the nose where it does not naturally reside.

Distortion or effacement of the nasal base can occur with untoward tension on compliant portions of the nasal base. When tension is combined with excision of portions of nasal sill, the distortion can become more prominent. If the central lip is lifted or excised more than the lateral portions,

Fig. 27. Sub-SMAS dissection is continued half-way down the central philtrum. Lateral dissection is typically carried to the same level or greater.

Fig. 29. 5-0 PDS suture enters between the nasal and labial muscle layers, passes deep grabbing the pyriform ligament, and exits just deep to the dermis.

Fig. 30. The 5-0 PDS is passed deep to the dermis to grab the SMAS layer only.

this can also produce an unnatural and disproportionate postoperative appearance to the lip that further exaggerates a suboptimal outcome. Central lip lifts are rarely indicated and most commonly produce an exaggerated upturn of the central lip. This often results in relative worsening of the appearance of lateral lip hooding. It is important to remember that there are limits to what a procedure at the nasal base can achieve. The intent to change the character of the lip significantly should be avoided.

Avoiding Sequelae

The first way to assure a superior result is proper incision design, following the principles of the bullhorn lip lift. This means avoiding cutting into and damaging the nasal sill by carrying incisions inside the nose. Most techniques that involve hidden incisions inherently require that healthy sill skin is excised and replaced with skin from the lip. Labial skin does not naturally occur within the nasal sill and it should not be placed there during a strictly cosmetic procedure. Once the sill is removed and scarring occurs, the sill cannot be replaced and the atrophic skin that replaces it is quite difficult to repair.

Fig. 32. The 7 central reference markings are closed with the deep layer of 5-0 PDS sutures. The 2 most lateral markings are closed using a 4-0 Vicryl entering from the inside of the nose, passing externally between the orbicularis muscle and nasal ala to grab the SMAS layer then exit through the nose by passing through the nasolabial junction.

Problematic healing also seems to arise from inadequate incision length and insufficient deep tissue release. Making smaller incisions, whether single in the center or bilateral incisions under the nasal sills, tend to increase complications as well. Smaller incisions may limit the proper release of tension and redistribution of skin, while also presenting the potential for disproportionate lifting. This means that, although incisions are limited, there may be higher tension placed on each incision point, resulting in poor healing. Uniform redistribution avoids irregularities and skin bunching by spreading the tension evenly along the length of the entire incision. The perioral region is extremely dynamic, and all possible efforts to relieve tension at the incision should be performed. Proper release of the deep structures to reduce closure tension, coupled with adequate deep suturing, followed by intricate superficial suturing, will enhance results. The practitioner should be aware that the nasal base is an unforgiving area with regard to

Fig. 31. A 5-0 PDS is tightened with a single knot, followed by a slip knot, then a locking knot.

Fig. 33. Superficial closure is performed with a combination of 6-0 nylon vertical mattress and interrupted sutures.

Fig. 34. Closure using enough sutures to avoid any step-offs or irregularities.

irregularities and scarring. Although it may not seem so, longer incisions tend to heal better than shorter ones.

Some lip lifting techniques rely on muscle suspension, excision, or plication to relieve tension on the skin.[6,10] This ideology may theoretically be supported by muscle-tightening procedures performed during facelift surgery; however, mimetic muscles are not routinely suspended during rhytidectomy. Rather, the SMAS-platysma complex is tightened, which carries no mimetic function. A dense SMAS fascia definitively exists in the upper lip just deep to the dermis and superficial to the orbicularis oris muscle. The SMAS-skin flap may be released and used for lifting similar to deep-plane lifting in the face. The orbicularis oris is a mimetic muscle that is extremely dynamic and sensitive to trauma. From the author's experience, muscle binding has a higher probability of causing fibrosis at the plicated region and may actually have a tendency to pull the nasal base in a downward direction. Still, muscle plication or imbrication may serve a purpose in some patients during various lip lifting procedures including the modified upper lip lift. When binding is performed during this procedure, it is typically limited to the uppermost 2 mm of the orbicularis muscle. The upper orbicularis is taken and suspended to the pyriform ligament using 5-0 PDS sutures to limit potential damage to the muscle and nasal base. Experienced practitioners may use muscle-binding techniques routinely with high success rates, but amount of muscle trauma in the hands of the novice surgeon should be limited.

Fig. 35. Sutures are typically removed at days 3 and 5. This photos was taken 5 days postoperatively.

Direct vermillion excisions tend to cause a blurring of the vermillion and a visible scar with a potentially unnatural appearance that almost always requires lip liner camouflage. Once the vermillion is distorted, it cannot be recreated. In the author's opinion, the only indication for an incision at the vermillion border is the rare patient who requires a corner of the mouth lift.[11] Corner lift incisions are limited and seldom cause issues; however, we perform them rarely because the modified upper lip lift has the ability to treat this region on most patients.

Complications

A chart review of 823 consecutive lip lifts from January 2015 to October 2018 in the author's private practice was performed. Histories were reviewed for any complications seen past the 3-month mark. Of note, there were no patients demonstrating any limitation in movement or smile. Five patients required revision to obtain further lifting or further lifting and symmetry. Two patients developed dermal atrophy and telangiectasias following injection with triamcinolone. Because of this, the author no longer injects triamcinolone postoperatively in these patients. Two patients complained of vague changes in character of the nostrils, which were difficult to depict in photos. Two patients experienced minor hematomas, which were limited by tamponade. Two patients had prolonged edema extending to the 4-month mark, which then resolved. Both of these patients had previous silicone injections and an 11-mm excision. Ten patients developed a rash from antibiotic ointment. Two patients presented with a 1-mm rim of eschar/epidermolysis of unknown cause around the lateral nostril base that healed without incidence. Although many patients received scar modulation with injections of 5-fluorouracil 50mg/cc and/or CO_2 laser treatments on the incisions, none were bothered by their incisions. There were no patients found to have increasing asymmetry. There were no incidents of infection.

Forty-five patients had a simultaneous lip lift with rhinoplasty with no adverse sequelae. Alarplasty was performed at a separate time on all but 2 patients to avoid lateral scarring. Sixty-two patients had simultaneous lip lift with rhytidectomy with no adverse sequelae. Sixty-eight patients had simultaneous mucosal lip reductions mostly to reduce polymer-related abnormalities. Fifteen received simultaneous dermis or SMAS grafts to augment lip volume and there were no adverse effects. One patient requested a subsequent corner lift. The remainder of the patients seeking corner lifting before surgery received an adequate degree from the modified upper lip lift.

SUMMARY

A variety of lip lift techniques have been created over time with the intent of diminishing scarring and poor outcomes. A great deal of energy has been misdirected toward compensatory measures such as changes in incision design rather than simply improving the manner in which the lip is lifted. The modified upper lip lift is a sub-SMAS release and suspension technique that simplifies procedural steps and minimizes risks of adverse outcomes. Furthermore, it permits a wider application of an often-needed technique to all ages, ethnicities, genders, and skin types. We have learned a great deal from other facial cosmetic surgeries, such as brow lifts, upper blepharoplasty, and deep-plane rhytidectomy. As guided by the evolution of upper blepharoplasty, muscle preservation is essential for maintaining proper function and volume. Face-lifting techniques have demonstrated a much greater efficacy when tension is adequately released then resuspended to a firm or fixed structure, such as is seen with deep-plane facelifts.

The upper lip lift has the ability to produce a high yield change on the face with a single, small procedure. It can produce a younger and more sensual appearance by shortening the perceived height of the midface, as well as by increasing tooth show and oral visibility. The nasolabial fold in most patients appears softer and shortened as well. This easily reproducible technique has repeatedly demonstrated consistent outcomes with an exceedingly low complication rate. The need for such a procedure is under-recognized in patients of all ages. The modified upper lip lift is a safe, consistent, reproducible, and widely applicable technique for any gender, ethnicity, and skin type.

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CUPID Lip Lift: Advanced Lip Design Using the Deep Plane Upper Lip Lift and Simplified Corner Lift

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Facial Surgery

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Abstract

Background: Upper lip lift is achieved with a variety of techniques but many questions remain about the benefits and drawbacks of each technique. The CUPID deep plane or modified upper lip lift procedure has recently been introduced to help mitigate risk and optimize outcomes.

Objectives: The aims of this study were: (1) to better characterize and simplify the complex and artistic decision-making process involved in upper lip lift and corner lip lift; (2) to present a mathematical guide to maintain the natural balance of the upper lip, optimizing muscle function, and to indicate when to add a corner lift; and (3) to elucidate design elements, aging, and future treatment considerations.

Methods: A PubMed (United States National Library of Medicine, Bethesda, MD) search was performed in October 2021 for all journal articles published on upper lip lift and corner lip lifts. The search covered from 1950 to the present day in all languages and without exclusion criteria. Outcomes and the evolution of deep plane upper lip lift design over the last 6 years were analyzed.

Results: By following the patterns demonstrated in over 2440 consecutive lip lifts, the authors have been better able to understand the nuances involved in proper design that will avoid acceleration of aging and exaggeration of appearance, and reduce the need for revision while maximizing results.

Conclusions: Upper lip lift design is more complex than most practitioners realize. The mathematical concept described herein makes it possible to obtain more aesthetically pleasing and consistent outcomes. This novel approach to lip lift design enables the practitioner to improve lip balance, facial harmony, and tooth show, and obtain adequate exposure of the lateral vermillion.

Level of Evidence: 4

4
Therapeutic

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Deep plane upper lip lift performed according to the CUPID lip lift design described in this paper is a powerful procedure that has significant aesthetic impact. This simple surgery has the ability to restore youth, sensuality, and balance to the entire face with natural and reproducible results, regardless of the patient's gender, color, skin type, or age.[1] Upper lip lifting has been described in the literature for 4 decades;[2] however, the majority of techniques have a high rate of dissatisfaction. For this reason, the upper lip lift procedure has classically been reserved for older, lighter, thin-skinned patients with significant skin wrinkles. Coincident with the development of the deep plane technique, the popularity and demand for lip lifting as a whole has increased substantially over the past 6 years for both young and older patients.

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Along with the rise in surgical numbers, we have also noticed an increase in complications and revision surgery for procedures performed elsewhere. Although a substantial percentage of secondary cases are performed to fix issues with scarring, a large subset is to treat asymmetry, lip imbalance, poor function, and an unnatural or exaggerated appearance. Detailed descriptions of anatomy and function with relation to aging and dentition are lacking. There is also a lack of consistency in nomenclature, adding to confusion about this procedure. This article seeks to elucidate and quantify the artistic nature of surgical lip design to help produce more consistent elegant, balanced, and natural results, while decreasing the likelihood of patients requiring revision. Moreover, a more natural and anatomically correct result generally will function more appropriately and age better. All too often, patients have been mismanaged or dismissed due to an inability to appropriately address an elongated upper lip, dental hooding, and loss or lack of an elegant Cupid's bow. Like blepharoptosis, upper labial ptosis may have substantial functional and aesthetic implications on the face that affect a patient's appearance and function.

METHODS

A retrospective review of 2440 consecutive lip lift patients in the primary author's (B.T.) practice was performed from November 2014 through September 2021. Follow up on patients was performed for a minimum of 3 months. No exclusion criteria were used. Secondary surgeries, those performed initially by other surgeons, constituted 220 of these cases (11%). Prior to 2019, the primary author infrequently performed corner lip lifts as described in a prior publication.[1] Since that publication and with initiation of the CUPID lip design, unilateral or bilateral corner lip lifts have been incorporated in roughly 90% of cases. We believe this has resulted in substantially improved outcomes. All research was retrospective and no experimental studies were performed on patients, in accordance with the Declaration of Helsinki.

Reviewing failures in the primary author's patients along with the results of other surgeons aided in the evolution of this technique and the development a more systematic approach and design for the upper lip. Although this article delineates some ideal aesthetics, it is important to keep in mind that our patients' lips are not all meant to look alike. We should simply strive to improve upon their already existing attributes.

The most desirable appearance seemed to come from a combination of attributes:

1. Proportionate lip height to width and the surrounding structures and entire face
2. Adequate incisor display
3. Easy and proper mouth closure
4. A gentle slope along the vermillion border from medial to lateral
5. Adequate exposure of the red vermillion along its entire length along with sufficient volume
6. Alleviation of angular depression or buried vermillion at the corner of the mouth
7. A smooth, continuous internal arc of the lip along the wet-dry border.
8. Symmetry at the Cupid's bow peaks (lateral symmetry is neither possible nor helpful in many cases)
9. Appropriate anterior projection on lateral view
10. Appropriate vertical slope on lateral view.

Patient Selection

A deep plane upper lip lift performed according to the CUPID lift design is a very precise procedure that can be performed in a predictable and consistent manner to shorten the height of the philtrum with or without altering tooth show to any significant extent. Pre-existing adequate upper incisor display is not a contraindication, although excessive display, perioral strain, or vertical maxillary excess certainly are. Many of the patients seeking this procedure simply have an elongated appearance to the midface or perioral region. Lack of central incisor show may cause patients to look older and/or lose sensuality. Shortening lip height may improve the balance of the entire face for appropriate candidates and improve appearance and sensuality.[3-6] The surgeon must recognize the necessary balance between the bony skeleton and soft tissue envelope. There are functional and aesthetic ratios that must be respected.[3] Excessive shortening of the upper lip may cause strain in the facial musculature and give a predominantly skeletal appearance. The goal is to create a softer appearance with better facial harmony. Exposure of unsightly teeth could also detract from the patient's physiognomy.

Elongated upper lips tend to have poorer function with increased flaccidity at rest as well as increased strain with smiling. It is at the discretion of the practitioner to decide whether the lack of tooth show should be treated with orthognathic, dental, or lip lifting procedures.[7] Similar to orbicularis oris function, the orbicularis oculi and surrounding musculature require adequate support from the eye. Enophthalmos and exophthalmos have profound effects on eyelid closure and position. A lip or any portion of the lip that is not supported appropriately by teeth cannot function well given the anatomy and dynamic of the orbicularis oris and perioral musculature. This is quite evident when dentures are removed from a patient's mouth and the lip becomes flaccid with poor movement and impaired phonation. Conversely, excess prominence of dentition may cause labial incompetence and poor mouth closure in repose. Be aware that patients with excessive alveolar-dental prominence tend to age more rapidly around the mouth. Gummy smiles are more common in these patients although many factors must be considered with regard to diagnosis and treatment.[8] The deep plane upper lip lift commonly decreases the gummy smile by mitigating strain with smiling. Upon examination, a lower lip raising reflex may be noted in some patients when the upper lip is raised manually on examination. Over time, the mentalis and labial depressors begin to hyperfunction in order to push the lower lip up towards the upper lip to achieve closure. With age, this may result in "peau du orange" or pebbling of the chin and a depression or downturn along the oral commissure correlating with depressor anguli oris hypercontracture.

This problem has become rampant as some less-experienced dental practitioners have become increasingly aggressive in treating patients by applying oversized veneers. To achieve appropriate incisor display, dentists might overlook soft tissue ptosis of the lip and add veneers to lengthen and project the upper teeth.[9] This may drag and lengthen the appearance of the midface, ultimately having a prominent effect on phonation and may even lead to xerostomia. It is of utmost importance for surgeons, dentists, and orthognathic surgeons to collaborate to avoid these issues. Generally, if the patient requires dental projection or lengthening, the lip lift is performed first and is succeeded by maxillary or dental work 3 or more months later. Conversely, if de-projection or shortening are required, it may be easier to have the dental, orthodontic, or orthognathic procedures performed first, and the lip lift performed after the soft tissues have settled into their new position.

Pre-existing exaggerations in appearance may easily become more pronounced during a lip lift. Patients with upturned noses have historically been denied this procedure, although this is not a contraindication. When performed properly, the incision will be barely visible, making patients of all nose types appropriate candidates. The central lip tends to lift to a greater extent than the lateral lip. In patients with an exaggerated upturn to the central lip or a short mouth, the practitioner must either take this into account during incision design or avoid operating on these patients all together. Asian patients in particular tend to exaggerate centrally very easily. Some Asian patients demonstrate a naturally steep vermillion slope, whereas others may have a narrow nasal base with poor lateral lip support. Caution must also be taken in patients demonstrating an exaggerated downturn at the lateral mouth and commissure. A lip lift can exacerbate the appearance of a down-pointing mouth. To improve the results of a lip lift, certain patients may be treated with a concomitant corner lip lift, neurotoxin injections into the depressors, volumization of the triangle inferior to the commissure, or even a facelift. Subnasal upper lip lift should be avoided in patients with severe angular depression of the mouth, although corner lifting may be performed.

Surgeons generally question the safety of performing an upper lip lift at the same time as a rhinoplasty. In most cases this is safe, and we advise making a classic subnasal lip lift incision that is distinct and performed simultaneously with the classic midcolumellar rhinoplasty incision.[10] Blood supply to all areas should be adequate unless multiple revisions have been performed or if nasal base suspension sutures are placed that may constrict the blood supply. Only minor sill-excision alarplasty may be performed at the same time. If more substantial alarplasty or nasal base narrowing is required, we recommend performing the procedures at least 3 months apart to avoid effacement of the nasolabial creases or scarring. We mostly prefer to perform the procedures separately to gain greater predictability in the final alar sill position and shape.

The Effect of Lip Filler

The presence of temporary or permanent fillers must be considered and properly planned for. An increasingly common reason why patients seek a lip lift is that lip fillers have weighed down and expanded the lip. Fillers may also cause impairment in muscle function and flexion of the orbicularis oris muscle. This is most commonly seen when a hyaluronic acid (HA) filler is injected directly along the vermillion border. The filler immediately spreads and crosses the vermillion because the lamina propria is a direct extension of the philtral superficial musculoaponeurotic system (SMAS). The rheology and potential for each filler to migrate differs. The cross-linking and characteristics of each filler may also change over several years in soft tissues. The most aggressive form of migration amongst HA fillers likely occurs with Juvéderm Ultra or Ultra Plus (Allergan; Irvine, CA). This particular product can carry a greater volume of water, may change the color of the philtrum or vermillion, and has a greater migratory potential than other HA products. Moving out of an overpressure closed system in the dry vermillion, the HA migrates with muscular contracture and lymphatic drainage patterns. The fillers tend to migrate in a cephalic direction above the vermillion border in the plane of the SMAS. Juvéderm may travel up to 10 mm and last over 10 years, whereas other HA fillers may move caudally 1 to 2 mm according to our observations. Top-down injection techniques and direct injection of the vermillion and wet-dry border are avoided in most patients. Filler migration may be identified on examination as there is typically a bulge of swelling in the philtrum directly above the vermillion, which is white or crystalline in nature. Vascular blush, blotchiness, and hyperemia may also be present along the vermillion border, which can also blunt lip definition.

Misplaced filler can be dissolved with hyaluronidase. If migrated filler is not identified above the vermillion or in the philtrum prior to dissolving, incomplete dissolution will result. Dissolving filler can restore function to the upper lip by the next day and obviate the need for a lip lift in some patients. It also decreases postoperative edema that would have been caused by the presence of hydrophilic fillers. Dissolving is typically performed at least 2 weeks before the lip lift procedure to allow rehydration of the SMAS. Once dissolved, some filler may have to be replaced to plump a collapsed SMAS layer.

Dissolving the filler may also change the soft tissue character internally, making dissection more difficult as the usually easy dissection plane becomes more adherent and the thin SMAS becomes more difficult to suture to. Dissolving may variably give the upper lip a darkened appearance in the skin of the philtrum—the opposite of the white glare produced with inappropriate fillers. It may also exaggerate indentations in the lip at the end of the lip lift procedure and minor aliquots of HA filler may need to be replenished at this point. If deflation from dissolver occurs in the red vermillion, it may assume a burned, dry, or scaly appearance until rehydration occurs naturally or with further HA filler placement.

The SMAS of the upper lip is the main support mechanism for the youthful appearance of the skin apart from the volume contributed by the orbicularis oris muscle itself. The SMAS layer tends to thin with age, worsening the appearance of rhytids in the upper lip. This may be exaggerated substantially following the dissolution of HA fillers. Human leukocyte antigen dissolvers might damage the naturally occurring human leukocyte antigens in the SMAS and this layer may lose its fluid-retaining capacity temporarily or permanently. The adverse effects from dissolver are more notable in SMAS or tissues that have already been damaged by overexpansion from fillers. The microcystic expansion effect of fillers may have unpredictable consequences in the SMAS and soft tissues. The sulci laborum, or vertical wrinkles, in the red dry vermillion typically return following dissolution of fillers. We must remind patients that this is natural, desirable, and as important as having fingerprints. Occasionally rehydration is required, which can be addressed with a gentle refilling of the lip. Dissolution with hyaluronidase should be avoided in patients with silicone hypertrophy or fat grafting. This will shrink and damage the healthy SMAS layer, while leaving the scar, fat, or granulation bed intact. Injection of fat into the upper lip has a high probability of vertical migration within or deep to the SMAS near the vermillion border. This may be addressed during a deep plane lip lift surgery. Postoperatively, fillers may have to be replaced to return to a normally appearing and functioning lip, although irregularities from dissolvers may persist for several years in some patients.

Anatomy and Nomenclature

In this section we will introduce a novel marking system, CUPID, to aid in the design needed for lip lift surgery. Using a proper deep plane release, each radial marking line individually gains the ability to control the lip shape in the way that a puppeteer controls a marionette to raise an elbow while dropping a hand. This allows the surgeon to enhance the shape and slope of the vermillion, while avoiding exaggeration during lip lifting. Changing the shape, slope, or curve of the vermillion border can change the character of the patient's appearance substantially. The classic subnasal lip lift inherently lifts the portions of the lip directly under the nose to a substantially greater degree than the lip segments lateral to this. The CUPID deep plane lip lift design uses a rotational advancement of lip skin towards the nose that is hinged around the apex of the incision at the lateral ala. Examining the radial markings used to aid the advancement reveals that the medial markings will experience more of an effective vertical lift than the lateral radial markings, which have a more diagonal vector. The vector of aging in the upper lip appears to follow the same course as the relaxed skin tension lines (RSTLs), drooping around the upper alveolus. Aging is more exaggerated laterally in the subfacial lip with a greater degree of resistance to ptosis in the midline under the subnasal lip. The appropriate vector of lifting should be performed in the opposite direction to these aging changes to obtain a balanced result without redundancies and imbalance. The nasal base and lip may both possess asymmetries, so symmetry can be improved by varying the excision design from side to side. Excessive alterations in design and symmetry may adversely affect the orbicularis muscle function, although the limits are difficult to determine.

For appropriate and thorough lip design, we require 7 radial markings correlating to 3 different points from nose to lip (Figure 1). Level 1 is the upper limb of the incision; Level 2 is the lower limb of the incision, and Level 3 travels along the vermillion border at correlating points. Guiding lines progress from vertical at the midline point of the Cupid's bow trough, with gradual radial rotation laterally towards the angle of the nasolabial fold, following the lip's natural relaxed tension lines and pores. The RSTLs in the perioral region are organized in an increasingly curved manner as they extend laterally and inferiorly to the mandible. Figure 2A,B demonstrates what we refer to as the "RSTL globe."

The initial marking line in the middle of the columella and philtral dimple is designated by the letter "C" for "central" (Figure 3). The paramedian lines are marked at the peak of the subnasal incision just lateral to the columella at the point where the medial crural footplates diverge into the nose at the junction with the alar sill. The designation for this point is the letter "P" representing the peak of the

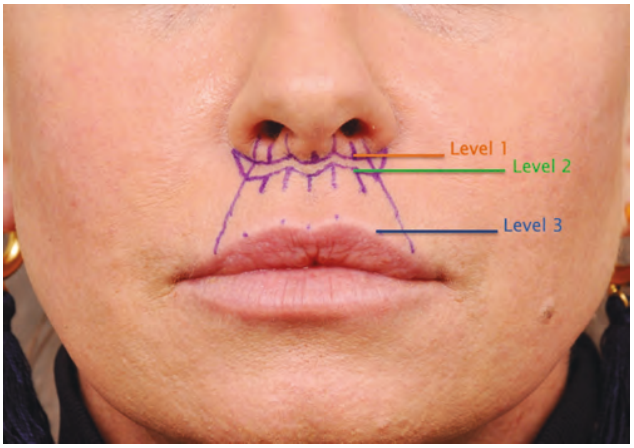

Figure 1. Three horizontal levels drawn on a 38-year-old female to determine the excision height and residual or final height of the lip. The relaxed skin tension lines guide the vector of lifting and the final shape of the lip.

incision and the peak of the Cupid's bow. "P" also refers to the paramedian line and philtral line. Inferiorly, the philtral column terminates exactly at the peak of the Cupid's bow. Superiorly, the philtral column does not always terminate at the peak of the upper limb incision. It is important to note that certain variations of the "bull's horn" technique place the peak inside the middle of the alar sill. This causes an inherent deformity at the nasal base and we advise strongly against placement of the incision inside the nose. Invasion of the nasal subunit with labial skin may cause rhinorrhea, a skeletonized appearance, or more exaggerated ptosis of the nasal base postoperatively. The alar sill and nasal base should be kept as an intact anatomic subunit and never crossed or violated. Laterally, a line is drawn from the internal angle of the alar recurvature, extending radially down the natural curvature of the lip. This diagonal line is designated by the letter "D" and can be placed by following the natural tension lines and radial angulation of the pores of the upper lip.

This diagonal line determines the lateral extent of the lift effect on the upper lip caused by a subnasal upper lip lift. The "D" line also marks the border between the subnasal lip as it transitions to the subfacial lip (Figure 4A,B). The differentiation between the subnasal and subfacial lip is a novel concept being introduced in this article and will be of utmost importance to surgeons and injectors when learning about aging of the lip and the effect of surgery and injectables on various parts of the upper lip. The majority of patients will experience a greater degree of aging in the subfacial lip and lateral mouth, which is hanging from the anterior cheek and face, relative to the central subnasal lip, which is more densely attached to the pyriform and supported by the front teeth. The subnasal lip lift inherently has more of an effect on the subnasal lip between the bilateral "D" lines. The white or gray roll of the vermillion border is also prominent medial to the "D" line along the subnasal lip and peters off past the "D" line where a corner lift can be performed without scarring or effacement of the vermillion roll. Fillers also have a greater lifting or eversion effect in the vermillion of the subnasal lip relative to the subfacial lip, which is very difficult to evert or lift with fillers. Of note, there is often a muscular indentation present lateral to the junction of the subnasal and subfacial and the "D" line. This represents the transition from orbicularis towards the connections of the buccinator and upper lip levator muscles.

Between the "P" mark and the "D" mark another line is drawn, called the intermediate line or "I" marking. Note that the markings from central to lateral spell out "CPID," giving our nomenclature for the CUPID lift (Figure 3). Lateral to the diagonal line, an outer horizontal marking "O" may be placed as a reminder to place the lateral internal mattress sutures, which will be explained later and have been described previously.[1] This line also helps determine the height of the corner lift. Each side of the lip carries a left or right designation noted by the letters "L" or "R." The excised height will be referred to as the "excision height," whereas the remaining height of the philtrum following excision and closure will be referred to as the "final height."

When performing the CUPID deep plane lip lift technique, these markings can be used to customize lip design and improve the character and accent of lips rather than just lifting them in a uniform, cookie-cutter fashion. This allows for a more balanced lift, improvement in character, and avoidance of overlifted or overexaggerated lips, which will yield a more attractive result and will also age better. This also allows the surgeon to obtain more symmetry not only in height but in shape and character of each side as well.

There are 2 slopes to consider when analyzing the lip. The first is the slope of the philtrum seen in lateral or profile view (Supplemental Figure 1A). This has been detailed in our previous article, demonstrating the descent of the lip from the nose on the lateral view, where various curvatures may be noted. The second is the slope of the vermillion border from the anterior view (Supplemental Figure 1B). Analysis of the slope and shape of the vermillion border are novel and important concepts being introduced in this article. The slope of the vermillion can be observed as the natural vertical descent of the lip from the Cupid's peak following laterally towards the oral commissure on frontal view. When designing a lip, great care must be taken to avoid any exaggeration of slope. Although beautiful lips with exaggerated slopes occur in nature, we must be cautious never to form one iatrogenically because the face will not tolerate it. We have found that a pleasant and balanced iatrogenic slope ranges around a final height difference of 2 mm between points "P," "I," and "D" from the anterior view (Figure 3B). Similarly, the trough of the Cupid's bow typically dips roughly 2 mm below the peaks in parallel with the dip

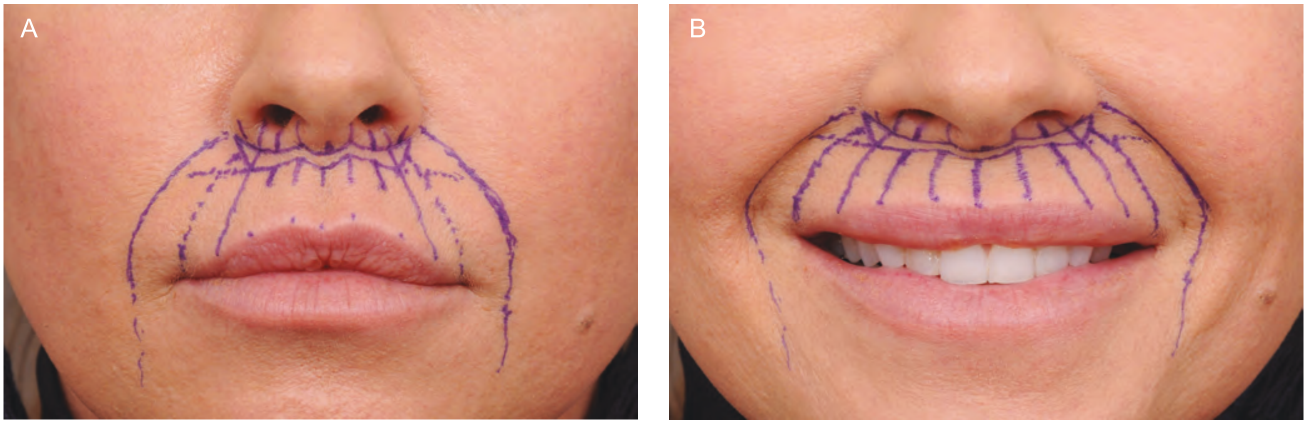

Figure 2. The RSTL globe drawn on a 38-year-old female. (A) RSTL globe at rest. (B) RSTL globe with smiling. RSTL, relaxed skin tension line.

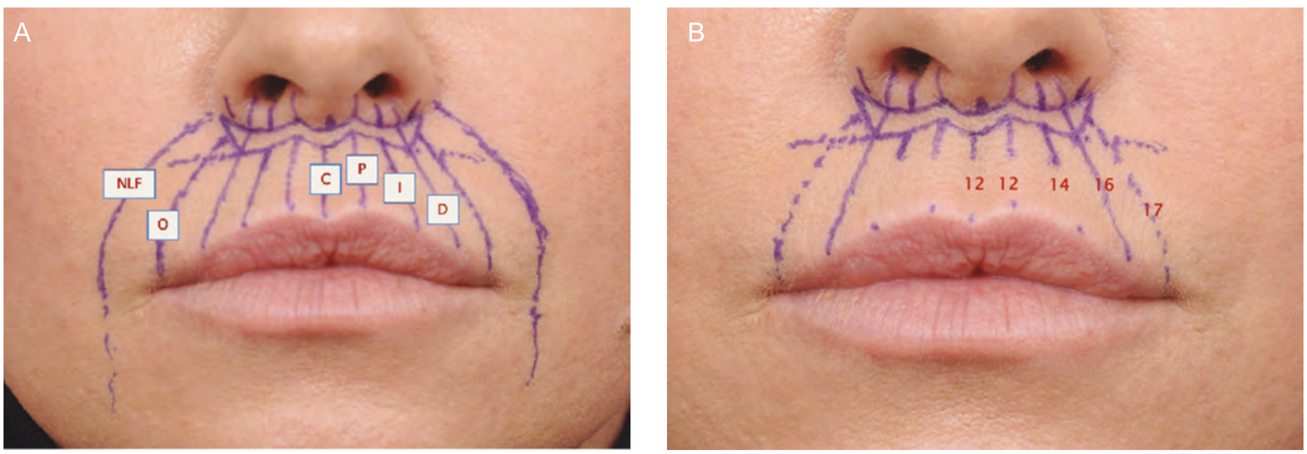

Figure 3. (A) CPID designation for the RSTL globe: C, center; P, peak; I, intermediate; D, diagonal; O, outer. (B) The residual CUPID measurements determine the final shape and slope of the vermillion border, shown on a 38-year-old female. A 2-mm slope between P, I, and D provides a continuous line. Sharp or blunt Cupid's troughs can be altered by making the C and P lines equal in height. NLF, nasolabial fold; RSTL, relaxed skin tension line.

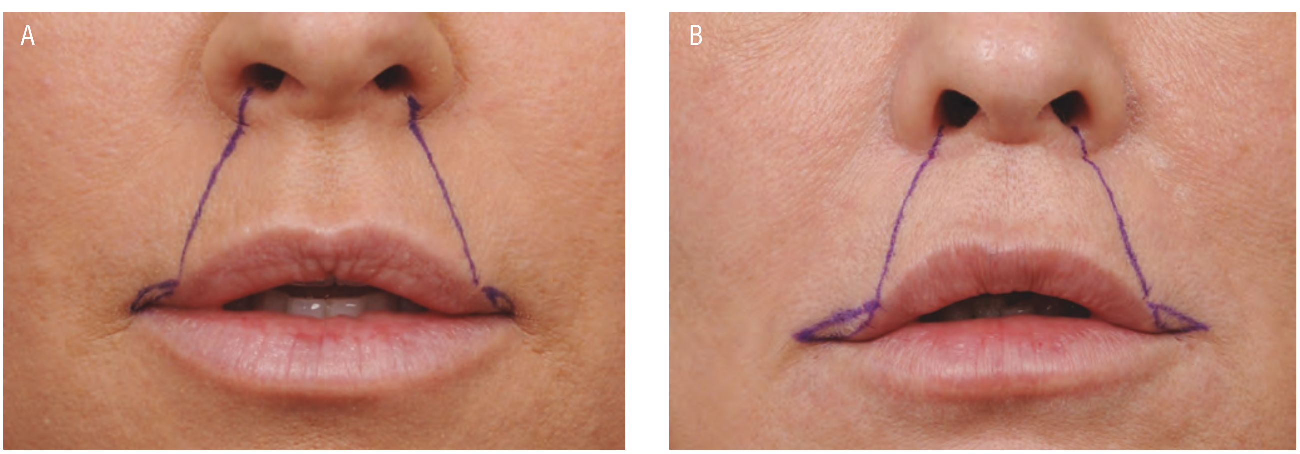

Figure 4. Corner lift markings for Type I and Type II corner lifts on a 52-year-old female. The diagonal line marks the transition from the subnasal to subfacial lip, which lacks support and is where the vermillion roll tapers off. (A) Type I corner lift utilizing an elliptical excision to replace philtral skin with red vermillion. (B) Type II corner lift involves an inflection past the commissure which effects a change to the lower lateral lip angulation and insertion, while lengthening the appearance of the upper lip.

of the columella from the peak points of the incision; therefore, the heights of "C" and "P" should be roughly equal. The excision height of "C" and "P" may be altered when reducing or enhancing the appearance of the Cupid's bow. If more control of shape is required, the space between the CPID lines may be divided in half and a 1-mm slope may be used between each marking. Maintenance or formation of this residual slope aids in maximizing vermillion exposure laterally and avoiding exaggeration with lip lifting. Lip types that have central peaking and lateral drooping are especially at risk of iatrogenic exaggeration. Certain ethnic variations, such as Asian lips, are also predisposed to central exaggeration and typically require a laterally biased excision, removing more laterally than centrally.

Corner Lip Design

Treatment of the lip lateral to the diagonal line may require a corner lip lift to expose a buried vermillion or avoid a drop off in slope. A primary goal of the lip lift should be to achieve adequate vermillion exposure throughout the entire length of the upper lip. A variety of naturally occurring patterns are noted upon analyzing the relation of the corner of the mouth to the central portion. The most helpful classification published is quite similar to what we use in our practice and has been described by Jeong et al.[11] Similar to the lateral canthus of the eye, the lower lip should gently slope upwards into a canted insertion point at the chelion, rather than being horizontal, bowed, or down-pointed. The connection point of the commissure may lay in the same horizontal plane of the aperture of the lips or above this plane. The lateral upper lip should gently sit over the commissural insertion of the lower lip, ideally with exposure of the vermillion extending for the entire lip (Supplemental Figure 2A,B).

The majority of patients undergoing the CUPID lip lift will require unilateral or bilateral corner lip lifts. Incorporated into the CUPID are two simple corner lip lift markings, designated Type I and Type II. Type I markings are mostly elliptical or fusiform in nature and end laterally at the oral commissure (Figure 4A). These are solely used to expose and lift the lateral vermillion. Type II markings extend past the commissure with an upward inflection, similar to the lateral extension limb seen in upper blepharoplasty (Figure 4B). Type II lifts are used in patients who require lifting of the commissure itself or neutralization of down-pointing rhytids extending inferior to the chelion. Type II lifts help avoid exaggerations in a down-pointed lateral mouth and make the angular depressions in sad and frowning mouths seem more pleasant and neutral. It is important to use the Type II corner lift precisely as it raises the insertion point of the lower lip to the chelion. In the appropriate candidates this will turn a frown into a happy or neutral smile, although if performed in someone with an existing upward curve, this may result in a "Joker's smile." A balanced, beautiful, and appealing commissure design is of utmost importance when maximizing lip lift results and avoiding exaggerated outcomes, while also avoiding worsening aging around the oral commissure. The upper limb of the corner lift incision is typically drawn as a direct, straightline extension of the vermillion border beginning at the diagonal line. The outer "O" line may be used to determine the height of excision of a Type II lift by keeping the "O" final height the same as the "D" final height. The lower limb simply follows the red/white border of the vermillion, completely excising the philtral skin and roll abutting the vermillion. The elbow of the inflection in a Type II lift should not violate the horizontal plane of the oral commissure. The lateral limb must also end before reaching the nasolabial fold line of the RSTL globe. If the excision height of the "I" line and "D" line are dramatically different, the corner lift may be initiated medial to the "D" line to shorten the final "D" height.

Inferior Vermillion Arc

The surgeon must also pay careful attention to the shape of the vermillion at the wet-dry border. Ideally, the vermillion should be exposed for the entire length of the upper lip. We believe the amount of exposure directly correlates to sensuality of the upper lip because the red of the lip is recognized by others as a sexual internal structure related to fertility and youth. Although the Cupid's bow contains a "M" shape, the inferior vermillion should maintain a smooth and continuous internal arc. Thin or "M"-shaped lips may portray a thin, villainous character. There are several options for softening this appearance if needed, including paramedian VY-plasties[12] (Supplemental Figure 3A-D).

A thorough understanding of the oral/dental relationship is also important. For the purposes of this article, we will focus mainly on a simplistic explanation of incisor display of the upper front teeth. In nature we may observe a pleasant incisor display of anywhere from 1 mm to 8 mm that looks young and beautiful, although the majority of patients under 35 years of age range between 1 and 5 mm.[13] Iatrogenically, we should be more cautious and avoid taking a patient to an incisor display over 4 mm. This may cause functional impairment with mouth closure. The orbicularis muscle naturally constricts against the front teeth, while the elevator muscles have the ability to pull the upper lip upwards. The upper lip does not have any inferiorly based depressor function to close the mouth. If the upper lip cannot meet the lower lip in front of the teeth in repose, the lower lip and chin must flex and strain to obtain complete mouth closure. This may result in acceleration of aging and strain around the mouth, causing depressor anguli oris hyperfunction and mentalis hypercontracture. Physically this manifests as a peau d'orange appearance on the chin, depression and down-pull around the mouth, dimpling in the depressor anguli oris region, rise of the point of the soft tissue pogonion, a deepened sulcus mentalis, and an overall sad or angry appearance. Unfortunately, dentists and surgeons often overlook this dynamic when placing veneers and performing lip lifts, rendering the patient with labial incompetence which not only causes the aforementioned changes in appearance, but functionally may cause xerostomia and deleterious changes in phonation.

Marking Placement

Precise incision design is the foundation upon which the deep plane upper lip lift depends. The design, as previously described by the primary author,[1] outlines a simple and effective way to achieve an even and symmetric lift with proper redistribution of a centrally focused advancement flap. It is essential to avoid any interruption or effacement of the nasal sill as well as excess lateral excision.

Step 1: Upper Incision Markings

First, the upper limb of the incisions is marked along the subnasal, perialar crease (Figure 1). Leaving a ledge around the incision offers no benefit. Laterally, the markings must not extend past the natural crease ending in any given patient. Going beyond this point will almost certainly cause a visible scar along the lateral alar-facial or alar-labial crease. The incision should also end where the vector of the marking becomes vertical. Further vertical extension along the crease will not aid in lifting. Centrally, on each side of the midline, there is a peak at the divergence of the medial crural footplate and the nasal sill. This may or may not coincide with the philtral column, also known as the paramedian or "P" line depending on the patient's anatomy. Avoid the practice of drawing the peaks too far laterally, in the middle of the nasal sill, to hide the incision intranasally. The incision should hug the border of the nasal skin to avoid the mixture of nasal and labial skin via excision of nasal skin and transposition of lip skin into the nose. Invasion into the nasal sill causes effacement of the natural subunits as well as skeletonization of the nasal base. This deformity is nearly impossible to repair in revision surgery.

Step 2: Diagonal/Radial Internal Sill Markings

Next, the diagonal ("D") markings are made from the internal angle of the nostril extending down the natural contour and relaxed tension lines of the lip (Supplemental Figure 4). The vector lines of the upper lip extend out radially towards the angle of the nasolabial fold as seen in the RSTL globe (Figure 2A,B). The "D" line is quite important because it marks the lateral extent of vertical lift effect of subnasal lip lift on the vermillion border. The use of a subnasal lip lift technique inherently means that in patients with a wider nose one can lift a narrower lip to a broader extent than a narrow nose overlying a wider lip. Figure 5A-D shows before-and-after photographs of 2 different patients following a lip lift without application of a corner lift. The patient on the left had a larger discrepancy between the width of the nose and the mouth, resulting in a failure to expose the lateral lip.

Step 3: Intermediate Line

Once the "P" line and "D" line are determined, an intermediate or "I" line is directly between the 2 lines from the nasal sill, extending to the vermillion border. This line helps control the slope and shape of the lip. Excessive pull on this line may cause an angry, scowling, or snarled appearance, whereas less relative lift of this line may relieve that appearance.

Step 4: Determine Height of Central Excision

The height of excision at the central lip must be determined next (Supplemental Figure 5A). At this point, the surgeon must negotiate between overall balance, incisor display, and lip height. Patients with longer upper lips sometimes display 1 or 2 horizontal creases across the central philtrum where the lip is straining to rise. This has been referred to by the primary author as the "line of declaration" in a previous publication.[1] Above this line is typically considered lip excess. This line may also become more apparent following rhinoplasty. The lip may drop in height with any de-projection technique such as full transfixion without resuspension of the columella to the septum. This may also occur with placement of an excessively long columellar strut that extends in front of the nasal spine, causing lip ptosis and impairment in mobility. Binding of the footplates in front of the spine or septum may also cause this issue because the footplates naturally extend around the nasal spine laterally. Table 1 provides a general estimate of the change to expect in incisor display with relation to excision height without use of orbicularis suspension. The change produced varies with lip strength, elasticity, and skin quality differences between patients of different ethnicities and skin types. Thicker, more elastic skin types will obtain less of a lift for any given excision height than a thinner, more deflated skin type.

Incisor display is measured as the difference in height between the border of the 2 central incisors and the lower vermillion wet-dry border at the stomion. If the lip border is exactly at the level of the central incisors, we designate this as "0" incisor display. A lip that is 2 mm longer than the teeth would have "–2 mm" display, whereas teeth that are longer than the upper lip would have "+2 mm" incisor display.

Markings must be made with the patient in the upright position. Just as lying a patient down during upper blepharoplasty may result in roughly 2 to 3 mm of lagophthalmos, the supine position may result in a phenomenon we have

Figure 5. The need for corner lifting depends on the amount of subfacial lip lateral to the diagonal line and the discrepancy between nasal width and labial width. (A) Before and (B) after photographs of a 50-year-old female patient with a narrower nose and greater amount of buried vermilion lateral to the "D" line, showing an unsuccessful classic subnasal lip lift without corner lift. (C) Before and (D) after photographs of a 52-year-old female patient with little nasolabial width discrepancy not requiring a corner lift to obtain lateral vermillion exposure.

Table 1. Guideline for Skin Excision Markings and the Resultant Change in Tooth Show

Excise	4-5 mm	6 mm	7 mm	8 mm	9 mm	10 mm	11 mm
Show	+0	+1	+2	+3	+4	+5	+6

These numbers reflect the changes noted in medium-density skin types without the use of muscle suspension. Excess temporary or permanent fillers may change these numbers. This guideline only applies to deep plane lip lifting.

dubbed "lagolabios." The incisor display may easily increase 4 to 8 mm or more when lying down and even more when injected with anesthetic solution. More important is the effect of gravity on the commissure and the lateral lip. With the patient sitting upright, the lateral lip and commissure droop to a greater extent than the central lip. The central lip is attached to a fixed structure in the midline—the nose—whereas the oral commissure is attached to and hanging from the remainder of the face. This means that when a patient is supine, the surgeon may note a greater correction on the lateral lip and mouth than is occurring from the lip lift procedure.

In general, a 4- to 5-mm excision would reveal more of the intraoral anatomy along with improved eversion and accent of the upper lip without increasing incisor display to any appreciable extent. This is the range of excision used in patients with adequate tooth show, pre-existing hypercontracture around the lower mouth, or a predisposition to exaggerating their appearance with lifting. For example, a lip with severe angular depression around the chelion, drooping of the lateral mouth, and a pronounced Cupid's bow tends to exaggerate and worsen with lifting. For a patient with 0 incisive display, the primary author would typically begin with a 7-mm or more excision to provide around +2 mm of tooth show. For a patient with a tooth show of –1 mm, at least 8 mm of height would be removed to obtain at least +2 mm of tooth show (or at least a 3-mm gain). It is important to remember that although a natural incisor display ranges from 4 to 8 mm, it would be unwise to produce this level of tooth show iatrogenically. Most patients do well with + 2 to + 4 mm of central incisor display in repose without looking exaggerated or causing issues with phonation and mouth closure. The central excision marking is made while holding the lip on gentle stretch, extending directly down the middle of the philtral trough (Supplemental Figure 5A). The residual or final height markings must be made without stretching the lip (Supplemental Figure 5B).

The paramedian/philtral "P" markings are then made with a caliper while gently stretching the lip. Symmetry must be considered when determining the excision height at each peak. Preoperative photography is essential in determining the need for an asymmetric excision given the many contributions to asymmetry at the midline. Asymmetry at the Cupid's bow peaks may arise from an asymmetric nasal base, variations in philtral column height, or neuromuscular differences from right to left. Just as we see with dexterity, the face has a dominant side or dominant subunits that may sit higher at rest and raise higher with flexion. If an asymmetry of philtral column height exists, markings may be made by measuring the residual height of the desired side and applying the same marking to the contralateral side without placing any tension on the lip. It is important to note that if an asymmetry exists with residual height measurement but not on the preoperative photograph, the photograph should take precedence because it will better reveal nasal base asymmetries contributing to lip height. If a ptotic nasal base is encountered, the surgeon must consider any height gains from nasal base resuspension, which may be asymmetric. If the alar sill is lower on one side following previous surgery of the nose, jaws, or lip, this must be restored accordingly with nasal base suspension sutures.

Upon analyzing the expected starting point of the lip, it is also helpful to view the profile view for slope and projection. An attractive lip typically has very little purely vertical descent prior to sloping anteriorly like a gentle ski ramp (Supplemental Figure 1B). From an anterior view we focus on balancing the size of the upper lip to the nose, the chin, and the remainder of the face. Our goals typically are to decrease philtral height, improve the accent and definition of the Cupid's bow and vermillion border, increase tooth show, and improve the volume show of the red vermillion.

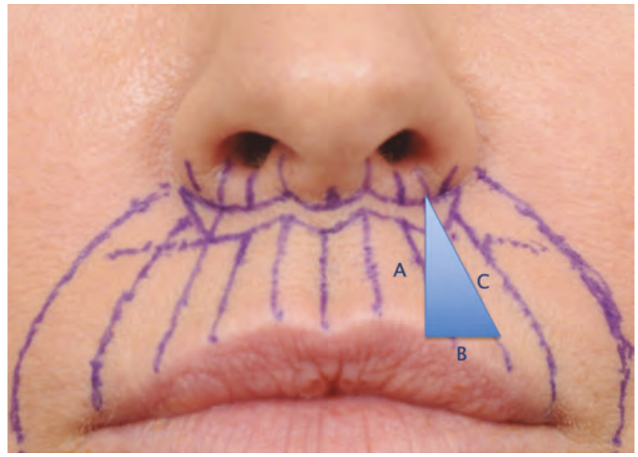

Figure 6. Drawn on a 38-year-old female, Pythagoras' theorem of $a^2 + b^2 = c^2$ demonstrates that more lateral relaxed skin tension line markings will yield less of a vertical lift than more medial markings. This demonstrates one of the causes of central exaggeration in subnasal lip lifting.

The surgeon must be sure to leave adequate lip height to avoid impairment in function or a foreshortened appearance. For most patients, a short residual lip height would be considered 11 mm. Leaving less than 10 mm behind is not recommended because this may impair function and flexion of the orbicularis muscle. Again, we must remember that although shorter lips may exist in nature, it would be unwise to form one iatrogenically.

A height of 11 mm is a convenient number to keep in mind for teaching purposes, as it not only refers to the minimum residual height of the lip but also refers to the maximum excision height in a single stage. Removing more than this during a deep plane lip lift may lead to bunching and issues with redistribution of skin. A second stage may be performed in the future, typically after 6 months, if indicated on rare patients. We do not believe there to be any proper lip height or specific range of heights that is better for any particular patient. One must simply analyze the balance of the face, improve lip function, and avoid causing problems with lip lifting.

Step 5: Lateral Markings and Slope

The remainder of the lower limb excision markings are now made, which will determine the excision height along the entire lip as well as the design, excision bias, and slope. When performing a lip lift, the natural inclination of the upper lip is to undergo a more exaggerated rise centrally than laterally. Several factors in the incision design of subnasal lip lifts contribute to this observation. The lift of the central portion is purely vertical, whereas the more lateral portions lift diagonally. At the "D" marking (Figure 6), the surgeon must consider Pythagoras' theorem, $a^2 + b^2 = c^2$, meaning a 7-mm diagonal (hypotenuse) measurement with a 3-mm gap (horizontal) will result in a 6.3-mm vertical lift rather than the 7 mm that would be achieved with a 7-mm excision at the "C" line. This means that a 2-mm radial line height difference will result in a final slope that is steady with a lift that is gradually diminishing as it approaches the "I" and "D" lines and beyond.

The deep plane upper lip lift is akin to a centrally vectored advancement flap. The lateral portions are pulled superomedially rather than purely in a vertical vector. The other main contributing factor is that the lip is wider than the nose in most patients. The larger the discrepancy between lip and nose width, the greater difference you will see in central vs lateral lifting. The central portions of the lip directly under the nose will experience a greater extent of lifting than the lateral portions, which are hanging from the face at the oral commissure. The diagonal reference marking helps delineate where the effect of lifting on the lateral lip will taper off.

To appreciate the ideal slope along the vermillion border, the practitioner must first become familiar with the final incision design of the upper lip lift and all the anticipated reference markings as described earlier (Figure 3A). There exists a single central marking, 3 pairs of radial markings (paramedian, intermediate, and diagonal), and a single lateral reminder marking that is used for the lateral deep suture.

The slope serves only as a guideline, but the primary author has observed that the most pleasant appearance for most lips would result in a height difference along the vermillion border of 2 mm between each point and the adjacent point along the PID line when measuring the residual vector line height (Figure 3B). For example, a residual "P" height of 12 mm would correspond to a "I" height of 14 mm and a "D" height of 16 mm. The excision height for the central markings is placed while the lip is held under gentle tension. The residual or final height must be performed with the lip in repose and not stretched. This will ensure the result at rest is as symmetric and aesthetically pleasing as possible regardless of the accordion effect seen with lax skin types or curling of the lip, which may not contribute to perceived vertical height. This design also helps avoid exaggeration or softening of the appearance of bowing or snarled lips by lifting the "P" and "D" points relatively higher than the "I" point. Lifting the "I" point excessively relative to the other points may cause an angry, snarled appearance. Although it is unwise to make any substantial changes to the shape or character of the lip, small changes may be made to avoid exaggeration or to correct changes caused by fillers over time.

The height of the chelion bilaterally may never be symmetric because the position is guided by facial asymmetries and not by subnasal philtrum height. Like the rest of the body, there exists a neuromuscular dominance on one side of the face. The brow and eye dominance are controlled differently and may demonstrate the opposite dominance. In general, the dominant side of the face will have a stronger smile, possibly a nasal tip deviation to that side, deeper nasolabial folds, and a higher chelion position. The opposite side tends to exhibit more drooping but less shadowing. These differences are erroneously attributed to side preference during sleep. Soft tissue and bony skeletal discrepancies, such as various forms of dental malocclusion, open bite, retrognathia, prominent dentition, vertical maxillary excess, and other issues, may also lead to muscular asymmetries and strain within the face.

In many patients with pre-existing central exaggeration, a buried lateral vermillion, angular depression around the commissure, low chelion height relative to the stomion, or a predisposition to exaggeration following a lip lift, a laterally biased lip lift must be performed. Revision surgery often requires this as well because the inclination of most surgeons is to remove too much centrally. Removing more skin centrally than laterally tends to give the patient an operated and strange appearance that does not age well. If the lateral portion and corners of the lip are not proportionately lifted, the down-pointing and sad appearance around the mouth will become substantially worse as the remainder of the face attached to the commissures droops with age. There are certain ethnic characteristics that predispose the patient to this as well. For example, patients with Asian heritage commonly receive a laterally biased upper lip lift. A standard excision design or larger lift in general may cause excessive exaggeration and volume display centrally. With greater levels of lifting and excision height, control over this potential exaggeration may be lost. In cases where more tooth show is needed, but greater excision heights would lead to exaggeration, we recommend performing orbicularis suspension to achieve the needed changes.

An excision height disparity of 2 to 4 mm from the "P" upper excision marking to the "D" point is easily tolerated by most patients. A higher skill level is needed to determine if a greater fraction would be tolerated by the patient's anatomy because greater differences between central to lateral height excision may cause difficulty with redistribution of the inferior relative to the superior flap. The upper lip lift is a centrally vectored rotation-advancement flap with a longer perimeter along the lower limb of the incision than the upper, even when equal amounts are removed. In addition, it is important to restrict any excision that would extend laterally or superiorly to the lateral extent of the upper limb marking apex. This can also cause visible scarring. Extending vertically past the naturally existing alar facial crease may result in a deepened scar with pores and pits along the alar facial sulcus. Lateral extension may result in atrophic or hypertrophic scarring from tension, issues with redistribution, alar/nasal widening, and even effacement of the upper nasolabial fold in cases where the lip is excised lateral to the ala and the cheek is attached directly to the nose. There is a substantial risk of this occurring during revision surgery where the surgeon may attempt to excise a scar lateral to the ala. This can be avoided by transitioning at the "D2" point to a vertical limb ascending towards the end of the alar crease.

Step 6: Corner Lifting

Direct lip lifts cutting along the central vermillion roll are avoided because these tend to efface the natural border and definition of the upper lip. Laterally, the white roll tapers off around the "D" line, enabling an incision to be made without any notable sequelae. If the incision marking terminates at the commissure, we call this a Type I corner lift (Figure 4A). Minor improvements can also be made to improve a down-pointed appearance around the cheilion and angular depression by carefully extending the excision by means of an upward inflection lateral to the commissure (Figure 4B). A corner lift with lateral extension is called a Type II corner lift. The inflection elbow is always placed above the horizontal plane of the cheilion, and the angle of inflection is roughly 90° to 120°, following the patient's natural anatomy. In lips that will not tolerate lifting of the lower lip insertion into the commissure, the corner lift should end at the commissure without any lateral extension (Type I). A 1-mm-long inflection will give a minor increase in angulation whereas a 2- to 5-mm-long limb will create increasingly greater amounts of correction. Overcorrection will cause an unnatural smirk or "Joker's smile." On the medial end of the incisions, the markings must taper off and elongate to avoid a notch.

The decision to perform a corner lift can be guided by the relative position of the diagonal radial line "D" by examining its point of termination along the vermillion and whether the lip lateral to this point requires lifting. The goal is to continue the slope previously depicted from "P" to "I" to "D" laterally in a straight line towards the commissure. It can be assumed that the deep plane upper lip lift will provide little lifting effect lateral to that line and that a separate incision along the vermillion will be needed. As can be seen in Figure 5A-D, if a congruence in width exists between the nose and the lip, the lateral lip will receive a strong lifting effect. In cases where there is more of a disparity, the lateral lip may not receive enough lift as shown on the left side of the photograph. In this scenario, the patient should have had an asymmetric corner lift, more so on the left side than the right. The patient was content with the results and refused the addition of a corner lip lift after her recovery.

The corner lift is typically performed upon finishing the upper lip lift to appreciate the resultant curvature of the vermillion. In most cases, a 1- to 4-mm height excision is needed with 0 to 6 mm of inflection length. The height may be determined by using the "O" RSTL which extends down from the apex of the incision. A horizontal lateral line extension is drawn from the "D2" point horizontally and the final "O" height between the lateral extension line and the top limb of the corner lift should be similar to the final "D" height (where D = O). The inflection limb should not extend into or past the nasolabial fold. More than this would be uncommon with this form of corner lift design. The large majority of corner lifts contain some inflection or Type II extension.

Step 7: Vermillion Assessment

Before beginning the surgery, it is important to assess the vermillion body for shape, previous scarring, and appropriate volume. Although the vermillion border and Cupid's bow demonstrate somewhat of an M-shape, most aesthetically pleasing lips do not parallel this along the wet-dry border. Rather, a smooth and continuous internal arc along the inferior line is most appealing and desirable (Supplemental Figure 2A). Embryologically, 3 tubercles exist in the upper lip and 2 in the lower.[14] Neither fillers nor surgery should exaggerate the appearance of the upper lip tubercles. On occasion, paramedian VY-plasties will help smooth the appearance of an M-shaped vermillion (Supplemental Figure 3A-D). The tubercle may also be trimmed, especially in patients with silicone-induced hypertrophy. Postsurgical modulation is often needed because the tubercle vermillion is sensitive and tends to thicken and experience hypertrophic scarring.

Some patients requiring a lip lift may have an abundance of volume. This occurs naturally in patients of African or Asian descent as well as in patients with silicone or other polymers placed previously with subsequent granulomatous hypertrophy. In these patients, a mucosal excision or volumetric reduction should be considered to maintain or decrease the size of the vermillion. For patients with excessive amounts of silicone-induced hypertrophy, various forms of reductions may be performed beforehand to avoid postoperative exaggeration. Liposuction should be avoided because this is much more likely to remove soft, healthy native tissue rather than scarred, fibrotic tissue. Similarly, hyaluronidase would target the healthy SMAS layer rather than the bulk of scar tissue. The deep plane dissection also allows reduction in fat grafting that may have traversed the vermillion into the philtrum. The fat may be accessed from either the upper lip lift, corner lip lift, or vermillion incisions. In some patients, this may also aid in tooth show. Naturally, a fat plane does not exist in the upper lip. Only dispersed fat droplets are found within the SMAS. Hence, when fat grafting is performed, there is no true fat plane for the grafting to incorporate into and it may spread in the submucosal, sub-SMAS plane.[15]

Nasal Base Suspension

When treating a patient with a loose nasal base, a nasal base suspension is typically performed. Even with a tension-free closure, effects of untoward tension may be noted months later. Laxity of the sill and nasal base may be a congenital or iatrogenic phenomenon. Excess laxity is very common following rhinoplasty and orthognathic surgery. The need for this is more common in rotated noses and nasal base types with weaker structure such as is seen in Asian patients. Furthermore, the cephalic orbicularis insertion line at the base of the nose tends to disinsert and rotate out over time in a clockwise fashion on lateral view. Nasal base suspension simultaneously aids in strengthening of the nasal base and sill, while reinserting the origin of a ptotic orbicularis internally and superiorly. If scarring exists from any type of previous surgery, the scar at the alar-labial junction should be excised and a subnasal ravine may be formed to deepen the nasolabial angle.

It is important to mark the orbicularis suspension height, discussed in the next section, before passing this suture. To perform the suspension, a 4-0 polydioxanone suture is passed from inside the pyriform aperture out through the nasal and labial muscle junction at the "D" line, then back in as a mattress, passing through the periosteum with a knot tied on the internal nasal rim. Typically, 2 sutures are placed on each side unless more are required. Great care must be taken to avoid asymmetric nasal base suspension or a snarled appearance by lifting the mid-sill excessively. If a patient possesses hyperlaxity at the "I" line, the dermis may be incorporated on the second pass as the suture is reversed and passed back internally. This will provide a sill pexy at the most sensitive point of dermal ptosis seen in patients with laxity. Nasal base suspension sutures should be avoided in cases where simultaneous rhinoplasty is performed to avoid strangulation of the basal columellar skin.

Muscle Suspension

Once hemostasis is obtained, the central lip flap is elevated to the nose to evaluate if there will be appropriate flexion and contracture of the orbicularis oris muscle underneath the advanced lip flap. A major benefit of deep plane release is that the orbicularis muscle will have even redistribution under the skin as opposed to other techniques that bunch the muscle in the excision area up towards the nasal base in an uncontrolled fashion, which may adversely affect orbicularis strength and function. The orbicularis oris muscle appears to function best in a mid-range of stretch or flexion. Longer lips seem to strain more when flexing, whereas excessively short lips have no further room to flex. Hence the length and function of the orbicularis oris muscle must be considered, looking at the overall length as well as the length compared with the remaining skin. Hydration and cushioning also play an important role. A mimetic muscle that is desiccated or denuded typically displays hyperfunction, whereas a mimetic muscle bogged down by an edematous or granulated SMAS becomes weaker. The same phenomenon is also noted with other facial mimetic musculature such as the zygomaticus complex. If the lip is flaccid and excessively ptotic in the setting of orbicularis hypertrophy, a muscle plication can be performed. Orbicularis muscle suspension is performed in roughly 25% of patients in our practices.

It is important to note that muscle plication inherently fibroses and obliterates the function of the plicated portion of muscle and that this procedure should be performed judiciously. If the orbicularis appears to roll onto itself as the lip flap is lifted to the nose, muscle plication would also be of benefit. If 5 mm of muscle folds over another 5 mm of muscle, this obliterates or restricts the motion of 10 mm of muscle. Rather, a 3- to 5-mm plication can be performed which would solely result in the upper 3 to 5 mm of muscle becoming fibrosed and obliterated. This leaves the remainder of the orbicularis oris to function in a more normal fashion. This problem is commonly seen in skin-only excision techniques without release because all the muscle in the excised area bunches onto itself upon closure. Bunching of the orbicularis oris muscle may have substantial effects on lip mobility and function. The mistake many practitioners make during muscle plication is suturing the muscle to muscle or muscle to the subdermal region of the nose rather than to the periosteum or pyriform ligament.[1] Rather than lift the lip, this tends to drag the nasal sill downwards.

A more advanced maneuver is to use minor muscle plication to strengthen a weak nasal base and avoid exaggeration in patients with more prominent, steep slopes such as with patients of Asian descent. Typically, a 3- to 4-mm marking is placed paralleling the nasal base and upper lip incision. Five buried 5-0 polydioxanone sutures are used to perform the muscle plication, attaching to the pyriform ligament or periosteum in a mattress fashion at the "C," "P," and "D" points only. Suture placement must alternate back and forth from left to right to avoid twisting the insertion of the pars peripheralis. An added benefit is the formation of a scroll of tissue at the nasal base which may strengthen it and decrease the chance of ptosis following healing. If the lip excision height determined is appropriate for external balance but inadequate for tooth show, a muscle plication may also be performed to increase incisor display without increasing the height of skin excision. In these situations, we compare the lip excision height to the volume of a speaker, while the muscle plication is the gain or the fine tuning. When plicating or imbricating, we knowingly sacrifice the function of the upper portion of muscle for the greater function of the remainder of the muscle.

In patients with a tendency for hypertrophic scarring, such as those with Asian, African, or Indian skin types, neurotoxins may be injected into the skin edges. We are undecided regarding the efficacy of neurotoxin injection into the incision because the results have been equivocal. Typically, 5 units of Dysport (Galderma; Lausanne, Switzerland) diluted with saline is injected into the dermal-epidermal junction of the upper and lower flaps, avoiding any intramuscular injection. This may mitigate the need for any postoperative modulation with CO_2 or 5-fluorouracil (5-FU), which is rarely needed in the incision.

Intraoperative Adjuncts and Postoperative Maintenance

The surgical technique for the modified or deep plane upper lip lift has been detailed previously by the primary author.[1] The procedure is typically performed under local anesthesia after administering 10 mg of oral valium to the patient. Anxiety should be avoided because bleeding may increase dramatically if not controlled. This may be due to diminished ability to clot[16] as well as increased blood pressure and heart rate. Patients are advised preoperatively to stop all blood thinners, oral supplements, and some food additives, including turmeric and curcumin, which have been used increasingly over the past several years and tend to increase bleeding.[17] Patients without any contraindications are given low-dose oral tranexamic acid the day before and on the day of surgery.

Perioral rhytids will be temporarily exaggerated during healing. The lip lift does not routinely improve these wrinkles. For this reason, if rhytids exist a fractionated perioral CO_2 laser resurfacing is performed at the end of the procedure. The lip is resilient to laser damage and performing a laser resurfacing on appropriate skin types is low risk. Patients undergoing more substantial lip lifts also may experience dryness and peeling of the vermillion skin. This likely occurs as the wet-dry border is lifted and a new wet-dry junction forms over the area of the wet vermillion mucosa. Squamous metaplasia may continue over the next several months as the new mucocutaneous line forms.

Indentations along with "D" line may occur infrequently in patients who have a deflated SMAS either from age or from prior dissolving of fillers. In these patients a small amount of HA filler should be placed into the subdermis/SMAS. Only a tiny amount is needed because the filler will partially hydrate after injection. Juvéderm and thicker fillers should always be avoided in the philtrum. If this philtrum appears darker from aging and deflation of the SMAS in the preoperative photographs, the volume and supple nature of the SMAS may be improved using nanofat/platelet-rich plasma injections. The patient shown in Supplemental Figure 6A-D was treated with nanofat/platelet-rich plasma injections to the SMAS layer and CO_2 laser along with bilateral Type II corner lip lifts.

Mupirocin 2% nasal ointment may be given to use twice daily to diminish the risk of methicillin-resistant *Staphylococcus aureus* colonization and infection, although infection is exceedingly rare. Postoperatively, patients are given valacyclovir, a skin flora oral antibiotic, and a steroid pack for recovery. Oral antibiotics are not used. Antibiotic ointment is switched to Aquaphor (Beiersdorf Inc.; Hamburg, Germany) ointment after 3 days to avoid the rash formation seen with antibiotic ointments. Patients return at Days 3 and 5 for suture removal. Prolonged presence of sutures may result in hypopigmentation, striations, and delayed formation of epithelial bridges between upper and lower suture points.

Patients may then return at 6 and 12 weeks postoperation for an off-label injection of 5-FU deep into bumps that may be present laterally in the muscle bed as well as low-energy CO_2 laser treatment of the incisions. Injections of triamcinolone are avoided because this is a high-risk area for tissue atrophy, telangiectasia formation, and discoloration. In rare cases where incisional hypertrophy is present, 5-FU may be injected into the hypertrophic scar. Microneedling may also be performed. 5-FU and lasering cannot be performed on the same area at the same time because of the risk of skin breakdown. Rarely, hyperpigmentation of the philtrum may occur in darker skin types. This will typically resolve without intervention, although the primary author has used microneedling of tranexamic acid into the pigmented areas to speed up the process. Confluent lasering may be performed on hypertrophic strands. Incisional lasering may be performed on all skin types, although low power is used to avoid hypopigmentation.

The deep plane technique commits the patient to a much longer recovery time with much more postoperative swelling than other techniques. Theoretically, the postoperative edema may aid in incisional healing because it decreases dynamic movement of the lip. Botulinum toxin placed intraoperatively should never be injected into the muscle—only into the dermis itself. Patients may look presentable at 3 weeks, but most require 3 months to look event-ready. We advise patients that the lip may have a stiff, awkward, and asymmetric appearance for up to 3 months with some temporary widening of the nose. The feeling of stiffness may persist for over a year although displayed motion and smiling is visibly natural and easier in postoperative photographs at the 3-month mark. The healing time must not be underemphasized to the patient. Patients with HA fillers, silicone, or other polymers may have even more prolonged healing. Postoperative photographs are taken at a minimum of 3 months. Any cosmetic dental work is typically performed after 3 to 4 months once the lip position has settled. Male patients can hide the healing more easily given their ability to grow facial hair.

RESULTS

A retrospective review of 2240 consecutive lip lift patients in the primary author's practice was performed from

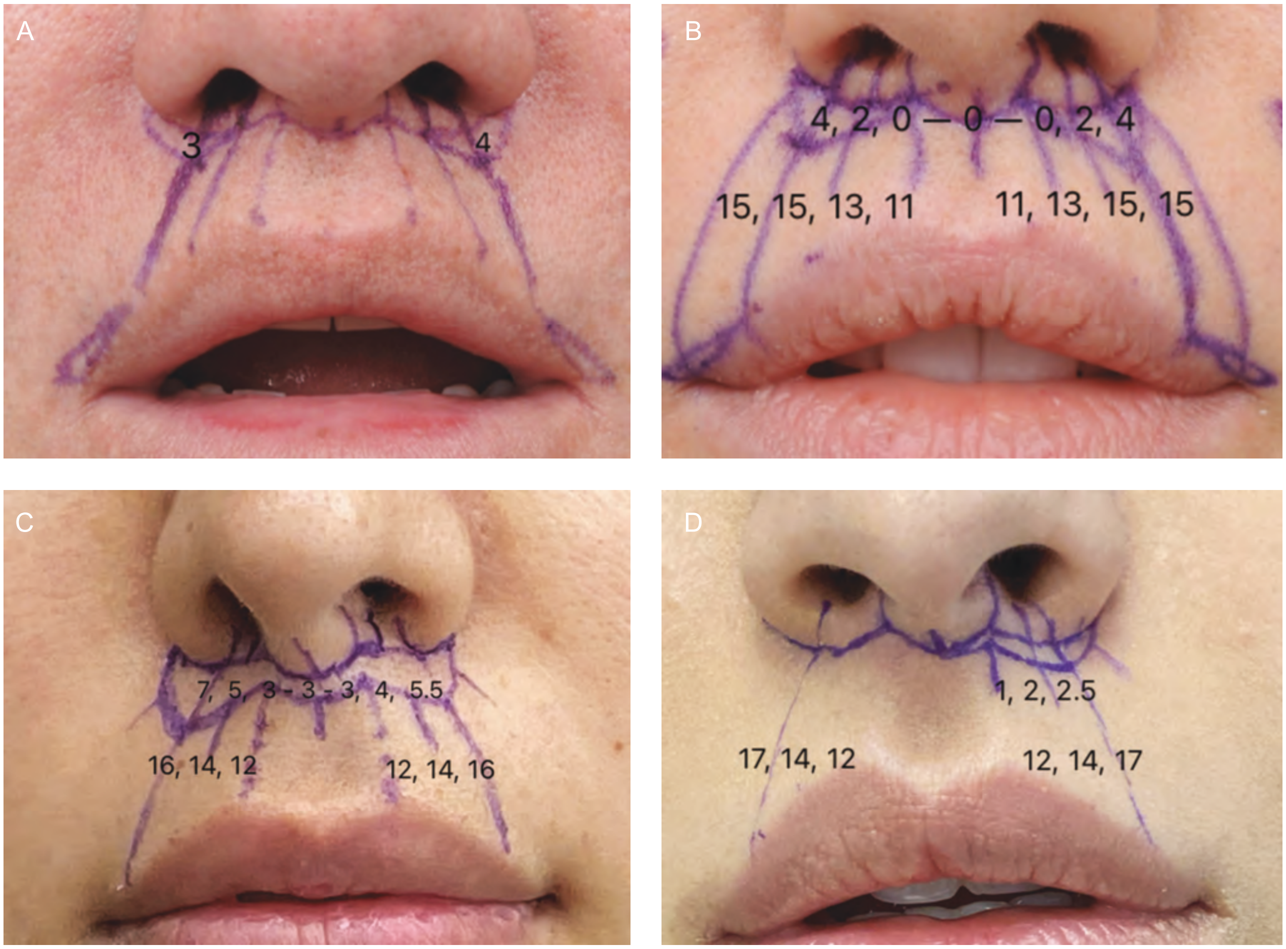

Figure 7. (A) Laterally biased revision in a 30-year-old male patient using the CUPID design to balance a laterally deficient lip status post deep plane lip lift that was performed with classic design and uniform height of excision. (B) Laterally biased revision on a 31-year-old female patient. The patient felt imbalanced status post classic design deep plane lip lift. The CUPID design was used to gain more uniform exposure along the entire lip. The results are shown in Figure 8. (C) Revision lip lift following subnasal lip lift by another surgeon on a 35-year-old female. The CUPID design was used with a lateral bias and asymmetric excision to gain increased exposure, balance, and symmetry with minimal change in tooth show. (D) Revision lip lift on a 35-year-old female patient for improved symmetry using the CUPID design on 1 side only. The original lift had removed more from the left according to the patient, but failed to gain symmetry. A 2-mm slope was not obtained to minimize down-turn of a bilateral revision.

November 2014 through September 2021. Patients were followed for a minimum of 3 months. No exclusion criteria were used. Patients were primarily female (98%) and aged from 20 to 85 years old. Secondary surgeries, those performed initially by other surgeons, constituted 141 of these cases (6%). In the primary author's practice there were 23 revisions of primary cases (1999 primary patients) contributing to a 1% revision rate. Herpetic vesicular outbreak occurred in 1 patient, hyperpigmentation in 2 patients, and dissatisfaction in 2 patients, both of whom were already suffering from silicone hypertrophy and expected the lip volume to decrease.

Revision patients from other practices were mostly treated for scarring, asymmetry, exaggeration and disproportion, and inadequate lifting. Several patients from other practices had their lips shifted off midline upon closure. Nasal base widening and ptosis was also common. Twenty-two patients had impaired lip mobility from previous lip lifts that improved after performing a deep plane release.

Of the primary author's own cases, only 2 were revised to improve hypertrophic scarring on 1 side of the nose. The remainder of the primary author's revision cases (21 cases) were performed to achieve a greater amount of lifting, better symmetry, or involved a corner lift to improve a lateral vermillion that had previously been inadequately treated before the addition of corner lifting and the CUPID lift design in the primary author's practice. Patients who

Figure 8. Revision CUPID lift on the 31-year-old female patient shown in Figure 7. (A, D) Before photographs showing filler excess. (B, E) After a classically designed, uniform excision deep plane lip lift. (C, F) After applying the CUPID lift design to revise the classic lip lift performed by the primary author.

follow up regularly are routinely treated with CO_2 laser over 2 appointments at 6 weeks and 12 weeks. Roughly 5% of patients require more intervention with 5-FU or further lasering.

The addition of the final slope calculations to the deep plane design along with incorporation of corner lifting in most patients have led to substantially more impressive and predictable results in primary and revision cases (Figure 7A-D). This article provides several examples of appropriate lip design resulting in comprehensive improvement throughout the upper lip (Supplemental Figures 7-10).

The deep plane upper lip lift addresses issues seen with scarring, nasal base effacement, disproportion, and overall failure of previous lip lift or bull's horn techniques. The orbicularis muscle is separated from the SMAS-skin flap and allowed to contract or redistribute evenly under the flap advancement. Alternatively, the muscle may be shortened for further gain in dental show without substantial sacrifice. The deep plane dissection also allows the surgeon to address issues such as permanent injections and fillers.

Suspension of the SMAS to the pyriform ligament ensures a more stable lift with less risk of causing nasal sill or alar base ptosis. We have also introduced novel portions of the procedure to help prevent nasal base ptosis in susceptible patients and to perform nasal base resuspension. Incorporation of the subnasal ravine and nasal base suspension suture is a valuable and easily performed adjunct during lip lifting surgery. Deep plane lip lift and SMAS suspension avoids the use of dermal sutures which may split and cause hypertrophic or atrophic reactions along the incision. Although the primary author has an international patient base, follow up was performed with nearly all patients either in person or virtually with videoconferencing for a minimum of 3 months. The main limitation of this study is the duration of follow up. The primary author has only been in practice 7 years and the design has evolved during this time. With an international patient base, several patients were not followed past a 3-month virtual follow up.

The CUPID lip design allows more uniform improvements along the length of the entire lip, treating the subfacial as well as the subnasal lip. This technique also aids in the design of revision lip lift markings. The CUPID lift technique offers clear advantages over the prior deep plane design[1] and alternative lip lift techniques involving endonasal incisions[18] which may not have the ability to shape the upper lip and control the slope, curvature, and shape of the vermillion border. The benefits of the CUPID lift design are clearly demonstrated in a photograph of a patient who initially received a deep plane upper lip lift followed 2 years later by a revision with the CUPID lift design (Figures 7B, 8A-F). The aim is to create a central and lateral balance along with exposure of the teeth and vermillion.

CONCLUSIONS

This article is intended to serve as a reference to better understand labial anatomy, facial aging, and the pitfalls and failures in lip lifting that have led to the evolution of the CUPID lift design. The novel approach—based on a mathematical concept—we describe here to lip lift design enables the practitioner to consistently improve lip balance, facial harmony, and tooth show, and obtain adequate exposure of the lateral vermillion. As surgeons, we must resist the pursuance of trends and overly creative lip designs. Rather, we should focus on enhancing the patient's own anatomy, achieving aesthetically pleasing and consistent outcomes, while avoiding the creation of any issues with aging.

Supplemental Material

This article contains supplemental material located online at www.aestheticsurgeryjournal.com.

Disclosures

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Male Deep-Plane Face and Neck Lifting
Advanced and Customized Techniques

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KEYWORDS

• Facelift • Male facelift • Deep-plane facelift • Male neck lift • Deep neck lift • Deep neck reduction • Deep face contouring

KEY POINTS

- The goals of male facelift patients may differ from those of female patients. Whereas the primary goals for women are youth and beauty, requiring both deep volumetric and superficial skin textural changes, a large proportion of men may seek improvements in the neck and jawline in order to restore masculinity and vigor in addition to youth.
- The word "facelift" in men remains taboo. Primary male facelift candidates will present with concern over loss of neckline definition and will need education and reassurance that necessary extension into the face will not feminize the outcome. Male patients would sooner admit to having a neck lift or blepharoplasty than a facelift, even if all procedures have been performed.
- Most men will judge the success of a facelift by the result in the neck. Without significant improvement in the cervicomental angle and hyoid position, the surgery may be deemed a failure.
- While surgical principles are identical for both sexes, male tissues may be heavier than female soft tissues, requiring a comprehensive deep-plane release to improve results and prevent scarring and failures.
- Specialists performing face and neck surgery should realize that more novel and extensive deep-plane techniques are more widely applicable and are rather uniform between men and women. Certain nuances remain that will improve male outcomes.

INTRODUCTION

Contemporary society has become increasingly critical of facial appearance.[1–3] The explosion of digital photography, online avatars, carefully curated lighting, postproduction editing, photographic filters, and makeup has seen women seek facial plastic surgery to correct perceived flaws and set high expectations. This used to be taboo, but with a shift in societal acceptance, when women undergo excellent facelift surgery, it is increasingly considered empowering and may actually receive praise from friends and family. Amid the advent of more natural facelift techniques, society has become more accepting of women who have had this surgery. Unfortunately, it still remains less accepted in men. Any hint of a facial rejuvenation procedure in a man might be met with dismissive judgment, disapproval, and intrusive questioning.[4] Many of the stigmata of more antiquated techniques may be covered in women with hair and makeup; however, in men, this is not a choice. This intersexual acceptance gap predicates the nuances of male concern at presentation to the facial plastic surgeon. While women seek restoration of estrogenic youth, such as arched eyebrows, a full midface, defined cheek profile, tighter jawline and flawless skin to ease makeup

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application, most men seek better neck and jawline definition associated with masculinity and strength giving less importance to other facial zones.[5,6] The demand for male facelift surgery is increasing.[7] Of utmost importance is a natural, unoperated appearance without the tell-tale signs of surgery (**Fig. 1**).[8] The dissatisfaction rate among male patients is higher than female patients for these reasons,[9] so surgeons performing male facelift and neck lift surgery should be cognizant of the causes of facelift stigmata and feminization in the male patient (**Fig. 2**). The surgeon must also be aware of the differences in soft tissue character and density that may lead to earlier failures and scarring when less thorough techniques are used.

Male Facelift Goals

1. Natural unoperated appearance
2. Acute cervicomental angle
3. Gonial angle definition
4. Softening of the nasolabial fold
5. Improvement in lower eyebag protrusion and lid–cheek transition
6. Midface improvements without overvolumization
7. Undetectable scarring
8. Unaltered or improved ears
9. Preservation of vascular plexus and facial hair

ANALYSIS OF THE MALE FACELIFT PATIENT

The remit of this article is facelifts for men, so we have omitted analysis of ancillary rejuvenation procedures such as brow lift and blepharoplasty. Depending on the patients' wishes and subsequent consent, planned modifications to the extended deep-plane procedure can be performed to curate a bespoke male facial rejuvenation. Described are some of the surgical stepwise techniques we employ to address the following common male concerns with a focus on vectorial repositioning and deep contour definition (**Box 1** and **Fig. 3**).

SURGICAL TECHNIQUE

Anesthesia

The procedure is performed under local or total intravenous anesthesia in all cases. Local anesthetic solution of 50 mL of 2% lidocaine, 50 mL of 0.25% bupivacaine, 250 mL of normal saline, 2.5 mL of 1:1000 epinephrine, and 5 mL of sodium bicarbonate. Three milliliters of cyanocobalamin is placed as a colorant and indicator for safety. Tranexamic acid in solution is avoided in large flap surgery for risk of cytotoxicity and vascular compromise but may be given intravenously without much concern.[10]

MANAGING THE NECK

There have been several decades of debate about management of the aging neck.[11–17] Submentoplasty and platysmaplasty are performed in 90% of our patients and nearly all revision or secondary lifts, patients with severe laxity and banding, exaggerated midline descent that would not be corrected with facelift alone, lengthening of the cervicomental distance, laryngeal setback, low hyoid position, and submental deep volume contouring. Liposuction is rarely performed to avoid contour irregularities, darkening the skin and worsening of platysmal banding seen with overaggressive fat removal. Submental work is performed prior to lateral face and neck lifting prior in the majority of cases.

Subplatysmal Contouring

A short submental incision is placed along the internal mandibular border rather than the submental crease to avoid visible migration superolaterally

Fig. 1. Before and after deep-plane facelift and neck lift, brow lift, upper and lower blepharoplasties, and rhinoplasty. Restoration of masculine proportions and contours without tell-tale signs of surgery.

Fig. 2. Before and after deep-plane facelift and neck lift and chin implant. Neck and jawline definition are the predominant masculine goals.

with lifting. Following sharp incision, the supraplatysmal plane is opened with initial sharp dissection then blunt dissection. Dissection is carried inferiorly, stopping at the top of the thyroid cartilage and then continuing laterally to the extent of the retractor. Excessive caudal skin delamination is avoided to maintain a healthy blood supply to the watershed zone of the skin around the cervicomental angle at most 2 cm caudal to the hyoid. The medial or paramedian platysmal bands inferior to the hyoid have medialized over time and need to be moved laterally and vertically to restore proper function and position. The medial platysmal borders of the submental platysma are analyzed and pulled toward the midline to measure laxity. The borders of the submental platysma are then elevated using monopolar electrocautery followed by blunt dissection on the immediate undersurface of platysma keeping deep neck contents down.

Box 1
Assessment of the male aging face

- Lower eyelid fat pad protrusion and/or ectropion
- Malar fat pad descent and the nasolabial fold
- Buccal fat prominence
- Jowls
- Prejowl sulcus
- Gonial angle and parotid size
- Cervicomental angle and hyoid position
- Larynx position
- Thyroid cartilage projection and definition
- Platysmal banding and neck soft tissue redundancy
- Glandular, digastric hypertrophy

Laterally, the dissection continues toward the lateral hyoid at the level of the lateral fascial sling of the digastric muscles. At this point, the submental and submandibular triangular fullness is evaluated, looking at the anterior digastric muscles, submandibular glands, and fatty lymphoid tissue in levels 1a and 1b. The central structures are more easily reduced and are thereby more likely to be over-reduced. When lying supine, the lateral compartment in the submandibular triangle may appear much less ptotic than when sitting the patient upright. For this reason, we recommend beginning reduction with the lateral tissues and remaining more judicious with the medial or central tissues. The central submental compartment should always remain slightly fuller than the anterior digastric and lateral triangles to avoid midline defects such as cobra or pseudo-cobra neck deformity. In most cases, we preserve the midline subplatysmal fat in its entirety.

Although the submandibular glands more often become ptotic than hypertrophic with age, there remains debate about whether or not to perform a submandibular gland reduction.[11,13]

Retrospective review of our cases reveals that imperfect outcomes or failures due to persistent gland or digastric prominence only occurred in 10% of patients prior to application of reduction techniques. For simplicity, in our practices, a submandibular gland reduction is performed if

1. The gland is pushing medially or inferiorly past the sling of the digastric.
2. The circumference of the neck at the hyoid appears too broad.
3. The gland has migrated into an anterior inferior capsule that would not reduce with lifting.
4. Volumetric reduction is required when the platysma would appear too weak to suspend the ptotic submandibular contents.

Fig. 3. Restitution of the youthful male face and neck can be achieved with adjunctive contouring procedures in the deep plane. A 71 year old gentleman exhibited all signs of male face and neck aging in Box 1. Following deep-plane facelift, deep neck contouring of ptotic structure, orbicularis oculi revectoring, and upper blepharoplasty, youthful unoperated masculinity is restored.

The latter can be assessed preoperatively but having the patient apply lingual pressure to their hard palate while seated and palpating the gland with and without platysmal contraction. The creation of dead space in the submandibular triangle and submentum may provide less resistance to central plication and improve lateral lifting in many cases. The surgeon must remain judicious in volumetric reduction to avoid the appearance of excavation. We prefer reliance on lifting to obtain the majority of results.

To perform gland reduction, the medial and inferior portions of the gland are delivered from the capsule and injected with local anesthesia. The gland is then gently pulled medially to release it from the capsule circumferentially until only the stalk from the mylohyoid and floor of mouth remains. This area is then transversely transected using needle-tip electrocautery for cutting and bipolar electrocautery for ligation of ducts and vessels (**Fig. 4**).

Reduction is performed until the inferior gland is at level with the mylohyoid, cephalic to the hyoid, or deep to the mandible. The risk of bleeding increases with more posterosuperior dissection as the vessel caliber increases.[18] Our experience concurs with previous reports that 30% of glands have a perforator inferiorly.[19,20] In the combined 460 cases reviewed in the authors' practices, there have been no sialomas or subplatysmal hematomas without the use of neurotoxin, a subplatysmal drain or capsular imbrication. Although fluid collection may not occur, submental edema and submandibular gland induration might occur. These respond well to postoperative, scheduled manual lymphatic drainage and prior education that the dead space might take up to 12 weeks to contract and often improve for longer.

Fullness of the anterior digastric muscles might also be present. Plication of the digastric muscles is avoided in almost all cases to avoid medialization of the submental contents, although this is a valid option to infill previous midline reduction when needed or temporarily medialize glands to improve access. Complete digastric resection should be avoided to prevent any change in function or loss of support of the underlying mylohyoid muscles. Anterior digastric reduction is performed by strip excision of the outer half of the muscle using bipolar electrocautery and/or scissors (**Fig. 5**).

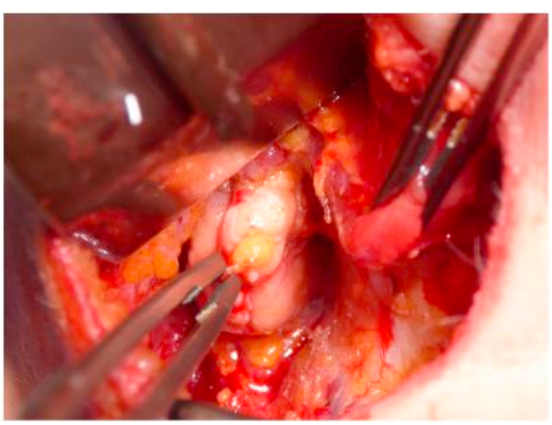

Fig. 4. Intraoperative view of the submandibular gland and the anterior digastric muscle through a 2 cm submental crease incision.

The midline submentum should remain slightly fuller than the paramedian submentum as the midline will retract internally following platysmal plication and even more so when in the vertical position. Anterior digastric reduction may similarly increase postoperative edema in the submentum.

Cervicomental Angle

After the lateral volume has been addressed, the midline can be contoured. Midline banding and residual blunting of the cervicomental angle may be a consequence of platysmal laxity, hypertonicity, or an obtuse line along the deep cervical fascia. To address the cervical angle, the submental deep cervical fascia is grasped and pulled toward the chin, and a horizontal fasciotomy is performed across the prehyoid deep cervical fascia to expose the hyoid periosteum. This separates the infrahyoid and submental deep cervical fascia, permitting tighter approximation of the platysma during plication and sharpening of the cervicomental angle. Thyroid cartilage prominence can be sculpted if necessary, although this is desirable in men. Caution, however, must be taken to avoid overexcavating the prehyoid tissues in a male with a prominent larynx and thyroid cartilage unless a prominent Adam's apple is desired. The thyroid cartilage should be in the same anterior plane as the hyoid from a sagittal view. To avoid a prehyoid indentation in some patients, a submental drawbridge flap may be performed. The submental fat is transposed into the infrahyoid space by releasing the fat pad from the direction of the submental crease with a pedicle just above the hyoid. Following transposition, this fat pad may be secured with a suture or upon plication of the platysma in front of the fat pad.

Platysmaplasty is then performed using a classic platysmal plication technique.[21,22] Cadaveric studies have demonstrated that full plication platysmaplasty may limit the extent of vertical lifting in the face.[23,24] We believe that this effect is neutralized by limiting plication to submental platysmaplasty alone without infrahyoid extension.

To perform the plication, the platysmal edges are approximated in the midline using buried 2-0 polyglactin (Vicryl) sutures beginning in front of the hyoid advancing toward the incision with 3 or 4 figure of 8 mattress sutures or with a running vertical mattress.

Once the midline submental platysmal plication is completed, the cervicomental angle is palpated to check for midline banding. If a band is palpated,

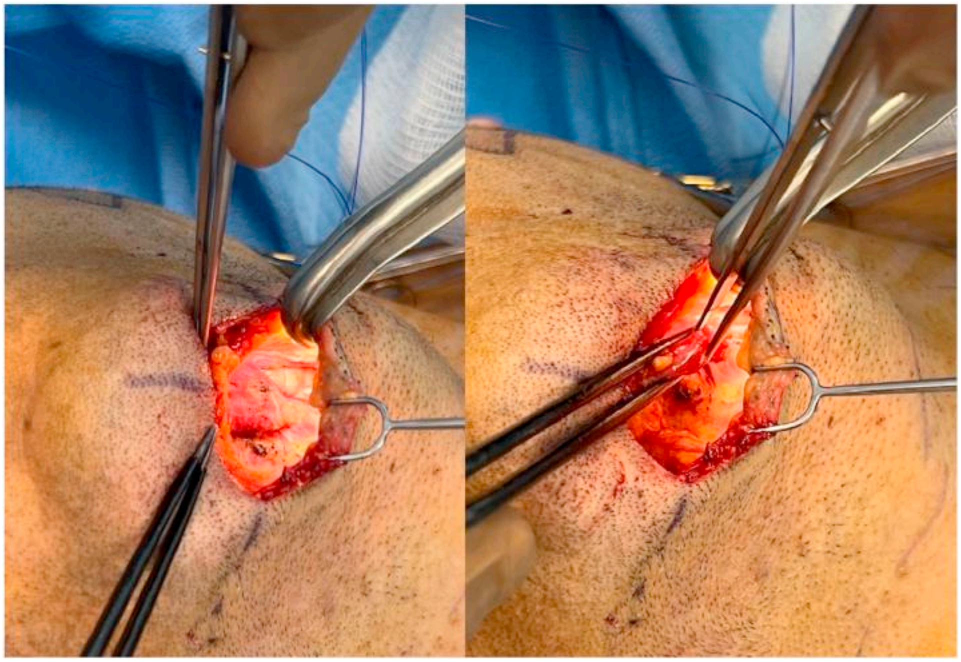

Fig. 5. Anterior digastric muscles are assessed for size and prominence and can be linearly reduced to sharpen the cervicomental angle.

a transverse or oblique myotomy is performed in the central 1 cm just inferior to the hyoid to release it. This is performed by retracting the platysma and incising the lower, medial third of the platysma using Metzenbaum scissors or monopolar electrocautery while keeping the deeper platysmal fascial layer intact to envelope the vessels and deep neck contents. The lateral two-thirds of the platysma should not be interrupted to avoid the loss of muscle integrity during the vertical lifting. If any dehiscence of the platysma has occurred, running plication may be performed to avoid herniation of deeper tissues.

Laryngeal Setback

The only benefit of infrahyoid platysmal plication is to posteriorly reposition the thyroid cartilage and larynx. This helps avoid prominence of the thyroid cartilage in patients where this is undesirable. Laryngeal setback can also have a profound effect on circumferential narrowing of the neck and by lengthening the cervicomental distance in those patients with a degree of retrognathia. The benefits of laryngeal setback or prelaryngeal platysmal plication must be weighed against associated limitation in lateral vertical facial lifting, which may be substantial. In most cases, we prefer to use the submental drawbridge flap, described earlier, to fill the infrahyoid indentation and soften the appearance of the thyroid shield from the lateral view.

EXTENDED DEEP-PLANE FACELIFT AND NECK LIFT

Marking and Skin Elevation

Incision markings are made followed by reference markings for the deep-plane entry point and Pitanguy's line. The entry design in our practices has been adapted using the "sailboat modification" to improve the positioning of the deep-plane entry point. This maximizes the composite area of the flap by reducing the delaminated skin at closure assuming the deep entry line will inset the temporal tuft incision angle. Limiting the amount of skin delamination may decrease ischemic effects on the distal flap including discoloration, beard hair loss, and telangiectasias as well as operative dissection time (**Fig. 6**).

It also improves volume along the zygomatic arch and lateral flap and lowers the chance of damaging the zygomaticus muscle complex. In addition, the superficial musculoaponeurotic system (SMAS) is thicker laterally providing easier entry and a better cuff for suspension.

Incisions are made with a No. 10 blade scalpel around the temporal tuft following the prehelical crease. The incision is placed in the immediate pretragal crease when present or in a retrotragal line when absent. The incision follows around the earlobe up the postauricular sulcus and crosses to the hairline as the mastoid flattens. The posterior limb incision follows the occipital hairline around 2.5 to 3.5 cm in most patients but can be

Fig. 6. Limited delamination of facial skin with the sailboat flap modification reduces skin stigmata of facelift trauma. Note no preauricular facial telangiectasia, but diffuse telangiectasia where a postauricular skin flap was raised. Scars are well concealed; earlobe shape and polarity are maintained; and hairline unaffected with careful incision planning and tensionless repositioning of facial soft tissues.

omitted in some. Incisions extending tangential into the occipital hairline are avoided to prevent hairline distortion and limitation in vertical lifting and redistribution.

Elevation of skin is performed with a No 10 blade scalpel in the subdermal plane leaving hypodermal fat on the reticular dermis to avoid violating the dermal vascular plexus or beard hair follicles, followed by scissor dissection and tension using the Anderson bear claw retractor and assistant counter tension. The postauricular skin is then elevated and connected to the facial skin dissection around the earlobe. The subcutaneous dissection continues using the Steven's Kaye scissors, bluntly spreading the supraplatysmal plane in the right hand while using a lighted facelift retractor in the left. The dissection is carried directly on the platysma to the midline. If a submental procedure was performed first, the 2 cavities may be connected at this point (**Fig. 7**).

Deep-Plane Transition

The sailboat line is marked on the SMAS deep-plane entry point and incised with a No 10 blade scalpel or monopolar needle with the dominant hand, while the other hand retracts the flap upward using a bear claw multiprong retractor. The deep plane is then entered and elevated beginning at the lateral border of the facial platysma where the risk is low.[25] Blunt dissection is performed with vertical spreads of the Steven's Kaye scissors and continues anteriorly over the masseter, which is considered the deep glide plane or mobile portion of the SMAS–platysmal complex. Dissection ceases at the anterior border of the masseter and then continues inferiorly into the neck. Dissection is then performed on the underside of the platysma to elevate it off the tail of the parotid fascia inferior to the mandible. Dissection may continue inferior to the parotid tail where the platysma overlies the sternocleidomastoid muscle (SCM) and the external jugular vein. The decussation plane of fibers that exists between the lateral platysma over the fascia of the parotid tail is referred to as the cervical retaining ligaments. In the authors' experience, these dense fibers are found over the parotid and not over the SCM, as described in prior publications. A marking pen is then used to delineate the lateral border of the platysma and the cervical retaining ligament from the tail of the parotid, extending inferiorly to the external jugular vein, where the retaining ligament terminates as a mobile plane again (see **Fig. 6**). Blunt dissection using vertical spreads with the Steven's Kaye scissors is then used from the top down to release the cervical retaining ligaments off of the parotid tail, continuing inferiorly over the SCM and the external jugular vein where the mobile platysma elevates off easily. Great care is taken to avoid cervical facial nerve branch dissection and the small branches to the depressor labii inferioris under the platysma.

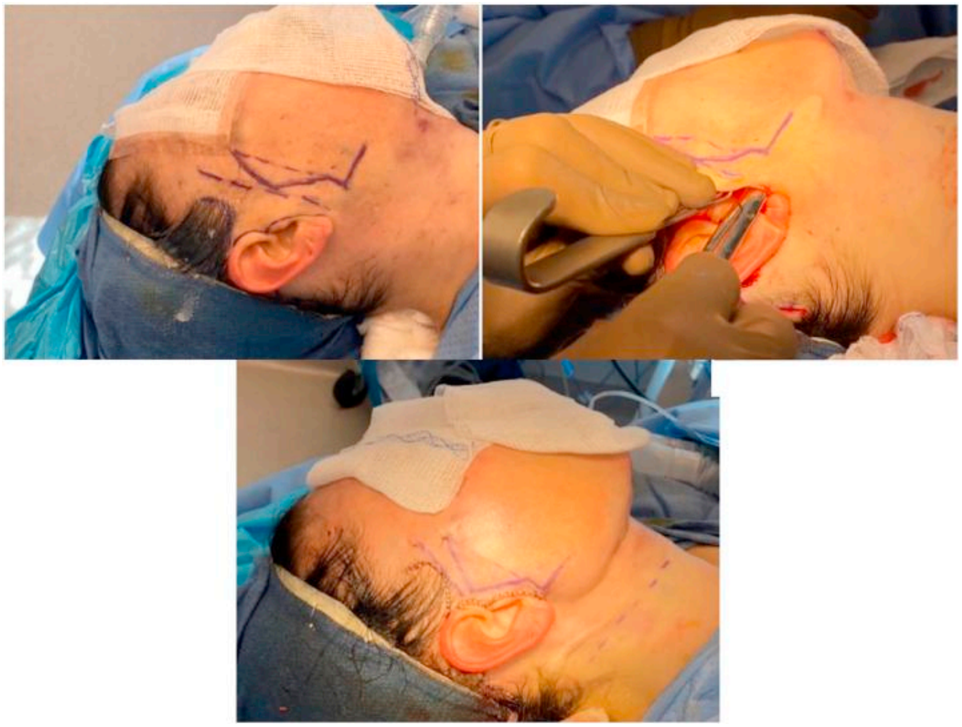

Fig. 7. Skin marking and sailboat modification of deep-plane transition point. Neck skin delamination is reserved for just 2 cm below the inframandibular border and the composite flap insets into the temporal tuft incision leaving minimal facial skin undermined at closure. We have termed this "Preservation facelift."

The midface dissection is performed next. The sailboat modification provides a thicker flap laterally that begins over the lateral extent of the zygomaticus muscles. Care must be taken to avoid transection of the lateral zygomaticus musculature, which may cause dimpling with smiling or smile block.[26] If partial or complete transection occurs, the muscles may be repaired with running absorbable sutures. The surgical plane in this region is contiguous with the plane of the platysma and contains the subdermal fatty fascial layer that we refer to as the fascial SMAS. Midface release is performed using blunt dissection to enter the sub-SMAS plane directly on top of the zygomaticus and orbicularis musculature. The orbicularis overlaps the zygomaticus muscle slightly at the point where the SMAS layer thins and tapers off over the orbicularis oculi. This zone is neither considered fixed SMAS (parotid region) nor mobile SMAS (platysma over SCM and masseter). Rather, a supramuscular dissection is performed to allow proper mobilization of the facial soft tissues without negatively impairing or affecting mimetic muscle function.

Orbicularis Retaining Ligament Release

The dissection can be extended in selective cases—which are identified and consented preoperatively to include lagopthalmos, lateral eyelid bowing, postblepharoplasty ectropion, or aging scleral show—so as to incorporate a cuff of orbicularis in the SMAS composite flap by bluntly releasing the outer and inner lamellae of the orbicularis retaining ligament (ORL) in the suborbicularis space. Care should be taken to tangentially transect the orbicularis for 0.5 to 1 cm and only between 4 to 5 o'clock on the left side and 7 to 8 o'clock on the right side to avoid damage to surrounding facial nerve branches, namely, the temporal branch above and the buccal/zygomatic branches below.[27] Finger palpation of the suborbicularis space confirms full release to the arcus and gentle retraction on a Pitanguy flap clamp applied to the orbicularis–SMAS cuff confirms capture of the lower eyelid complex and cranial mobility of the lower lid margin to a more esthetically pleasing and youthful position, as well as deherniation of the suborbicularis oculi fat and softening of the palpebromalar sulcus (**Fig. 8**).

Midface Release

Dissection is carried in an inferomedially with blunt vertical spreads of the Steven's Kaye scissors or with a Trepsat dissector pointing toward the nasal alar base angled 10° deep. Tactile, percutaneous feedback helps maintain the proper plane of dissection as the SMAS release continues toward

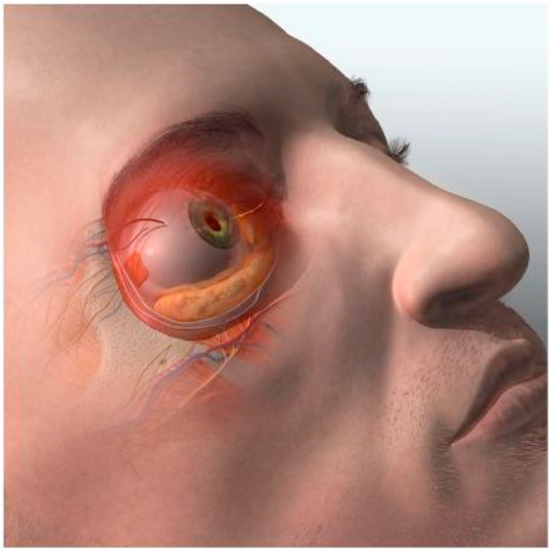

Fig. 8. The orbicularis retaining ligament (ORL) is a bilaminar structure. Safe tangential orbicularis transection and release of the ORL at defined points enable elevation of the midface en bloc and correction of postblepharoplasty or age-related scleral show and lateral lid bowing.

the nasolabial fold inferiorly and the nasal bridge medially. At this point, the buccal decussation zone is the only remaining area that needs to be released to connect the sub-SMAS pockets of the neck and midface. The lateral extent of the zone has been referred to as McGregor's patch or the zygomatic cutaneous ligaments.[28] This dense region of osteocutaneous fibers extends from bone to skin and anteriorly along the maxilla. Although release of this zone may occur at the level of skin or deeper along the bone, we believe the most effective release to occur at the level of the deep plane, allowing mobilization and repositioning of the fascial SMAS and superficial malar fat pad. Incision is performed under vertical counter tension sharply incising through roughly a 1 $\times$ 1 cm patch until palpable release of the reticular fibers is achieved. The transverse facial artery perforator exits in this region or anterior and inferior to the patch in 1 to 2 branches in most cases. When transected, bipolar cautery avoids the facial hematoma with the assistant watching the face for facial nerve stimulation. Elevation then continues anteriorly along the line of the parotid duct through the buccal decussation plane which contains the junctional interweaving fibers of fascial SMAS and platysma. These fibers must be released off the buccal capsule to permit full mobilization of the midfacial flap. Dissection typically terminates at the anterior extent of the buccal capsule, where platysmal fibers are seen diving deep and inserting into the fascial SMAS. If the buccal fat is protruding or proptotic, it may be reduced. A small shelf is then made along the sailboat entry line, to provide a composite cuff for suspension. The facial flap is then repositioned and fixed via a cuff to the temporal parotid and tympanoparotid fascia (Lore's fascia).[29,30] Nonabsorbable or absorbable sutures can be used for the deep-plane suspension, as long as the sutures are positioned under no tension toward the individual patient's vector of greatest elevation. Confirmation of the greatest vector and position for suspension is achieved with palpatory feedback and the avoidance of bulging on either side of the incision rather than looking for the greatest effect of lifting remotely and distally. The proper appearance cannot be assessed with the patient swollen and supine. The vector of aging for that particular patient might not be the same on each side and is confirmed by passing a suture through the apex of the composite sail pulling the cranial end cranially, the lateral posteriorly with equal tension to lift the midface, jowl, and neck in vector of maximal correction. This demarcates the fixation point and if correctly designed should inset in to the 90° perihelical–temporal tuft skin incision, leaving minimal skin delaminated.

Gonial Angle

Once the facial flap has been suspended, the cervical retaining ligament patch is mobilized vertically, posteriorly, and deep in all X, Y, and Z dimensions to maximally manipulate and restore neck contours. Classically, the platysmal flap is posterosuperiorly lifted and sutured to the lateral mastoid fascia using a myotomy or transposition flap. Although this may provide a strong area for fixation, it may blunt the gonial angle in patients with a broad mastoid bone and fail to fully restore the submentum, as it most often will provide a less vertical vector than needed. To overcome the structural limitations of lifting over the mastoid, the second author (BT) has developed a technique—the "mastoid crevasse" which has substantially improved surgical outcomes in a large variety of patients (**Fig. 9**).[31]

The mastoid crevasse technique overcomes all natural limitations caused by variances in mastoid tip height and width as well as mandibular ramus height and position. The mastoid crevasse is opened by a vertical incision using needle-tip monopolar electrocautery along the anterior mastoid line. Incision is made down through the mastoid fascia to expose the anterior wall of the mastoid tip. The mastoid tip is bordered by the parotid tail anteriorly, the conchal bowl and ear canal

Fig. 9. Suborbicularis space dissection and orbicularis retaining ligament release incorporate lateral orbicularis into the SMAS–platysmal composite flap during deep-plane facelift. In some patients, this might obviate the need for lower blepharoplasty by using an orbicularis hammock to deherniate infraorbital fat pads.

superiorly, and the SCM inferiorly. Anteriorly, this dissection frees the parotid tail from the mastoid allowing the parotid and surrounding tissues to be compressed back into the deep pharyngeal space. Superiorly, the conchal bowl can be elevated very slightly to facilitate a more vertical repositioning of the platysmal cervical retaining ligaments, allowing a more substantial correction of the inferior neck and submandibular triangle. Inferiorly, the dissection stops at the SCM to avoid greater auricular nerve damage. The facial nerve exits the stylomastoid foramen 1 cm deep.

Parotid Reduction

If parotid hypertrophy is present, a minor tail of parotid reduction may be performed at this point to reduce the tail of the parotid, although this may introduce a minor risk of sialoma and should only be performed as needed. The fascia overlying the parotid tail is elevated reflecting the great auricular nerve within the fascia. A wedge of parotid can safely be excavated from underneath the retracted fascia. Parotid excision is limited to the anterior border of the great auricular nerve while avoiding any excision deep to the mastoid tip to avoid any heat dispersion to the facial nerve as it exits the stylomastoid foramen. Wedge removal provides increased collapsibility of the parotid and less resistance to platysmal lifting and inset of the parotid tail into the deep pharyngeal space. The fascia should be closed to lessen the risk of parotid gland exposure and potential sialoma. If sialoma occurs, treatment with a combination of bland diet, anticholinergic patches, botulinum toxin injections,[32] serial aspiration,[33] suction drainage, and/or compression with a bolstered gauze and silk net provides the compressive surface area to provide sialostasis far better than a net alone (**Fig. 10**).

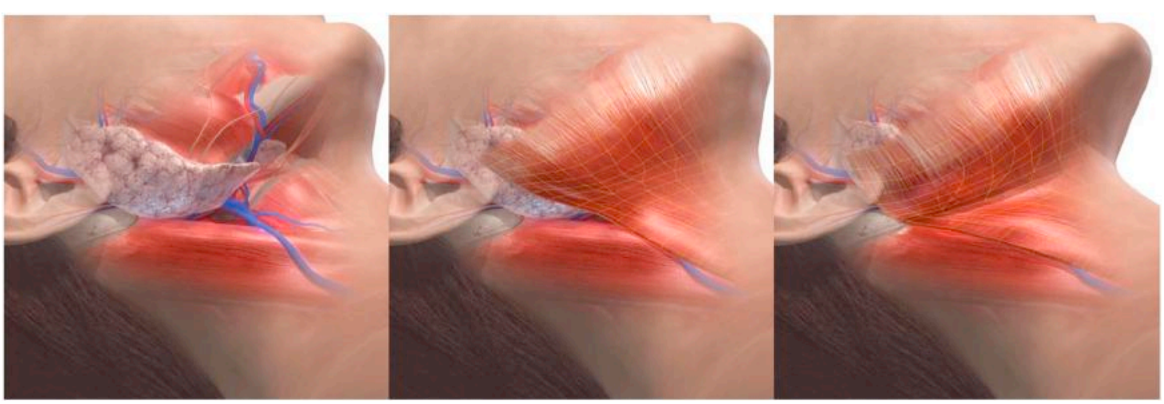

Fig. 10. The mastoid crevasse. Lateral platysma inset deep on to the anterior mastoid process enables true vertical platysma elevation, inframandibular border depth, and definition and contour creation of the mandibular ramus.

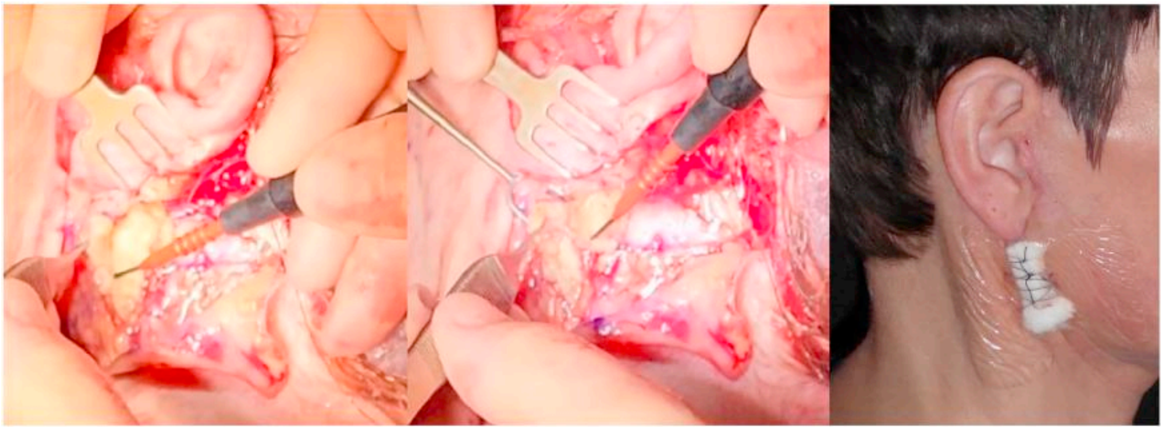

Fig. 11. (*A*) Dissection under superficial cervical fascia, reflecting the great auricular nerve forward enables hypertrophic parotid tail reduction to slim the lower facial third and define the ramus better. (*B*) Sialoma can be effectively compressed with a bolstered net, along with antisialogogues, a bland diet, botulinum toxin type A injection, and serial aspiration or drainage.

Lateral Necklift Crevasse Inset

Exposure of the anterior mastoid line allows inset of the platysma into the anterior mastoid rather than an onlay over the mastoid. This provides a better position of fixation with substantially improved gonial angle depth and vertical platysma movement. It is important to maintain continuity and integrity of the inframandibular platysma, which directly elevates the hyoid and submental contents. This also aids better encapsulation of the parotid gland and tail, slimming the lateral facial fifths, especially in patients with parotid hypertrophy.

The divided cervical retaining ligament condensation of the lateral platysma is sutured on the anterior mastoid wall. The placement should be as vertical as possible, extending deep to the conchal bowl. The inframandibular platysma is tethered deep to the gonial angle, which serves as a lateral pulley or fulcrum, which has a secondary movement against the lateral hyoid and tertiary pull against the chin. This results in a more substantial elevation of the hyoid as it now swings vertically to or above the level of the chin and mandibular border. With the hyoid in a more internal and superior position, a greater correction of the anterior digastric slope and bowing is achieved, with restoration of the submandibular triangle contents toward the floor of mouth, resulting in a negative vector submentum in many patients (**Fig. 11**).

Myotomy is limited or avoided unless tethering of the platysma exists across the span of the gonial angle. If needed, partial myotomy or fasciotomy is performed in the shape of the gonial angle,

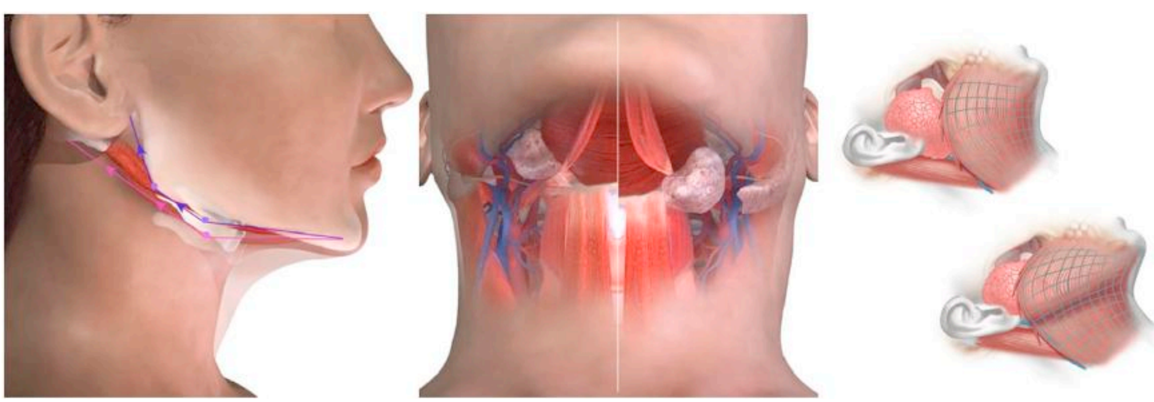

Fig. 12. The inframandibular platysma is tethered deep to the gonial angle, which serves as a lateral pulley or fulcrum and which has a secondary movement against the lateral hyoid and tertiary pull against the chin. This enables substantial vertical elevation of the hyoid to or above the level of the chin and the mandibular border. With the hyoid in a more internal and superior position, a greater correction of the anterior digastric slope and bowing is achieved, with restoration of the submandibular triangle contents toward the floor of mouth, resulting in a negative vector submentum in many patients.

avoiding a full myotomy or release. This will help form the shape of the vertical ramus and gonial angle while maintaining integrity of the inframandibular platysma (**Fig. 12**).

Contrary to antiquated beliefs, limiting skin dissection in the neck improves the gains achieved in skin quality. The true improvement in the appearance of the skin comes as a result of the formation of depth and contour rather than from stretching or pulling. There should be no tension on or around the soft tissues of the ear, assuring prevention of a pixie ear or telltale rotation of the ear.

Excess skin is then trimmed. A tension-free closure at all points helps ensure minimization of scarring.

Dermal sutures are avoided if possible to limit ischemia that may be caused by constriction of the dermal plexus as well as to avoid suture spitting that may result in atrophic or hypertrophic scarring. A No 7 French round drain may be placed in the neck bilaterally overnight. The suction tubing is mainly used to aid in redistribution of skin and to drain off blood-tinged, seromatous exudate rather than for actual prevention of a hematoma. Netting sutures are not routinely placed but saved for noncomposite areas of the neck skin delamination in hypertensive patients at risk or excessive bleeders, and they are removed after 72 hours. A soft headwrap is placed overnight with great care to avoid compression ischemia at the cervicomental angle.

SUMMARY

Men rightly fear the telltale signs of facelift surgery and have historically been less inclined to seek surgical rejuvenation of the aging face. The deformities of both tension and vector caused by superficial, nonligament releasing, tension-based SMAS techniques have made men a discerning facelift demographic seeking higher quality results today. As professional and social lives extend well into the sixth decade and beyond, men are an increasing subset of our patient base.[7] Using the techniques described in this article, we can deliver male patients predicable, unoperated outcomes, providing proper and impressive changes around the face, jawline, and neck. Structure is returned to such an extent that most patients perceive such a restoration as completely customized to their needs and restoration of their specific aging changes. While surgeons treating female patients primarily seek midface volume increase and a smooth ogee curve, when treating men we may be more focused on a strong, masculine jaw and neck line. Using more advanced techniques, as described in this article, all of these improvements may be universally achieved in both men and women without a fear of looking operated. Men and women both have a human face that will look natural on the outside if they are kept anatomically natural on the inside.

CLINICS CARE POINTS

- To some extent, the goals of male facelift and neck lift surgery (cervicomental angle, gonial angle, and submental and facial contour) can be anatomically customized to patient personal preference.
- Three-dimensional vectoring at the gonial angle is more important than maximal lateral distraction of the platysma in neck lift outcomes.
- Limitation of skin dissection may decrease ischemic effects on the distal flap including discoloration, beard loss, and telangiectasias, and operative dissection time and hasten visible recovery in male patients.
- Elevation of the cervical retaining ligaments allows for stronger mobilization of the fixed platysma of the parotid tail and provides a stronger density of tissue to suspend relative to weaker, more friable platysmal muscle.
- ORL release is a powerful addition to the SMAS–platysmal composite flap and can obviate the need for concomitant lower blepharoplasty in some patients.
- Any subplatysmal midline reduction necessitates equal lateral deep neck reduction. Failure to do so may result in a relative appearance of submandibular gland ptosis causing cobra or pseudo-cobra neck deformity.

DISCLOSURE

The authors have nothing to disclose. The techniques and methods outlined in this article are the opinions of the authors.

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Extended Composite Approach to Deep Plane Face Lifting with Deep Contouring of the Neck and the Nuances of Secondary and Tertiary Facelifting: Principles for Restoration of Natural Anatomy and Aesthetically Attractive Face and Neck Contour

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Facial Plast Surg

Abstract

Patients seek second facelifts either due to dissatisfaction with the primary procedure or years later after continued face and neck aging following successful first surgery. Previous surgical anatomical disruption, deformity of tension and vector, scar formation and skin excision compounded by the proliferation of historical energy-based skin treatments, thread lift procedures, and injectables make revision rhytidectomy a complex process of causal identification and surgical repair. Patients seeking revision due to dissatisfaction with a primary procedure, or worse visible deformity, have a heightened sense of anxiety which necessitates accurate diagnosis, careful examination, comprehensive documentation, and confidence in any planned secondary intervention as well as conservative expectation management. This article outlines the author's approach to identify the challenges posed and successfully perform secondary and revision rhytidectomy using a modified extended deep plane approach.

Keywords
- revision
- facelift
- neck lift
- secondary facelift
- deep plane facelift

The patient requesting revision facelift presents a potentially complex surgical and psychological challenge.[1] Contemporary society has become increasingly critical of facial appearance, the explosion of digital photography, online avatars, video conferencing, carefully curated lighting, postproduction editing, photographic filters, and makeup have seen the aesthetically aware public increasingly seek facial plastic surgery to correct all perceived flaws and optimize their facial appearance.[2] Recent technical advances, focused expertise in niche facelift practices, and online before and after galleries have rightly set expectations high. Facial plastic surgery and specifically rhytidectomy has a high satisfaction rate leading to previously happy patients requesting secondary rhytidectomy years later for continued natural facial aging.[3] However, if prior expectations of primary facelift surgery are not met or there are visible stigmata of surgery, revision surgery is sought by a patient who is not only a more challenging surgical case but might have diminished trust in the process of surgery as a whole. It is common for both secondary and revision facelift patients to present having already tried less invasive nonsurgical treatments such as radiofrequency and ultrasound skin tightening, thread lifting, and/or injectable volumizers and biostimulators.[4] These interventions might compound the challenge facing the facial plastic surgeon with tissue scarring, tethering, plane adhesion, and deformity making revision rhytidectomy a more technically demanding complex and riskier procedure.[5–8] Despite this, satisfaction rates remain high in revision rhytidectomy.[9] In this article, the author

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describes the assessment, management, challenges, and principles of secondary and revision rhytidectomy using a modified extended deep plane approach.

Revision Facelift Assessment and Challenges

A wealth of information online has led to an increasingly discerning and educated patient demographic. The patient presenting for revision facelift will often be aware of technical lift failure or specific deformities of tension and vector, equally patients might present requesting revision rhytidectomy after an expertly performed and well-healed outcome that has not met their expectation or specific aesthetic taste. The revision facelift surgeon must be aware of tissue limitations, their own technical ability and mutual aesthetic preferences, previous interventions, and often masked psychosocial aspects of patient dissatisfaction.[10]

Patient Assessment

In an increasingly global marketplace, patients will often seek international secondary opinion precluding easy in-person consultation and examination. Detailed knowledge of medical history, previous surgical technique, challenges in previous surgery and/or recovery, and intervening nonsurgical intervention are essential in revision surgical planning. While a thorough history and photographic analysis can be undertaken and comprehensively documented remotely, a detailed physical examination is essential prior to revision rhytidectomy. The face and neck should be methodically examined[11] paying attention to glide plane adhesion, contour irregularity, skin and soft tissue laxity and/or tension, skin quality, preauricular skin reserve, and surgically created deformity.

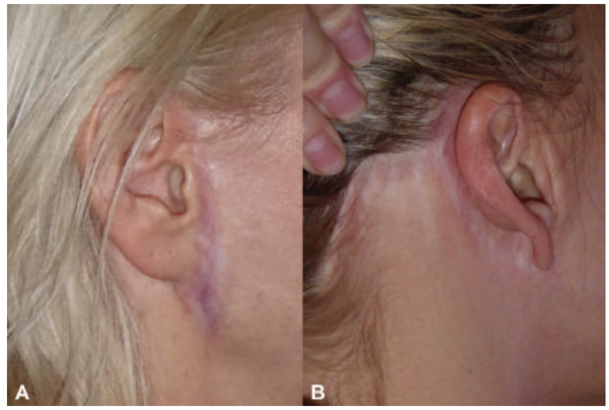

Fig. 1 (A) Hypertrophic, preauricular scar due to skin tension and (B) hairline step deformity due to poor incision planning.

Common Examination Findings

Even in a perfectly performed previous rhytidectomy without skin tension at closure, any tension-based facelift without full ligament release will inevitably lead to tension transfer to the skin incision[12–14] (►**Fig. 1**).

Preauricular skin tension, reserve, quality, vascularity, and telangiectasia should be assessed.[15] Scar atrophy, migration, and hypertrophy, tragal blunting or amputation, hairline disruption,[16] ear pole rotation and pixie ear deformity,[17] contour irregularity, and altered rhytid direction might suggest inappropriate tension that will need to be released and revectored (►**Fig. 2**).

The midface should be assessed for mobility, smile block,[18] volume, and descent.[19] Lateral vector superficial musculoaponeurotic system (SMAS) lifts might over time create the juxtaposition of preauricular lateral tension and

Fig. 2 Atrophic scarring and lift failure 2 years after a superficial musculoaponeurotic system (SMAS) minilift and following revision deep plane face and necklift and deep neck reduction.

pendular medial midface descent leading to suborbicularis oculi fat (SOOF) herniation, lagophthalmos, lateral lid bowing and scleral show in the upper midface, and lateral sweep, malar descent, and/or buccal fat pseudojowl herniation in the lower midface.[14] All facial nerve movements should be examined for movement and synkinesis.[20,21] The neck should be carefully evaluated for superficial fat loss from liposuction, cryolipolysis, and/or deoxycholic acid injections with adherence of skin to underlying platysma. The platysma is assessed for integrity, banding, strength, and hypertonicity. Cobra neck deformity is a submental concavity from prior central interdigastric fat reduction, with visible paramedian submandibular gland and/or digastric muscle convexity.[15,22,23] Previous scars and hairline should be examined for temporal tuft amputation or postauricular step.[16] Errors of omission are common. The face and neck are one anatomical unit and a facelift should always include a neck lift and vice versa.[24] Other body scars should be assessed for healing and a detailed history to exclude collagen connective tissue disorders if poor scarring is the presenting complaint. All findings should be carefully documented with preoperative photography and/or videography if necessary (►**Fig. 3**).

Previous Interventions

It is almost ubiquitous in the modern paradigm that patients have already sought a nonsurgical alternative to improve their facial appearance. These add a degree of complexity and risk to any revision procedure.[5–8] While previous surgical scarring is expected it is usually predictable and easily dissected. In the author's experience, energy devices using plasma and ultrasound can create unpredictable dense scarring across several planes complicating tissue dissection and significantly increasing the degree of tissue trauma increasing the risk of poor flap integrity, tissue tearing, and nerve injury. Injectable biostimulators occasionally act like tissue glue fusing glide planes with dense scar. Nonabsorbable thread lifts impede dissection and resist tensionless repositioning of released glide planes. They require removal and are often barbed or entwined in facial nerve branches (►**Fig. 4**).

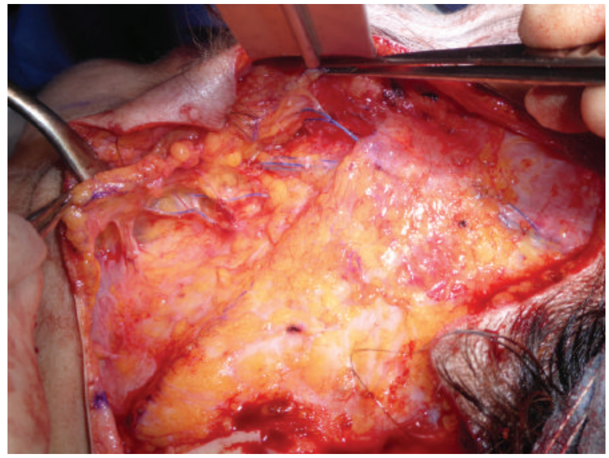

Fig. 4 Nonabsorbable barbed monofilament threads under composite deep plane flap entwined in buccal and zygomatic facial nerve branches.

Injectable fillers do not hinder surgical dissection but might increase recovery due to edema and water retention[25] (►**Fig. 5**).

Expectation Management

Patients seeking a secondary rhytidectomy years after their successful primary have trust in the procedure and recovery

Fig. 3 Superficial musculoaponeurotic system (SMAS) lift earlobe pole rotation, pixie ear deformity, and atrophic scarring and after revision deep plane face and neck lift.

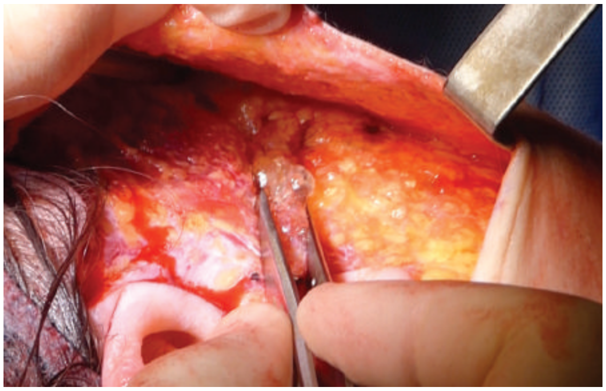

Fig. 5 Hyaluronic acid filler persisting over a decade after injection might prolong surgical edema.

and have firsthand experience. Conversely, patients seeking a revision facelift due to dissatisfaction present a more complex problem. In both, an open and frank discussion regarding their goals and expectations is key. The former group will by definition have tissue quality a decade older and the latter previously operated scarred tissue. Both are higher complexity and risk compared with primary surgery, but the revision facelift group has also lost trust in the procedure and/or their previous facial plastic surgeon. This should be compassionately addressed with impartiality. These patients might be seeking redress and/or looking for confirmation of assumed previous malpractice. It is always best to encourage them to look forward not backward, remain an impartial advocate, identify the concern, and how it might be addressed.[18] The threshold for satisfaction in this group is lower. Realistic expectations should be set, natural asymmetries discussed, a full discussion of heightened risks, no guarantees made, and everything documented meticulously. The author has a low threshold for declining to undertake revision surgery if prior resentment persists and will offer counseling before considering surgery.

Revision Rhytidectomy Principles

The goal of any facelift surgery is a happy patient. Patients are happy when they look naturally rejuvenated without signs of surgery. The best way to achieve this is to restore tension-free anatomy, unrestricted glide planes, and ensure balance and harmony across all facial subunits. The face and neck should always be addressed as one unit. Concomitant brow lift, blepharoplasty, and skin rejuvenation are often required. Deeper tissue contouring and angles can be customized to patient preference. A secondary rhytidectomy requires meticulous identification of issues, their cause, and surgical planning. It is often possible to plan incisions around naturally concealed contours even if previous scar excision is planned. Suboptimal scars are usually due to immediate or delayed skin tension and migrate allowing new trichophytic incisions to be made optimally. Hairline shift or temporal tuft amputation is best addressed secondarily with follicular unit transplantation.[26]

The SMAS and platysma are weaker in secondary and revision facelift patients. The facial plastic surgeon should be aware that careful dissection of a thick composite flap is needed to prevent tearing of the weaker thinner SMAS during elevation,[9] which is why the author uses a preservation approach to limited skin delamination.[27,28]

Tension Release and Revector

Faces and necks age in a pendular fashion. Gravitational inertia causes the skin and soft tissue envelope to descend along the sub-SMAS glide plane. Patients commonly seek revision rhytidectomy when these principles have not been followed. Most signs of facial aging present in the central three-fifths, yet most SMAS level facelifts tighten the lateral fifths with SMAS plication, resection, or imbrication. Between the tightened lateral fifth and central three-fifths sit the retaining ligaments of the face which resist lateral tightening. Over time, this resistance transfers tension to the incision line causing scar migration, atrophy, ear pole shift, and pixie ear deformity. Lack of lift anterior to the retaining ligaments leads to juxtaposition of preauricular tension and midface failure, lateral sweep deformity, and jowl recurrence[29] (►**Fig. 6**).

Similarly, in the neck insufficient release leads to recurrent platysma banding and/or pseudo-cobra neck deformity due to failure of the submental muscular sling (►**Fig. 7**).

In almost every revision rhytidectomy case in the author's practice, the patient has presented with dissatisfaction due to tension and vector. The goal of revision surgery is to restore natural anatomy by releasing all tension, and repositioning the skin and soft tissue envelope. This is achieved with a modified extended deep plane approach which respects normal anatomy and guide planes with deeper structural tissue contouring where appropriate (►**Figs. 8** and **9**).

Deep Structural Contouring

Deep Neck Reduction

Blunting of the cervicomental angle is rarely due to superficial fat excess and is more commonly due to platysmal laxity with or without deep neck glandular and/or muscular ptosis. The latter can be assessed preoperatively but having the patient apply lingual pressure to their hard palate while seated and palpating the gland, deep fat, and digastric muscles with and without platysma contraction. The creation of dead space in the submandibular triangle and submentum may provide less resistance to central plication and improve lateral lifting in many cases (►**Fig. 10**).

The revision facelift surgeon must remain judicious however in volumetric reduction to avoid the appearance of excavation. Overresection centrally while attractive supine intraoperatively will lead to cobra neck deformity later while upright and global overresection might lead to a gunshot neck appearance[22,23] (►**Fig. 11**).

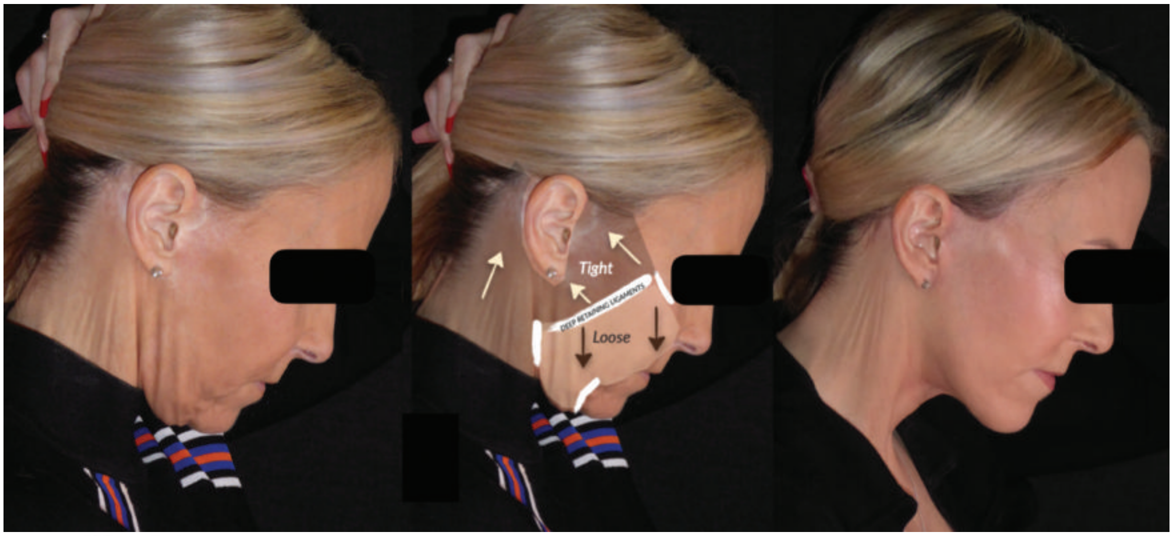

Fig. 6 Juxtaposition of preauricular tension and central face pendular descent with atrophic migrated scarring and lateral sweep in a patient having undergone superficial musculoaponeurotic system (SMAS) lift and after 6 months deep plane revision rhytidectomy with full ligamentous release and redrape.

Buccal Fat Reduction

Buccal fat prominence is best assessed intraoperatively after full release in the deep plane. Only recently as deep plane facelift surgery becomes popularized are surgeons routinely considering the contribution buccal fat makes to an attractive ogee curve in facelifting.[30] Ptotic or prominent buccal fat pads might be genetic, or become apparent due to disruption of SMAS integrity. They can be reduced or suspended[31] easily under a composite deep plane flap (►**Fig. 12**).

Parotid Reduction

Where lower facial third slimming is required and/or there is parotid hypertrophy, a superficial parotid lobe reduction can be performed within the mastoid crevasse. Wedge removal provides increased collapsibility of the parotid and provides less resistance to platysmal lifting and inset of the parotid tail into the deep pharyngeal space. It is essential to close the capsule meticulously and inject botulinum toxin into the exposed gland to avoid sialoma in these cases (►**Figs. 13** and **14**).

Midface Correction/Orbicularis Revectoring

Prior lateral vector tension with or without ligament release might devolumize the midface and reduce lower lid support.[14] The midface dissection can be extended in selective cases with lagophthalmos, lateral lid bowing, postblepharoplasty ectropion, or aging scleral show to incorporate a cuff of orbicularis in the SMAS composite flap by bluntly releasing the outer and inner lamellae of the orbicularis retaining ligament in the suborbicularis space after prezygomatic space entry and zygomatic cutaneous ligament release. Care should be taken to tangentially transect orbicularis for 0.5 to 1 cm and only between 4 and 5 o'clock on the left side and 7 and 8 o'clock on the right side to avoid damage to surrounding facial nerve branches, temporal above and buccal, zygomatic below[32] (►**Fig. 15**).

Finger palpation of the suborbicularis space confirms full release to the arcus and gentle retraction on a pitanguy flap clamp applied to the orbicularis-SMAS cuff confirms capture of the lower lid complex and cranial mobility of the lower lid margin to a more aesthetically pleasing and youthful position, as well as deherniation of the SOOF and softening of the palpebromalar sulcus (►**Figs. 16** and **17**).

Skin Preservation Deep Plane Facelift

The preauricular skin quality in secondary and revision rhytidectomy is often poor, thin, and marked with telangiectasia. The SMAS is also weaker and thinner.[9] This might be due to older age at time of secondary surgery or tissue integrity change following prior elevation and subsequent scarring. Preoperative measures such as nicotine cessation, hyperbaric oxygen, and lymphatic drainage are useful adjuncts. Tranexamic acid should be avoided in the tumescent solution but is given intravenously.[33] Reelevating a wide preauricular skin flap before the deep plane transition anterior to Pitanguy's line, risks further vascular compromise, skin quality detriment, and leaves a temporary dead space for fluid accumulation. For this reason, the author uses a modified deep plane entry incorporating the sailboat modification and limits cervical skin undermining—the preservation deep plane facelift.[27,28] This maximizes the composite area of the flap by reducing the delaminated skin at closure assuming the deep entry line will inset the temporal tuft incision angle (►**Figs. 18** and **19**).

Limiting the amount of skin delamination may decrease ischemic effects on the distal flap including discoloration and telangiectasias and reduces the dead space for fluid accumulation. It also improves volume along the zygomatic arch and

Fig. 7 Three-dimensional (3D) Vectra (Canfield Scientific) before and after revision deep plane repair of pseudo-cobra neck deformity caused by failure of the submental platysma sling effect without retaining ligament release.

lateral flap, lowers the chance of damaging the zygomaticus muscle complex and resulting smile block, and the SMAS is thicker laterally providing easier entry and a better cuff for suspension. The reduced preauricular skin delamination hastens visible recovery (►**Fig. 20**).

Extended Deep Plane Face and Neck Lift Technique

Deep Neck Reduction

Submental surgery is always performed first. Following submental incision, the supraplatysmal plane is bluntly dissected inferiorly to the top of the thyroid cartilage then laterally to the extent of the Aufricht retractor. The medial platysma are elevated by blunt dissection on their immediate undersurface. The dissection continues toward the lateral hyoid at the level of the lateral fascial sling of the digastric muscles where the submental and submandibular triangle fullness is then evaluated, assessing anterior digastric muscles, submandibular glands, and fatty lymphoid tissue. When lying supine, the lateral compartment in the submandibular triangle may appear much less ptotic than when sitting the patient upright. For this reason, the lateral tissues are reduced first and more judicious with the medial or central tissues. The central submental compartment should always remain slightly fuller than the anterior digastric and lateral triangles to avoid later midline defects such as cobra neck or pseudo-cobra neck deformity. To perform gland

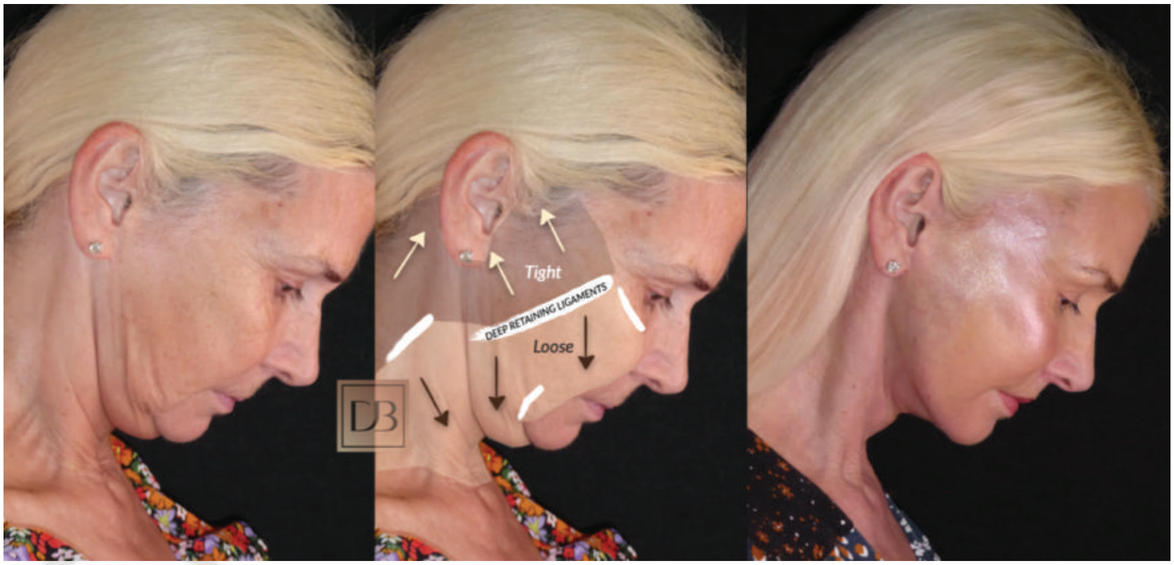

Fig. 8 Juxtaposition of preauricular tension and central face pendular descent in a patient 10 years after successful superficial musculoaponeurotic system (SMAS) lift without ligament release and reposition. Six months after secondary deep plane facelift with full ligament release and tension-free redrape. Homogeneity of tension restored across facial fifths.

Fig. 9 Juxtaposition of preauricular superficial skin tension and central face pendular descent causing skin pleating and contour deformity and 6 months after secondary deep plane facelift with full ligament release and tension-free redrape restoring contour homogeneity.

reduction, the medial and inferior portions of the gland are delivered from the capsule, and injected with local anesthesia. The gland is then released from the capsule circumferentially until only the stalk from the mylohyoid remains. This area is then transversely transected using needle tip electrocautery for cutting and bipolar electrocautery for ligation of ducts and vessels (►**Fig. 21**).

Reduction is performed until the inferior gland is at level with the mylohyoid. Risk of bleeding increases with more posterosuperior dissection as the vessel caliber increases.[34]

Fig. 10 Six months after deep plane facelift with deep neck, parotid, and buccal fat reduction.

Fullness of the anterior digastric muscles might also be present. Plication of the digastrics is avoided in almost all cases to avoid medialization of the submental contents, although this is a valid option to infill previous midline reduction when needed or temporarily medialize glands to improve access. Anterior digastric reduction is performed by strip excision of the outer half of muscle using bipolar electrocautery and/or scissors. Platysmaplasty is then performed using a classic platysmal plication technique.[35] Cadaveric studies have demonstrated that full plication platysmaplasty may limit the extent of vertical lifting in the face.[36] This effect is neutralized by limiting plication to submental platysmaplasty alone without infrahyoid extension. To perform the plication, the platysmal edges are approximated in the midline using buried 2/0 vicryl sutures beginning in front of the hyoid advancing toward the incision with a running vertical mattress.

Marking and Skin Elevation

Incisions are made with a 10-blade scalpel around the temporal tuft following the prehelical crease. The incision follows around the earlobe up postauricular sulcus and crosses to the hairline as the mastoid flattens. The posterior limb incision follows the occipital hairline around 2.5 to 3.5 cm in most patients but can be omitted in some. Elevation of skin is performed with a 10-blade scalpel in the subdermal

Fig. 11 Overresection of central interdigastric fat might lead to cobra neck deformity.

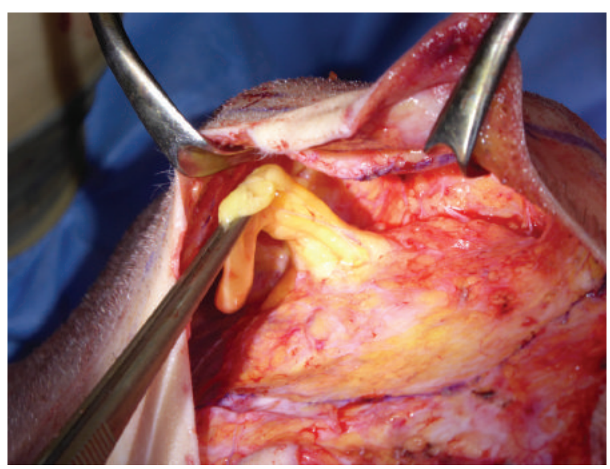

Fig. 12 The buccal fat pad is easily accessed, reduced, or suspended under a composite deep plane flap.

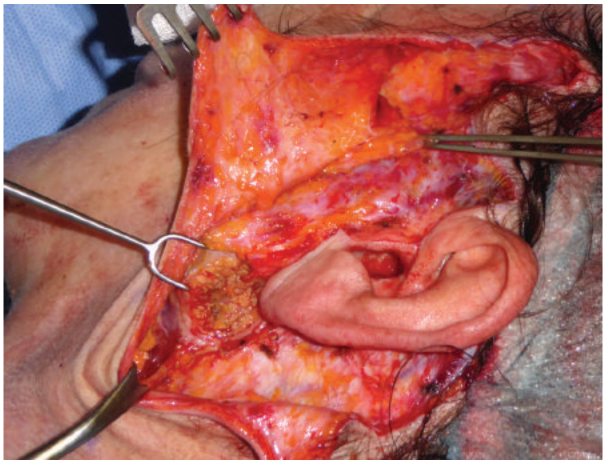

Fig. 13 Excavation and reduction of superficial parotid lobe via the mastoid crevasse approach.

plane leaving hypodermal fat on the reticular dermis followed by scissor dissection and assistant countertension. The post-auricular skin is then elevated and connected to the facial skin dissection around the earlobe. The subcutaneous blunt scissor spreading dissection of the supraplatysmal plane continues to the midline. If a submental procedure was performed first, the two cavities may be connected at this point. In a preservation approach an undissected skin island remains.

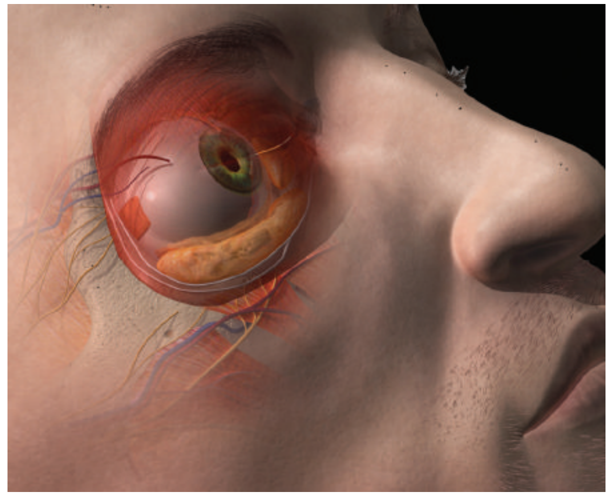

Fig. 15 Orbicularis retaining ligament is a bilaminar structure that can be released as an extension of the superficial musculoaponeurotic system (SMAS) composite flap to revector transected orbicularis between facial nerve branches.

Deep Plane Transition

The sailboat line is marked on the SMAS deep plane entry point and incised with a monopolar needle (►**Fig. 22**).

The deep plane is then entered and elevated beginning at the lateral border of the facial platysma where risk is low.[37] Blunt dissection continues anteriorly over the masseter as the mobile glide plane is entered and continues inferiorly into the neck (►**Fig. 23**).

Fig. 14 Before and 6 months after deep plane facelift with deep neck, parotid, and buccal fat reduction.

Fig. 16 Before and 6 months after revision deep plane facelift with orbicularis revectoring to restore midface and lower lid support following previous lateral vector superficial musculoaponeurotic system (SMAS) lift.

Fig. 17 Before and 6 months after deep plane facelift with orbicularis revectoring. Previous transcutaneous lower blepharoplasty with ectropion and lid retraction. Restoration of attractive lower lid position without secondary lower blepharoplasty.

The underside of the platysma is elevated off the tail of the parotid fascia inferior to the mandible and continues to the sternocleidomastoid muscle (SCM) and external jugular vein. The decussation plane of fibers that exist between the lateral platysma over the parotid tail fascia are referred to as the cervical retaining ligaments. Blunt scissor dissection from top-down releases the cervical retaining ligaments off the parotid tail. Great care is taken to avoid cervical facial nerve branch dissection and the small branches to the depressor labii inferioris under the platysma.

Midface Release

The midface dissection is performed next using blunt dissection to enter the sub-SMAS plane on top of the zygomaticus

Fig. 18 A modified sailboat modification of the deep plane entry enables composite flap inset into the temporal tuft incision. Areas of skin elevation marked in green (with permission Dr. Alessandro Gualdi).

and orbicularis musculature. A supramuscular dissection is performed to allow mobilization of the facial soft tissues without affecting mimetic muscle function. Dissection continues over zygomaticus using blunt vertical scissor spreading or a Trepsat dissector pointing toward the nasal alar base angled 10 degrees deep. Tactile percutaneous feedback helps maintain the proper plane of dissection as the SMAS release continues toward the nasolabial fold inferiorly and nasal bridge medially. At this point, the buccal decussation zone is the only remaining area connecting the sub-SMAS pockets of the neck and midface (►**Fig. 24**).

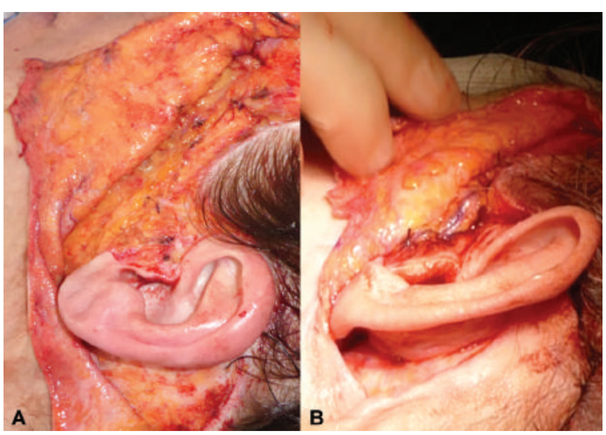

Fig. 19 Preservation deep plane facelift. (**A**) A standard extended deep plane composite flap inset. (**B**) Limited skin delamination with the preservation deep plane facelift.

The lateral extent of the zone has been referred to as McGregor's patch or the zygomatic cutaneous ligaments.[38] Sharp dissection under vertical countertension palpably releases the reticular fibers. The transverse facial artery perforator exits here and is easily bipolar cauterized. Elevation then continues anteriorly along the line of the parotid duct, through the buccal decussation plane which contains the junctional interweaving fibers of fascial SMAS and platysma, dissection terminates at the anterior extent of the buccal capsule. A small shelf is then made along the sailboat entry line to provide a composite cuff for suspension. The facial flap is then repositioned and cuff fixed to the temporal parotid and tympanoparotid fascia (Lore's fascia).[12] Nonabsorbable or absorbable sutures can be used for the deep plane suspension, as long as the sutures are positioned under no tension toward the individual patient's vector of greatest elevation. Confirmation of the greatest vector and position for suspension is achieved with palpatory feedback. The vector of aging for that particular patient is confirmed by passing a suture through the apex of the composite sail pulling the cranial end cranially, the lateral posteriorly with equal tension to lift the midface, jowl, and neck in vector of maximum correction. This demarcates the fixation point and if correctly designed should inset in to the 90-degree perihelical-temporal tuft skin incision leaving minimal skin delaminated (►**Fig. 25A, B**).

Mastoid Crevasse

Once the facial flap has been suspended, the cervical retaining ligament patch is mobilized vertically, posteriorly, and

Fig. 20 Preservation deep plane facelift recovery.

deep with the mastoid crevasse.[39] The mastoid crevasse is opened by vertical incision using needle tip monopolar electrocautery along the anterior mastoid line to expose the anterior wall of the mastoid tip. Anteriorly, this dissection frees the parotid tail from the mastoid allowing the parotid and surrounding tissues to be compressed back into the deep pharyngeal space. Superiorly, the conchal bowl can be elevated to allow a more vertical repositioning of the platysmal cervical retaining ligaments, allowing a more substantial correction of the inferior neck and submandibular triangle. Inferiorly, the dissection stops at the SCM to avoid greater auricular nerve damage. Exposure of the anterior mastoid line allows inset of the platysma into the anterior mastoid rather than onlay over the mastoid (►**Fig. 26A–D**).

This provides a better position of fixation with substantially improved gonial angle depth and vertical platysma movement. It is important to maintain continuity and integrity of the inframandibular platysma, which directly elevates the hyoid and submental contents. This also aids better encapsulation of the parotid gland and tail, slimming the lateral facial fifths, especially in patients with parotid hypertrophy. The divided cervical retaining ligament condensation of the lateral platysma is sutured on the anterior mastoid wall (►**Fig. 27**).

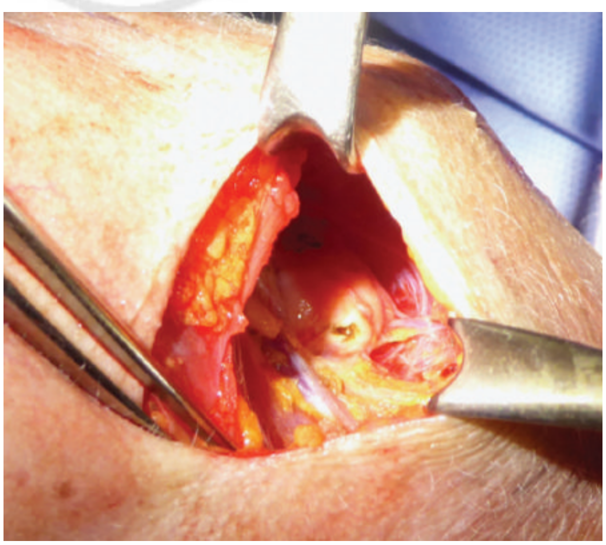

Fig. 21 Submandibular gland access. Intracapsular dissection of submandibular gland. Note inferior "vessel of Sullivan" seen in 30% of glands.

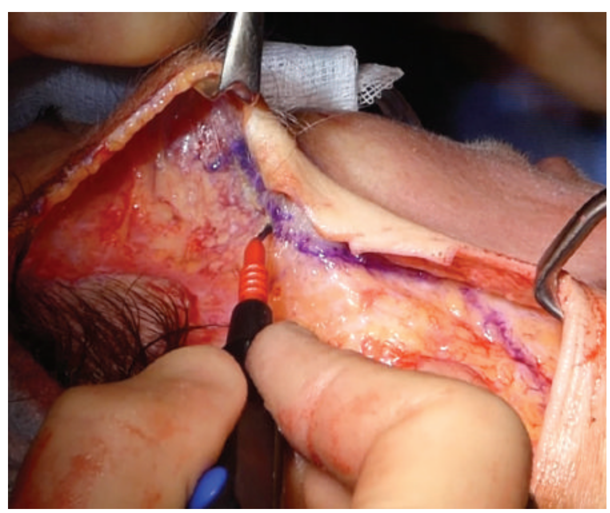

Fig. 22 Sailboat modification of deep plane transition line.

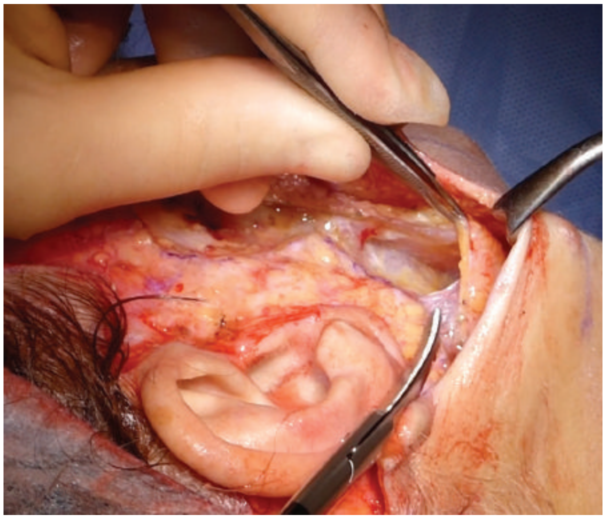

Fig. 23 Premasseteric space dissection in the deep "glide" plane.

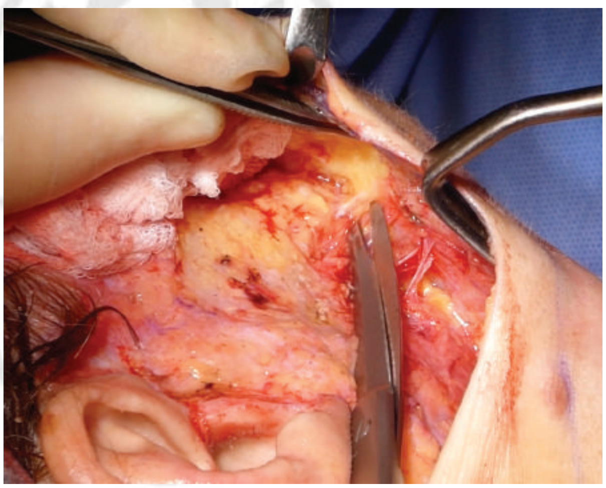

Fig. 24 Dissection through zygomatic cutaneous ligaments and buccal decussation zone.

Parotid Reduction

If parotid hypertrophy is present, a minor tail of parotid reduction may be performed to reduce the tail of the parotid. The fascia overlying the parotid tail is elevated reflecting the great auricular nerve within the fascia. A wedge of parotid can safely be excavated from underneath the retracted fascia. Parotid excision is limited to the anterior border of the great auricular nerve while avoiding any excision deep to the mastoid tip to avoid any heat dispersion to the facial nerve as it exits the stylomastoid foramen. The fascia should be closed to lessen risk of parotid gland exposure and potential sialoma. If sialoma occurs treatment with a combination of bland diet, anticholinergic patches, botulinum injections,[40,41] serial aspiration,[41] suction drainage, or compression with a bolstered gauze and silk net[28] provides the compressive surface area to provide sialostasis far better than a net alone.

Closure

There should be no tension on or around the soft tissues of the ear, assuring prevention of pixie ear or tell-tale rotation of the ear. The facial and neck insets and minimal skin delamination prior to closure (►**Fig. 28**).

Excess skin is trimmed. A tension-free closure at all points helps ensure minimization of scarring. A 7-French round drain may be placed in the neck bilaterally overnight. The suction tubing is mainly used to aid in redistribution of skin and drain off blood-tinged seromatous exudate rather than for prevention of hematoma. Netting sutures are not routinely placed but saved for noncomposite areas of the neck skin delamination, in hypertensive patients at risk, or excessive bleeders and they are removed after 72 hours. A soft headwrap is placed overnight with great care to avoid compression ischemia at the cervicomental angle.

Conclusion

Revision deep plane rhytidectomy is a technically challenging procedure in a patient population who has lost further

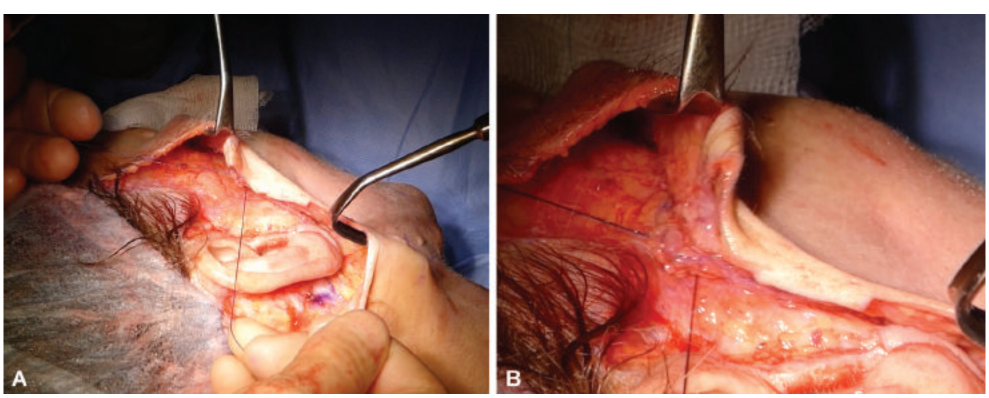

Fig. 25 Sailboat flap tensioning and inset. (**A**) The vector of aging for the hemiface is confirmed by passing a suture through the apex of the composite sail and (**B**) pulling the cranial end cranially, the lateral posteriorly with equal tension to lift the midface, jowl and neck in vector of maximum correction but without significant tension.

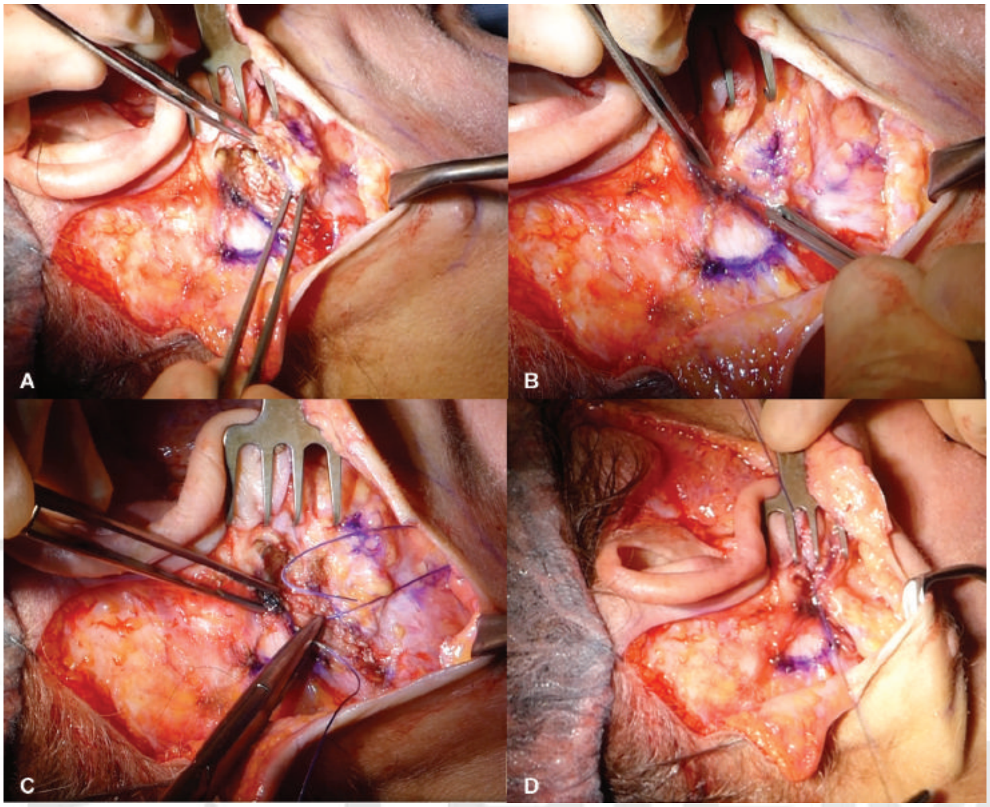

Fig. 26 (**A**) Incision along the mastoid line reflecting fascia containing greater auricular nerve forward, (**B**) fascial release enables collapse of parotid tail into the pharyngeal space, (**C**) condensation of cervical retaining ligaments and platysma fixed deep on anterior mastoid periosteum, and (**D**) full closure of capsule up to conchal bowl to prevent sialoma.

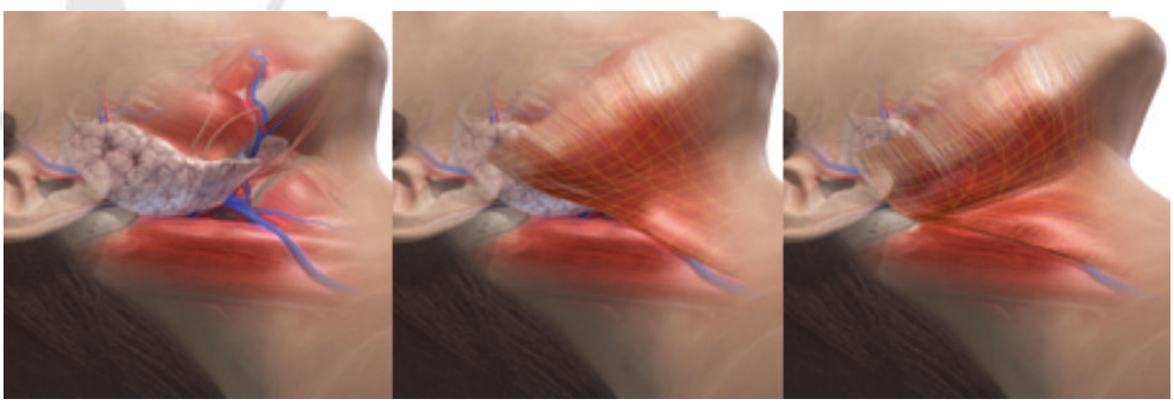

Fig. 27 The mastoid crevasse. Lateral platysma inset deep on to the anterior mastoid process enables true vertical platysma elevation, inframandibular border depth and definition, and contour creation of the mandibular ramus (with permission Dr. Ben Talei).

confidence not only in their appearance but in surgery as well. If the principles discussed in this article are followed and natural anatomy is restored, the facial plastic surgeon has the opportunity to not just restore a patient's confidence in their appearance but their confidence in our specialty as well. It is a technically demanding surgery that might require the advanced techniques discussed but if done well and sufficient time given to preoperative assessment and discussion and clear documented expectations, can be highly rewarding for both patient and surgeon.

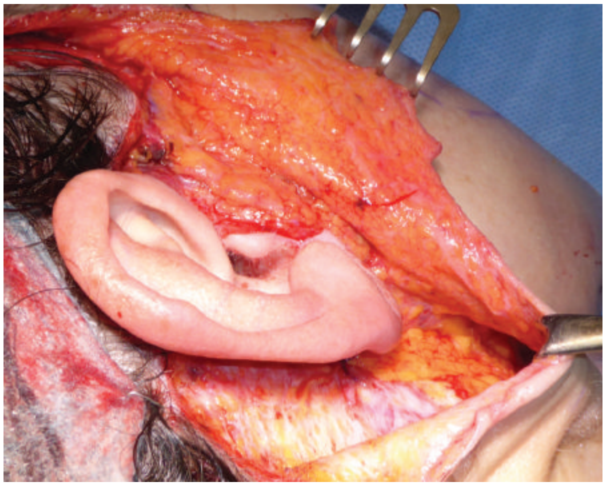

Fig. 28 Limited skin delamination at closure. Note sailboat composite flap inset to temporal tuft incision and lateral platysma in mastoid crevasse. Cervical skin undermining extends two finger widths along the inferomandibular border.

Conflict of Interest
None declared.

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ORIGINAL INVESTIGATION Aesthetic/Cosmetic

Limited Delamination Modifications to the Extended Deep Plane Rhytidectomy: An Anatomical Basis for Improved Outcomes

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Abstract

Background: This study introduces variations of a limited delamination approach to the deep plane face- and necklift.

Objectives: To report surgeons' perceptions of limited delamination deep plane rhytidectomy, define the anatomical basis to support these modifications, and report complication rates.

Methods: This retrospective multi-institutional chart review study of patients undergoing a modified classical deep plane face- and necklift. Surgeons' perception of outcomes and self-reported complications were collected.

Results: In total, 3964 patients having undergone face- and necklift with six surgeons being included. Most patients were female (87.9%) with an age range of 31–83 years (mean 58 years). Most were primary procedures (2672/3964; 67.4%) with a median follow-up of 425 days (range 21–5470). Preliminary surgeon experience demonstrated increased ease of flap management, improved biomechanics, smaller perceived rates of skin discoloration, and telangiectasia of the skin and lower revisions rate (n = 11; 0.8%). Complication rates were low for hematoma (n = 24; 1.9%) and seroma requiring needle aspiration (n = 26; 2%) and minor infection (n = 18; 1.4%).

Conclusions: A multicenter surgeon experience with the limited delamination extended deep plane rhytidectomy is based on anatomical evidence and demonstrates low complication rates and surgeon-perceived improved long-term outcomes. Prospective comparative outcomes of these evolving techniques are warranted.

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Key Points

Question: In patients undergoing face- and necklift using a limited delamination deep plane face- and necklift approach, do the outcomes and low complication rates compare with previous reports in the literature, and is there an anatomical basis to support this technique?

Findings: Patients undergoing this technique experienced lower revision rates, minimal hematoma, contour irregularities, and an improved perception of recovery.

Meaning: This modification of the widely used approach in deep plane face- and necklifting is supported on an anatomical basis and by low revision and complication rates reported by six surgeons in a multicenter review.

Introduction

Since the inception of facelift surgery in the early 20th century, successive developments have increasingly underscored the pivotal importance of addressing the superficial musculoaponeurotic system (SMAS) layer while concurrently shifting emphasis away from the skin. The original bilamellar approach involving extensive skin undermining, or "delamination," carries the associated drawbacks of reduction in biomechanical strength of lift and creating a sizeable dead space that may lead to prolonged healing, vascular compromise, skin relapse, and contour irregularities. The wide adoption of the classical composite deep plane rhytidectomy introduced by Hamra[1] involves delamination to a line from the lateral canthus to gonial angle and critics of the technique cite limitations with inconsistent midface lifting, temporal flap management issues (i.e., bunching), increased dead space, and persistent periorbital edema.[2] Even as the skin and subdermal fat-fascial layer (e.g., the facial SMAS) are a single composite unit that ages and descends as a single unit, solutions to rejuvenation have treated them differently. The concept of minimizing delamination has been introduced by Mendelson,[3,4] Owsley,[5] and others; however, the benefits of full ligament release to create a contiguous flap have been overlooked. Previously Gordon[6,7] and, more recently, Talei[8,9] have described the combination of minimal delamination and deep ligament release to generate a fully mobile composite SMAS flap with superior biomechanical properties. Even still, full delamination in the neck is performed by both SMAS flap and deep plane surgeons. Baker[10] and Pelle-Ceravolo[11] introduced a composite skin and platysma flap for neck rejuvenation; however, these techniques disrupt normal anatomy and do not consistently yield superior central neck contouring. In addition, no study to date has described a minimally delaminated composite flap in both the face and the neck.

The authors herein describe the technical and anatomical details of an extended minimally delaminated composite cervicofacial flap in rhytidectomy. The hypothesis is that preservation of fibrous septa at the lateral band, lateral to the zygomatic–cutaneous ligament, and as a skin island over the cervical retaining ligaments may allow for improved biomechanics, easier flap management, reduction in dead space, and improved early and late outcomes. The research question of this study is to report the surgeon's perceptions of outcomes and report complication rates, as measured by rates of hematoma, seroma, minor infection, wound dehiscence, and revision rates among patients undergoing this approach to face and neck lift.

Materials and Methods

This retrospective chart review study met the exempt status at the principal investigator's institutional review board. Patient consent for the use of photographs was obtained in all cases. The goal of this study is to describe the modifications made to the classical deep plane procedure that allows for limited skin undermining. In addition, the authors self-reported complication rates.

Surgical technique

The technique involves preoperative markings for skin incisions, a more lateral approach with or without a "sailboat modification" for deep plane entry, and limited neck skin undermining. Variations of the procedure may include (1) deep neck contouring, (2) a skin island resulting from limited delamination of the lateral and central skin pockets, (3) the mastoid crevasse, and/or (4) variable manipulation of the orbicularis oculi muscle.

The steps are as follows (videos available in Supplementary Videos S1 and S2):

Surgical markings (Fig. 1). Preoperative markings are drawn with the patient in an upright position:

1. Skin incisions according to surgeon preference (red).
2. The "sailboat modification" to the deep plane entry point is shown (pink).
   A. Pitanguay's line is marked and the classic deep plane entry from lateral canthus to gonial angle.
   B. The sailboat is marked with the patient holding their face vertically with the maximum desired result. The skin pleat that touches most closely to the incision line that transects the preauricular and temporal markings represents the triangle peak. This usually corresponds to a shape equidistant from the incision line (usually around 2.5 cm) that results in a vector of 70° from Frankfort horizontal.
   C. Alternatively, simple entry on a line from a point lateral and inferior to the orbicularis oculi muscle down to the gonial angle can be performed. Soft tissue type and hairline must be considered at this time.

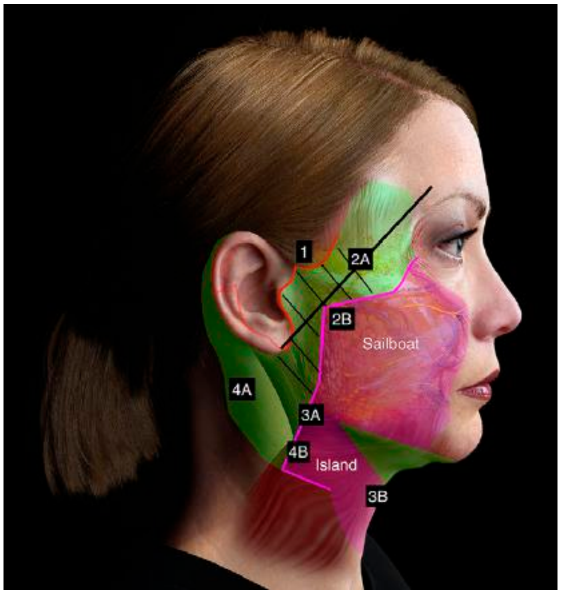

Fig. 1. Skin markings with planned extended composite deep plane entry. Green: subcutaneous dissection. Pink: deep plane dissection. Note the skin island between the submental and lateral neck compartments that is preserved.

3. Central skin undermining extent.
   A. Extend the classic deep plane entry point through the gonial angle to the anterior belly of the sternocleidomastoid muscle.
   B. Central skin dissection extends 1–2 cm anterior to this line laterally and 1 finger-breadth caudal to the hyoid centrally.
4. Lateral skin undermining extent—the skin "island."
   A. Lateral skin undermining proceeds as usual subcutaneously from the posterior auricular incision.
   B. The dissection stops at a mark 5–10 mm anterior to the sternocleidomastoid muscle to preserve a cuff of platysma to suture-inset with (as is done for the face).
   C. The surgeon premarks the segment of skin that overlies the gonial angle with patient holding their face and surgeon manipulating the muscle laterally.

Details of procedure

Sedation and local anesthesia are carried out according to surgeon preference. The submental incision is made along the internal line of the mandible, and skin is undermined according to markings described (Fig. 1, green). The platysma is elevated from the medial borders and dissection extends along the anterior belly of digastric to the lateral fascial sling where the submandibular gland is identified and trimmed as needed. Should a deep neck be required, it is critical that lateral submandibular deep debulking be considered prior to midline submental deep contouring to avoid a hollowed-out submental appearance. Excessive midline volume reduction should be avoided or limited. Once the lateral neck has been contoured, central neck reduction can be performed that may involve deep compartment fat excision, trimming, plication of the anterior belly of digastric, and/or fasciotomy at the level of the hyoid. Platysmaplasty with or without inferior myotomy windows caudal to the hyoid can be performed at this time as plication above the hyoid does not limit lateral lift as much as infrahyoid plication. Submental fat contouring is deferred until after the lateral deep plane and platysma insets have been accomplished.

Attention is then turned to the face where limited skin undermining to the markings and infragonial "skin island" is followed by deep plane entry and dissection. Some authors advocate for entry inferior to the orbicularis oculi muscle and preservation of the overlying septa to avoid postoperative edema and others enter tangent to the orbitomalar ligament if malposition of the lower lid is to be corrected. The premasseteric and prezygomatic spaces are clearly defined, and the intervening zygomatic ligament complex is carefully divided above the level of the zygomaticus major muscle. Once the masseteric cutaneous ligaments are fully released, the platysma is dissected inferiorly off its attachments to the tail of parotid. Buccal fat can be reduced or transposed at this time. This is followed by limited undermining into the loose areolar space before level Ib where the submandibular gland is located. The anterior extent of subplatysmal dissection typically terminates at the anterior line of the masseter or facial artery. Dissection toward the submandibular gland from a lateral approach should be avoided to prevent dehiscence of the platysma, maintain integrity of the area, and avoid nerve injury. Some of our authors perform a low lateral platysmal myotomy over the zone of the external jugular vein currently, whereas others recommend preservation of the lateral platysmal integrity and encapsulation of the underlying structures. The technique referred to as the Mastoid Crevasse by Talei et al.[9] can be performed to enhance the 3D depth of the gonial angle, define the inferomandibular border, and to use it as fulcrum to maximize traction on the central neck. Parotid wedge excision or contouring with bipolar can be performed within the crevasse if lower facial third slimming is required. Alternatively, the flap can be fixated to the lateral mastoid periosteum. A platysma myotomy at the inferior mandible border is omitted or limited to a short, partial thickness external fasciotomy to prevent loss of strength and integrity of the inframandibular platysma. This is especially important in patients with tall mandibular rami and patients with large parotid glands.

After irrigation with antibiotic-soaked solution, closure of the deep plane is done. Generally, flaps are sutured in a vertical vector where maximal tissue excursion is appreciated without skin bunching. Talei notes this is generally a 70° lift of the SMAS-platysma complex, resulting in a roughly 60° skin excision around the temporal tuft and a platysma suspension of 85–90° from Frankfort horizontal.[8] Skin is trimmed and closed, and any remaining dead space (superior to hyoid, anterior to temporal hair) can be addressed with hemostatic netting, tacking sutures, or fibrin glue. No drains or compressive wraps are used. The net result of the early entry to the deep plane, limited skin undermining in the neck, a full release, and resuspension is a significant reduction in dead space. This contrasts with conventional deep plane entry at a line from the lateral canthus to the gonial angle that results in a gap from incision line to composite flap and throughout the neck (Fig. 2B vs. D).

Results

Pooled databases from six surgeons collected 3964 patients undergoing face- and necklift. Most patients were female (87.9%) with an age range of 31–83 years (mean 58 years). Most were primary procedures (2672/3964; 67.4%) with a median follow-up of 425 days (range 21–5470 days). Demographic details are included in Table 1. Preliminary surgeon experience demonstrated smaller perceived rates of skin discoloration and telangiectasia of the skin. The key findings of this initial patient sample (Table 2) demonstrate that risk of major and minor hematoma rates 0.1% and 1.7%, respectively. All five hematomas were described in the post-auricular region or in the inferior neck delaminated zone (when limited dissection was not performed). Seroma, minor infection, or wound dehiscence were all at or <1.6%. Importantly, revisions remained low (0.8%) with over 1-year follow-up for 90% of patients in this cohort. In addition, the rates of skin issues related to wide skin undermining were perceived to be reduced (i.e., telangiectasia, necrosis, breakdown, and infection).

Discussion

The biomechanics of an effective rhytidectomy is the ultimate goal for surgeons and the patient and is at the core of the limited delamination concept. Hamra first published on the deep plane rhytidectomy in 1990[1] that differed from Skoog's original description of a sub-SMAS dissection[12] by the release of the zygomatic–cutaneous ligament and improvements in the upper midface and nasolabial fold. Although originally controversial, his observation that extreme traction to the composite flap would obviate skin tension and improve excursion of the midface and neck has been confirmed by multiple authors and has been widely adopted especially in the last decade with variations of the technique have been introduced over time.[13–16] One of the most significant modifications is a shift toward limited skin delamination; however, the anatomical basis for this biomechanical superiority has only been published recently.[17] Rohrich and Pessa's[18,19] cadaveric studies on the compartmentalization of fat in the aging face revealed the presence of septa, vertically oriented bilaminar membranes that span from the underlying SMAS to the dermis. Mani[20] described the "deep plane transition zone" lateral to the zygomaticus major muscle where maintaining skin attachments improved midface excursion. Gordon et al. have described the importance of these septa and expanded this anatomy to fusion zones that span through the SMAS to deeper structures coalescing as the facial ligaments (personal communication, submitted for publication). The principle of preserving the fibrous septa as key attachments of the SMAS to the overlying skin (while simultaneously releasing the deeper facial ligaments) represents a distinct biomechanical advantage that improves excursion of the midface and subsequently influences the vertical mobility of the neck. Talei et al.[8] describe the advantages of the "sailboat modification" that include this lateral entry and also show minimal inter-suture angle differences. Combined, this geometric pattern solves the issues in superior flap management born from the Hamra design, allowing consistent vertical vectoring throughout the flap and avoiding bunching at the temporal hairline. The ability to avoid loosened suturing improves mid-face excursion, which consequently improves neck contour, preventing relapse.

The authors of this article expand the concept of limited delamination of the face to include the neck. Historically, lateral neck composite flaps aimed to define the jawline by applying traction closer to midline. Pelle-Ceravolo modified their lateral approach by dissecting to the mid-body of the platysma.[11] Gonzalez[21] described the lateral overlapping plication of the platysma procedure without submental incision. Both techniques combine significant skin undermining and nonphysiological manipulation of the platysma. Furthermore, their points of fixation are in two dimensions, failing to accentuate the 3D contour of the entire jawline. In the limited delimitation approach, an anatomically preserved composite neck flap is created, specifically, the skin island overlying the cervical retaining ligaments and 1 finger breadth caudal to the hyoid bone overlying the cervicomental angle suspensory ligament.[22] Preserving these connections fixates the platysma and skin to deeper structures and improves definition of the underlying gonial angle, reducing the need for negative pressure suction drains. When compared with one of the largest reviews of neck lifting by one surgeon[23] where hematoma rates were 1.3% (minor) and 2.7% (major), the surface area dissected in this modified technique is reduced by over 50%. Studies show that cervical flaps exhibit greater stress relaxation and creep than facial flaps, correlating to clinical observations that the neck relapses faster after rhytidectomy.[24–26] Despite this, even with composite flaps being adopted widely for the face, most surgeons will approach the neck in a bilamellar fashion with wide undermining, in some instances to the last horizontal crease. There exist two main limitations in

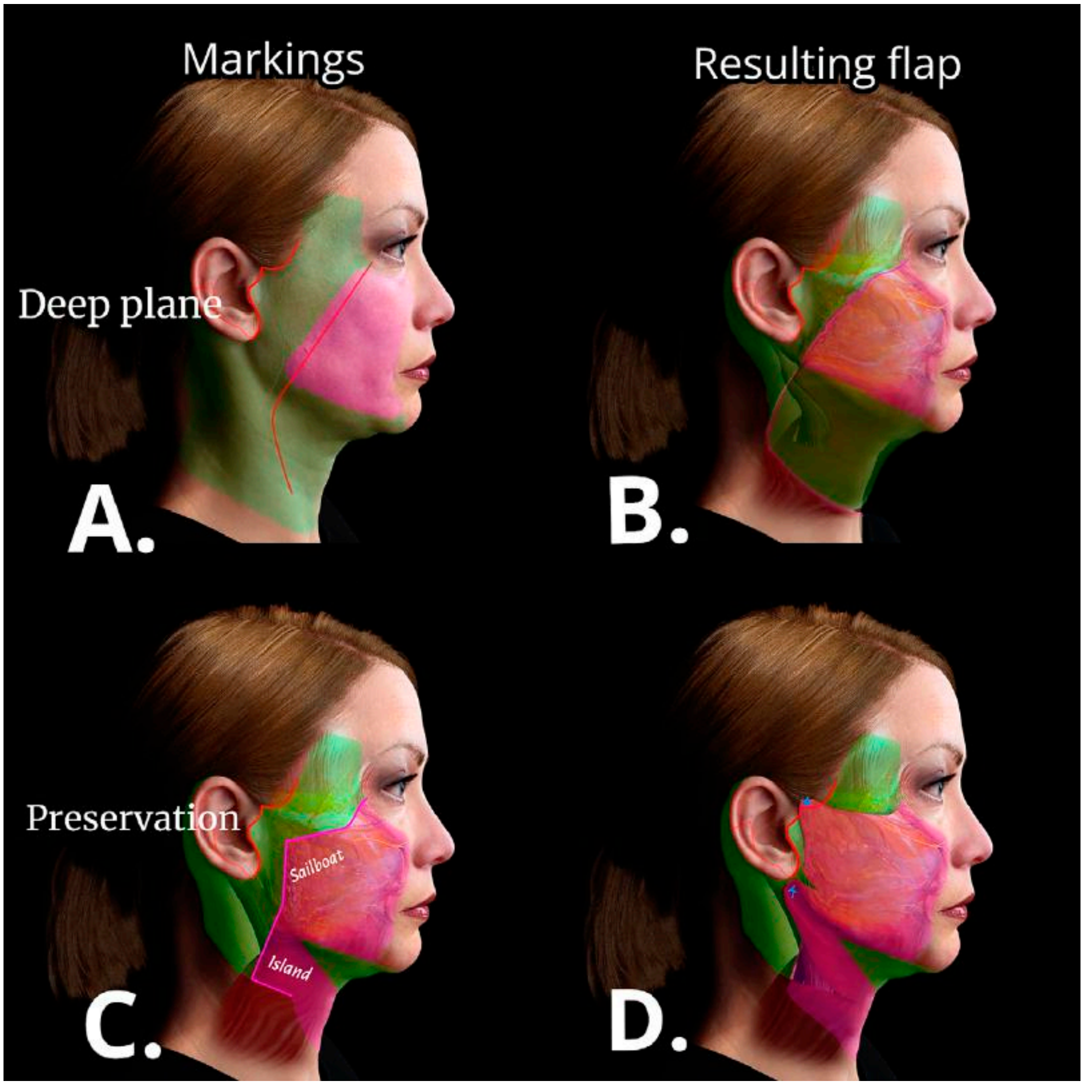

Fig. 2. Comparison of standard deep plane face- and necklift versus preservation deep plane face- and necklift markings and resulting flap. **(A)** Deep plane entry point. **(B)** Deep plane flap inset. **(C)** Preservation entry point. **(D)** Preservation flap inset. Note the differences in the resulting dead-space surface area between **B** and **D**.

the skin island approach. In patients with intraoperative tethering of the skin, the island may be selectively released with a liposuction cannula if needed. However, if significant defatting of the superficial neck is required, the island must be released in full.

Much debate still exists on which SMAS-release technique, the bilamellar or composite allows for greater force to be applied to the SMAS before vascularity is compromised or creep and stress relaxation result in failure.[27,28] With lateral band entry and sailboat design, the technique allows for the surgeon to apply significant force on the flap without concern for skin flap compromise or bunching at the temple. Our approach involves a suspension of muscle along physiological vectors of the neck. Like Pitanguay's ligament preservation in preservation rhinoplasty, maintaining dermal connections allows for any force applied to the SMAS to be translated directly to the skin when manipulated in the z-axis (not just x or y). Because an anterior deep neck contouring accompanies the crevasse accentuation of the posterior jawline, muscle is redraped in three dimensions into the newly elongated cervico-mental distance, and thus, an excessive 2D force is unnecessary.

In addition to improved biomechanics and flap management, reducing dead space formation benefits the overlying skin. Because the composite flap starts more laterally and undergoes extended release, it is inset close to or at the skin incision eliminating any dead space created in the subcutaneous plane. This allows for the preservation of both perforating

Table 1. Characteristics of patients undergoing limited delamination modifications to the extended deep plane face- and necklift

Total patients	*3964*
Mean age (range)	58 (31–83)
Sex (% female)	3484 (87.9%)
Primary cases (%)	2671 (67.4%)

Table 2. Surgeon-reported complications

Total patients	*3964*
Hematoma requiring surgical evacuation	5 (0.1%)
Small hematoma requiring needle aspiration	70 (1.7%)
Small seroma requiring need aspiration	63 (1.6%)
Minor infection	54 (1.3%)
Wound dehiscence	12 (0.3%)
Transient skin puckering	4 (0.1%)
Revisions	32 (0.8%)

musculocutaneous vessels, direct cutaneous vessels, and their anastomoses in the hypodermis.[29–31] Tacking the SMAS flap just anterior to the skin closure supports most of the tension and protects the superficial dermal plexus.[32] This results in a less mottled, healthier-looking pre-auricular skin that has preservation of color and fewer telangiectasia on close inspection. In addition, surgeon perception on patient recovery was enhanced in the short term. The decreased dead space contributes to less bruising and untoward puckering or swelling (Figs. 3 and 4). The benefit of minimizing manipulation of the orbicularis oculi muscle spares the patient from prolonged periocular edema. Lastly, this approach has enabled some authors to eliminate the use of drains that carry with them the potential for tract formation, malfunction, inadvertent damage on removal, and, importantly, patient discomfort

Fig. 3. (Clockwise from top left) Preoperative, 1 day postoperative, 6 days postoperative, 8 weeks postoperative.

Fig. 4. (Clockwise from top left) Preoperative, 1 day postoperative, 7 days post-operative, 12 weeks postoperative.

and fear. Some authors close the remaining small dead space with hemostatic netting,[33] tacking sutures, or fibrin glue, which has effects on the formation of minor hematoma and bruising as well as prevention of skin migration in the postoperative period.[34,35]

Finally, the benefits of hematoma, seroma, and necrosis were seen. This proves especially useful in higher-risk patients who are undergoing secondary surgery, have had multiple nonsurgical treatments that damage the microcirculation of the skin, or have a history of smoking. Although reports vary on the incidence of hematoma (2–15%),[33,36–41] our initial patient experience has shown a 0.1% rate of major collections. A limitation of this study is that the only area for hematoma formation described was the post-auricular area that is not addressed by this technique; however, a logical benefit to the skin island is a potential for compartmentalization of hematoma from the lateral to central neck. For example, a post-auricular hematoma that would expand into the central neck requiring evacuation in the operating room may be reduced to a minor hematoma requiring needle drainage at the bedside instead. Another limitation is that statistics on adjuncts for hematoma prevention like use of netting or tranexamic acid were not obtained, but of note, much of the experience with lateral entry predates the use of these adjuncts.

These data must be interpreted in the context of the study design. The principle focus of the article was to describe the technique and illustrate the theoretical and logical advantages over other methods of face- and necklifting. The authors collectively pooled demographic data and self-reported complication rates without formal chart review. This recall bias would certainly affect the data. Long-term follow-up is warranted to determine accurate revision rates.

Conclusion

The implications of these findings could represent a further shift away from a bilamellar approach and toward more extensive composite lifting. The limited delimitation cervicofacial flap, known colloquially as the "preservation face and necklift," may represent a simple but potential improvement on the composite flap in deep plane face- and necklifting. The tenets of the technique involve minimizing skin undermining, earlier deep plane entry, and extended flap elevation. Anecdotally, the surgeons perceived benefits in short recovery and less postoperative skin changes (telangiectasia). This technique can be added to the armamentarium of any facelift surgeon without the need for increased technical acumen or training. Future studies examining short- and long-term results, complication rates, and unforeseen limitations are needed.

Authors' Contributions

B.T., M.R., N.A.G., and M.N. were responsible for conceptualization. Data curation was done by M.R. Formal analysis was done by M.R. Project administration was done by M.R. Patient data were given by all authors. Writing the original draft was done by M.R. Review and editing of the final draft were done by all of the authors.

Author Disclosure Statement

No conflicts of interest are relevant in this study.

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There are no financial considerations in this study.

Supplementary Material

Supplementary Video S1
Supplementary Video S2

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Complications Associated with Fat Grafting to the Lower Eyelid

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KEYWORDS

• Blepharoplasty complication • Eyelid volume • Fat graft • Fat transfer • Fat transplantation • Lipofilling • Lipogranuloma

KEY POINTS

- Techniques of facial fat transfer or fat grafting can produce serious periorbital complications.
- Complications of lower eyelid fat grafting are largely technique related, allowing avoidance by appropriate surgical technique.
- Characteristic patterns of fat grafting complications above and below the orbital rim demand specific approaches to treatment.
- Effective techniques are available for the treatment of complications of lower eyelid fat grafting.

INTRODUCTION

Autologous fat grafting has gained increased acceptance and utility in the periorbital area for the rejuvenation of the aging face since its description by Coleman in 1995.[1] The technique provides a means of augmenting facial volume, which represents a fundamental shift from the surgical paradigm of the past century, which focused on tissue subtraction via excision of variable amounts of skin, muscle, and fat.[2] Fat grafting, along with fat preservation blepharoplasty (native fat transposition), have led to natural surgical outcomes that avoid the volume-deficient stigmata of traditional lower blepharoplasty, and focus on the re-creation of the curves and contours of youth.[2,3] Fat grafting is used as an adjunct to lower blepharoplasty, or as a stand-alone intervention.[2,4–7] In the periorbita, the primary goal of treatment is effacement of the eyelid/cheek interface with special attention to the tear trough deformity.[8–10] This is accomplished by direct or tissue adjacent fat grafting of these periorbital depressions.[6]

Many complications may occur with fat grafting of the lower eyelid including volume undercorrection or overcorrection, contour irregularities, prolonged bruising and swelling, infection, granulomas and inflammation, and vascular embolization with visual loss or cerebral infarct.[2,11–22] This attention to volumizing the lower eyelid tear trough area creates a subset of patients with overvolumized tear troughs and associated facial deformities who suffer short- and long-term complications. The treatment of these chronically overvolumized patients prompts specific surgical approaches to evaluation and therapeutic procedure.[2,19]

Attention to appropriate principles in patient evaluation and treatment, including safe surgical technique, will avoid most complications of fat grafting in the lower eyelid and periorbital area.

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VOLUMETRIC-RELATED AND CONTOUR-RELATED COMPLICATIONS

Numerous volumetric-related and contour-related abnormalities may be encountered with autologous fat grafting of the lower eyelid, stemming from the diverse surgical techniques across all steps of the procedure. Furthermore, there is no standardized approach to fat preparation, with techniques varying from the injection of minimally or unprocessed suctioned autologous fat to various techniques of drainage, sieving, washing, and centrifuging fat.[14] The short-term and long-term survival of grafted autologous fat is also quite variable, and surgeons must acquire surgical knowledge of the appropriate volumes and surgical technique suited to their own surgical variables and the needs of individual patients.[6,13,23] Failure to appropriately account for these variables results in undercorrection or overcorrection of the lower eyelid tear trough, with inappropriate placement causing other complications.

The Overvolumized Tear Trough

Excessive or inappropriate attention to volumizing the lower eyelid tear trough area creates a subset of patients with overvolumized tear troughs and associated facial deformities that can result in short-term and long-term complications. The treatment of these chronically overvolumized patients prompts specific approaches to evaluation and treatment.

Patient evaluation and prevention

The patients with inappropriately and overvolumized tear troughs and adjacent areas exhibit several characteristic configurations. Common features that the authors have observed from the treatment of these patients is the association of these complications with large injection volumes, surgical technique injecting fat parallel to the tear trough, and the operative use of open-tip Coleman cannulas that are larger and more prone to the injection of larger fat volumes. Intuitively, the injection of fat volumes to the tear trough of greater than 1.5 to 2 mL/side is also more frequently associated with significant overvolumization.

These findings highlight the importance of meticulous surgical technique to limit graft resorption caused by intraoperative traumatic adipocyte damage and postoperative graft necrosis.[23] Precise surgical technique during harvesting, processing, and injecting of the fat graft maximizes the reproducibility and graft survival without requiring aggressive overcorrection, which may result in postoperative complications. During fat harvesting, key technical considerations to increase adipocyte viability include use of manual syringe aspiration with gentle negative pressure instead of conventional high-vacuum liposuction systems and use of larger-diameter harvesting cannulas to limit adipocyte destruction and shear stress, respectively.[24–29] In the fat processing step, it is important to eliminate nonviable free oil droplets, blood, and additional debris to limit their inflammatory effects, which would otherwise increase adipocyte degradation in the graft recipient site.[30] Finally, important considerations during injection into the lower eyelid include use of a small-diameter blunt micro-cannula to minimize trauma to the injection site, strategic tunneling with injection only during withdrawal of the cannula to deposit the fat particles within the preformed tissue plane, and deliberate allocation of only small-diameter fat particles in a fanning pattern to maximize oxygen diffusion across the small diameter fat deposits, minimizing central fat necrosis.[31–35] Typical fat volumes injected near the tear trough are in the 0.02 to 0.04 mL/pass range. Larger volumes per pass are more prone to complication. Attention to these critical surgical techniques reduced the risk of overvolumization of the lower eyelid and the associated complications.

Patient phenotypes seen in overvolumization can be categorized as:

1. Above orbital rim (eyelid)
   a. Discrete large nodule(s): often related to high-volume and bolus injection of fat or focal accumulation of fat owing to intersecting placement tunnels with large local collections of fat.
   b. Multiple small nodules: owing to focal overvolumization, with- or without superficial injection between the skin and orbicularis muscle.
   c. Diffuse: this configuration may result from free dermis fat or pearl fat graft placed retroseptal, or injected fat that is generally localized within the orbicularis muscle or anterior to the orbital septum. Diffuse overvolumization may occur with multiple inappropriate passes, especially paralleling the orbital rim. Injecting parallel to the orbital rim and tear trough is often associated with this complication, and this technique is opposed to the more generally appropriate technique of approaching the inferior orbital rim from below.
2. Below orbital rim
   a. Nodular: more focal fat collections.
   b. Diffuse: entire tear trough and adjacent cheek generally overvolumized. Fat is generally deep to the muscle medially and within the SOOF plane laterally.
3. Combinations of 1 and 2

Surgical Treatment

Patients with chronic complications due to overvolumization in the lower eyelid frequently require surgical treatment of their volume and contour abnormalities. The phenotypic categorization previously noted leads to surgical pearls in treatment.

1. Above orbital rim (eyelid)
   a. Discrete large nodule(s) (**Fig. 1**A): amenable to transconjunctival or transcutaneous (via small stab incision) excision. Generally excised surgically as a distinct nodule of fat that can often be differentiated from the native orbital fat (**Fig. 1**B). The easiest of these overvolumization complications to deal with.
   b. Multiple small nodules (**Fig. 2**A): the least common configuration and the most difficult to treat. May be more amenable to transconjunctival excision (**Fig. 2**B). If superficial fat between skin and orbicularis muscle present, "clean up" via small cutaneous incisions may be required.
   c. Diffuse (**Fig. 3**A): transconjunctival approach with horizontal splitting of the orbicularis muscle to expose grafted fat, which will be apparent and can be prolapsed and teased from the muscle (**Fig. 3**C–E). Only modest orbicularis muscle weakness is generally encountered with appropriate surgical technique. Performed properly, dramatic surgical improvement can be achieved (**Fig. 3**B). With diffuse overvolumization, the surgeon may also excise native fat to retro place the grafted fat.
2. Below orbital rim
   a. Nodular: may be able to reach and tease-out via a transcutaneous or transconjunctival approach (**Fig. 4**).
   b. Diffuse: can generally excise medially and consider repositioning of the native orbital fat (if present) or the use of a dermis fat graft if a secondary defect is encountered. Laterally, fat that cannot be readily excised from the SOOF may require cautery ablation or smoothly contoured excision with cutting cautery.
3. Combinations of 1 and 2

The Undercorrected Tear Trough

Patient evaluation and prevention

Undercorrection of the tear trough in lower eyelid fat transfer may be the result of inadequate or inappropriate placement of fat during fat grafting.[2,11,20] Importantly, this risk of postoperative undercorrection and the possible need for additional sessions of fat transfer should be thoroughly discussed with the patient during preoperative counseling.

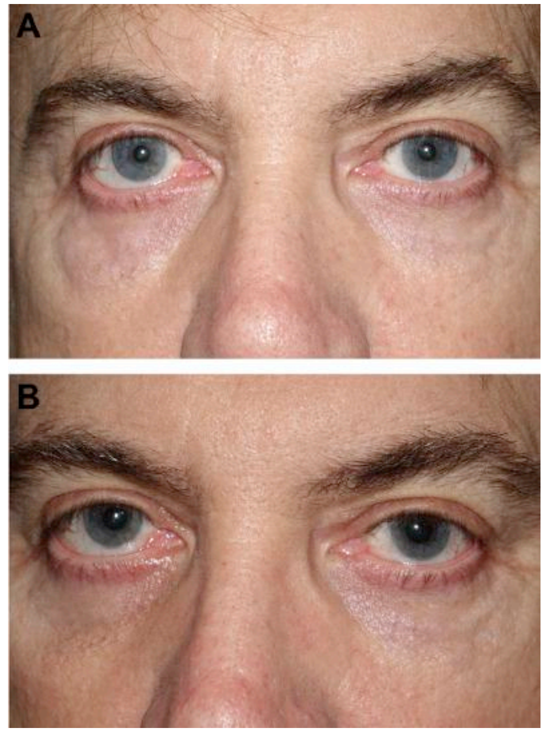

Fig. 1. (*A*) A patient with a discrete large nodule of grafted fat in the right lower lid before transconjunctival revision surgery. (*B*) The same patient after transconjunctival surgical revision.

Surgical treatment

Achieving ideal outcomes should always be the targeted goal, but conservative fat grafting of the lower eyelid with small volumes is advised, because this is more easily addressed with surgical revision, relative to the more invasive treatments to correct overvolumization.[20] These approaches to lower eyelid undercorrection include repeat fat grafting, volumization with hyaluronic acid gel fillers, or techniques of surgical fat repositioning using lower eyelid fat.[7,13,14,36]

OTHER COMPLICATIONS

Several additional perioperative and postoperative complications may be encountered with lower eyelid fat transfer, ranging from minor, transient issues to more severe debilitating and disfiguring complications. When performing periocular fat transfer, constant awareness of presenting features and management strategies is necessary to minimize the occurrence of these unwanted complications.

Postoperative ecchymosis prevention begins with preoperative instructions to temporarily

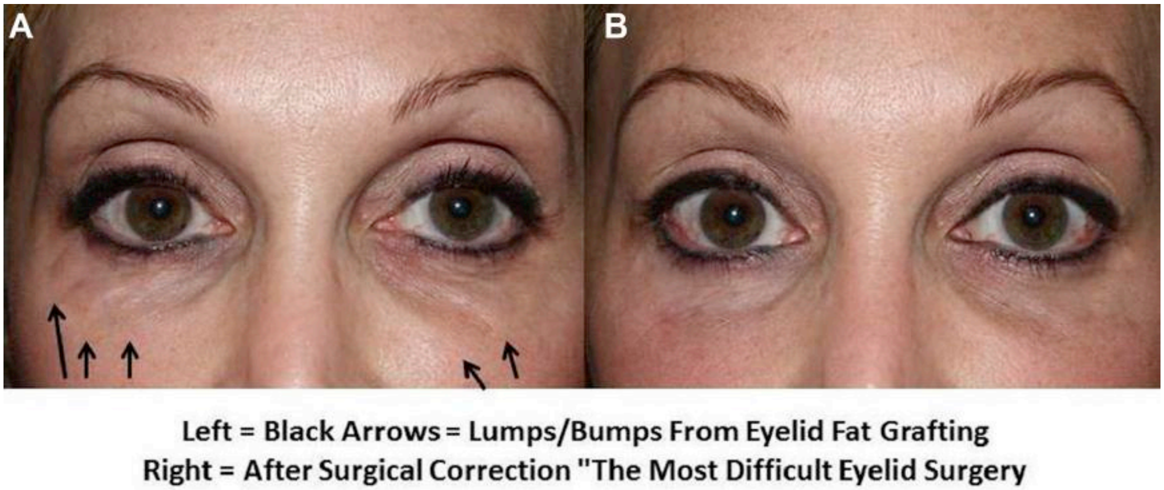

Fig. 2. (*A*) A patient with multiple small nodules. The arrows point to multiple lumps and bumps due to inappropriate grafted fat, largely in the orbicularis muscle. (*B*) The same patient after transconjunctival surgical revision with improvement in multiple areas of inappropriate eyelid contour due to grafted fat.

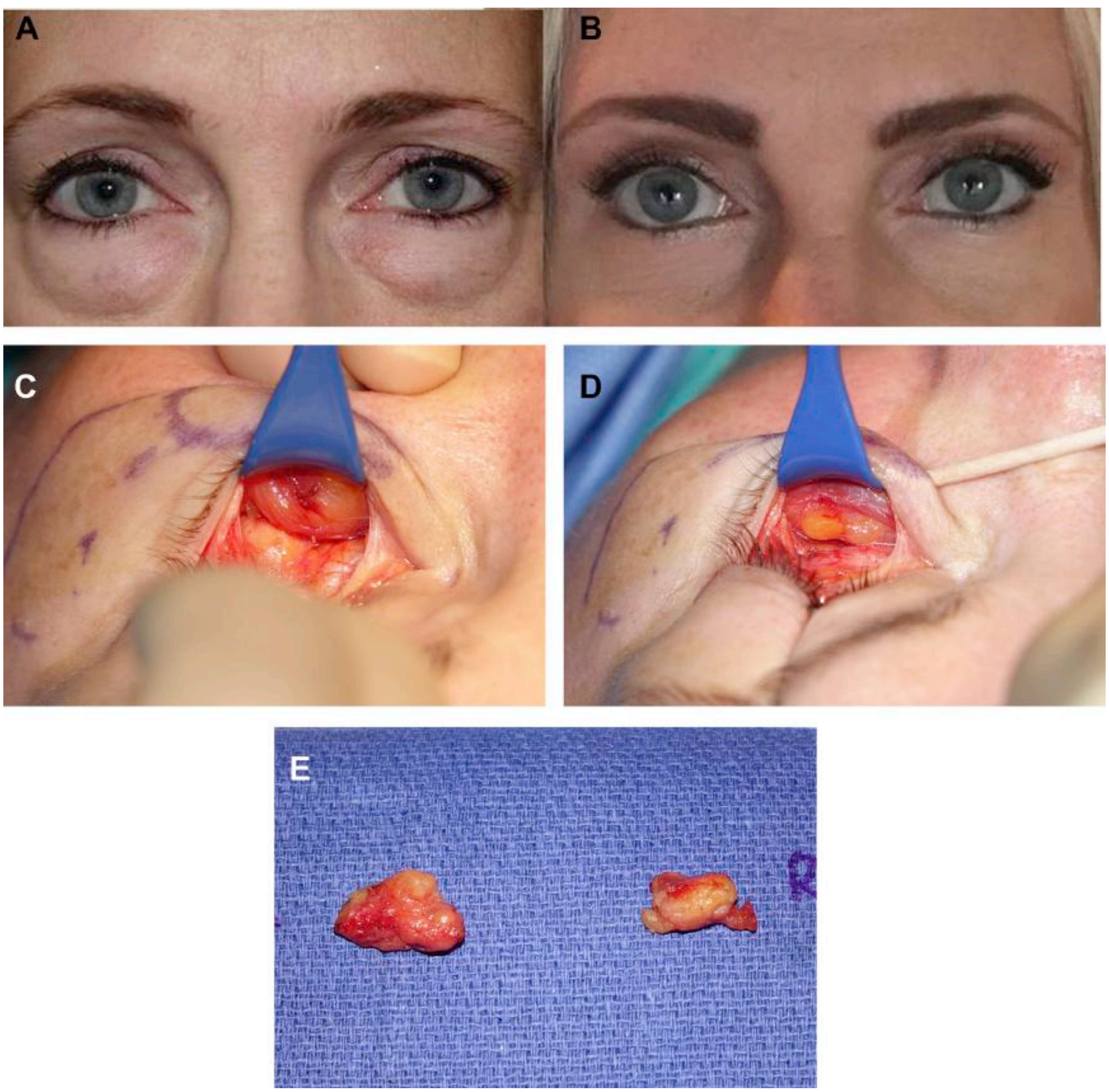

Fig. 3. (*A*) A patient with diffuse excess grafted fat above the tear trough. (*B*) The same patient 3 months after transconjunctival excision of grafted fat. (*C*, *D*) Transconjunctival approach to excision of grafted fat showing exposure by horizontally splitting the orbicularis muscle. (*E*) With Desmarres retraction and blunt dissection, the grafted fat is generally removed en bloc.

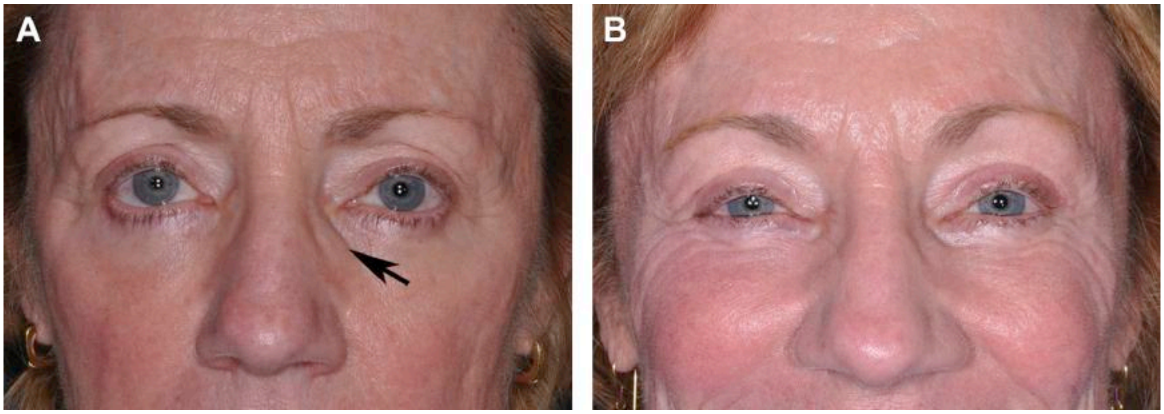

Fig. 4. (*A*) A patient 3 months after 4-lid blepharoplasty and facial fat grafting with a nodule of grafted fat below the orbital rim medially (*arrow*). (*B*) The same patient 1 month after minor room excision under local anesthesia via a 5-mm skin excision over the nodule. A discrete nodule was excised with resolution of the objectional contour anomaly.

discontinue all anticoagulant and antiplatelet therapies, if medically appropriate. In addition, dietary and herbal supplements including vitamin E, fish oil, and *Ginkgo biloba* extracts are stopped before surgery to avoid their increased bleeding risk. Intraoperatively, inadvertent trauma is reduced by ensuring that the harvesting and injection cannulas are withdrawn close to the entry point before pivoting and reinsertion, which limits accidental insertion in the same trajectory.[13,37] Prolonged ecchymosis and edema at the fat grafting sites lasting greater than 2 to 3 weeks are minimized by elevation of the head and application of ice compresses. Periocular bruising at the injection site may be reduced with use of positive pressure systems designed to facilitate capillary collapse to diminish the spread of subcutaneous bleeding. Although placement of ice packs on the injection site can also minimize pain and edema, significant caution must be taken to avoid direct icing because severe cooling may contribute to ischemia and failure of the free fat grafts.[38] Postoperative infections are rarely encountered after autologous fat grafting; however, most surgeons, and the authors, routinely treat patients with prophylactic antibiotics.[19,21]

Undesirable harvest site scars, persistent erythema, and hyperpigmentation can develop at the harvesting cannula entry site.[2] The incidence of these cutaneous findings is reduced with strategic placement of harvest site incisions within the umbilicus or the medial thigh, resulting in discrete surgical sites that are more cosmetically appealing to patients. Furthermore, these entry sites are often subject to high levels of manipulation and distortion to maximize the accessibility of fat graft donor sites, and should be closed with interrupted, nonabsorbable superficial sutures to provide improved dermal wound apposition to prevent exposure of subcutaneous tissue more prone to granulation. Intralesional injection of triamcinolone (Kenalog) and/or 5-fluorauricil can be used to address persistent granulation or hypertrophic scarring at these entry sites. Sites with nonresolving hyperpigmentation may be treated using topical bleaching creams such as hydroquinone. As a last resort, scar revision may be performed to excise the undesirable scar.

Interestingly, delayed-onset diplopia as a complication of hypertrophy of the fat graft was described in a patient who gained 33 lb over a 2-year period, and ultimately required surgical excision of the hypertrophied fat to improve symptoms.[15] Such hypertrophy of grafted fat is occasionally observed in fat grafts of all sorts, and is a surgical consideration in patients at risk for this.

Serious vision-threatening, and even life-threatening, complications can occur with periorbital fat grafting. Several reports have described irreversible vision loss or stroke after periocular fat grafting caused by retrograde intravascular fat injections through the dorsal, nasal, angular, or supraorbital arteries.[12,18,39] The intravascular fat travels retrograde until the injection is terminated, and then results a fat embolism to the ophthalmic artery, causing permanent blindness, or to the internal carotid artery, causing subsequent embolic cerebral strokes. Preventative techniques include use of a blunt cannula in the periocular area to minimize the risk of inadvertent intra-arterial injections. In addition, small, 1-mL syringes should be used in the periocular area to limit the pressure needed for injection. Finally, fat injection that is only performed as the cannula is being withdrawn reduces the risk of arterial embolism.

SUMMARY

Techniques of facial fat grafting to the lower eyelid and adjacent midface often offer impressive surgical results, but carry risks including early or late undercorrection, prolonged bruising and swelling, infection, granulomas and inflammation, and vascular embolization with visual loss or stroke. Grafted fat may involute with weight loss, or increase to an inappropriate degree should the patient gain weight. Surgical judgment and technique are paramount to achieving excellent results and avoiding complications.

Specific patterns of inappropriate grafted fat are encountered above and below the orbital rim. Recognition of these patterns is helpful to appropriately advise the patient regarding treatment options and to plan surgical revision of these patients. Many cases are amenable to a transconjunctival approach to the inappropriate fat with careful exposure and excision. A limited anterior exposure via a small cutaneous incision may be appropriate in specific cases.

Appropriate and knowledgeable surgical technique to avoid complications is always the best approach. When patients with complications of excess and inappropriate fat grafting are encountered, carefully planned revision surgery can often salvage an acceptable result to the benefit of the patient.

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Original Article

The Detailed Anatomy of the Deep Plane of the Face and Neck with Current Nomenclature

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Facial Plast Surg

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Abstract

The fundamental goal of modern face and neck lifting is to enhance and restore a more youthful facial appearance by addressing soft tissue descent. There are variations in described facelift technique including superficial musculoaponeurotic system (SMAS) flaps, composite flaps, deep plane, skin flaps, and subperiosteal facelifts, among others. The term "deep plane rhytidectomy" was originally described by Hamra. This term has since been linked with facelift surgery with recent advances including incision placement, treatments of SMAS–platysma complex, and mastoid crevasse among others. In the lead authors' experience, using deep plane techniques have demonstrated superior facial surgical rejuvenation results with less dependence on ancillary measures such as fat grafting or implantation for midface volumization. In order to successfully perform any face or neck lift, it is key to understand the relationship of the skin, the fat compartments, and the ligamentous attachments. This chapter details the anatomy of the deep plane of the face and neck and explains some nuances as it relates to surgical lifting. We also describe recent anatomical revelations of the mandibular ligament and its management in deep plane face lifting. In this chapter, given this opportunity to share personal experiences and preferences, the authors hope to describe relevant anatomy for the deep plane and provide some clarity on the merits of deep plane face and neck lift technique.

Keywords

- deep plane
- face lift
- neck lift
- rhytidectomy
- SMAS

Layers of the Face

Proper lifting requires thorough understanding and conceptualization of the deep plane and the superficial musculoaponeurotic system (SMAS) with overlying fascia. The SMAS was originally described by Mitz and Peyronie in 1976 as a distinct musculoaponeurotic layer between the superficial fat and the deep fat connecting the various facial muscles allowing for complex facial mimicry.[1] To properly understand facial aging, understanding of the planes, layers, structures, and attachments of the face is crucial. The face has a layered anatomy with five layers. The skin (epidermis and dermis) is Layer 1. Layer 2 consists of the subcutaneous adipose and fascial tissue, and Layer 3 is composed of the SMAS/musculoaponeurotic layer, which is the main focus of deep plane facelift surgery. Layer 4 is the loose areolar plane of the spaces, which encompasses the soft tissue spaces with the deep fat and the retaining ligaments. The final Layer 5 consists of deep fascia covering muscles or periosteum over bone. There is some confusion within face lift didactics concerning what we refer to as the SMAS during SMAS elevation and lifting.

Elevation of the platysma–SMAS complex, as used in prior articles,[2–4] refers to elevation of the deep glide plane in the lower face and the surgical deep plane in the midface and lateral face. In these instances, what we inaccurately refer to as the SMAS is actually Layer 2—the subdermal fat/fascial layer. Hence, the deep plane lift is technically more of a middle plane lift and is submuscular, where the platysma exists and directly supramuscular, in the midface over the

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mimetic musculature. Although technically inaccurate, for ease of explanation and continuity in didactics, we will refer to this layer as the SMAS fascia when referring to the subdermal fat–fascial layer where it exists.

The SMAS fascia or subdermal fat/fascial layer varies in thickness from region to region and depending on aging or trauma. This layer is connected directly to the hypodermis with dense attachments and should be treated as a single layer with the skin as much as possible. This layer thickens in the anterior midface in a fat compartment called the superficial malar fat pad, which is released and elevated in our deep plane technique. With aging, this SMAS layer may lose thickness from fat loss or loss of hydratory retention. Given the color and thickness, it is a primary mechanism for skin support, structure, and color. Changes in the thickness and water-retaining capacity of the subdermal fat–fascial layer may be directly responsible for changes in skin tone and reflection of radiance that changes with age or repeat facial treatments. Darkening and shadowing is notably accelerated in certain regions with a thinner subdermal fat/fascial thickness that thins faster with age, such as the prejowl sulcus and area over the depressor anguli oris muscle. This causes an earlier darkening from lack of proper color and light reflection, hence maintenance of color and volume is of utmost importance.

The SMAS layer itself is a connective system of fascia and muscle containing mimetic musculature and connections responsible for facial expression. The muscular movements are transmitted to the skin through the overlying subdermal fat/fascial layer. If the overlying layer is too thin, the energy is transmitted harshly and hypercontracture of muscles becomes evident with little overlying resistance to movement. If the overlying tissue is excessive or carrying excess water, either from edema, fat, or fillers, then the energy becomes diffused as it transmits to the skin and less muscular twitching is noted. Less muscle movement is noted as well with increased resistance to flexion from excess overlying hydration or tissue, whereas the muscles may flex excessively if not covered by adequate tissue and resistance/impedance. Hence, proper overlying tissue hydration and thickness is necessary for effective, proper, and softer muscle movements in the face. Adequate support and position of the muscles is also necessary for proper muscle function in the face and neck.

With regard to the terminology, in the temporal region superior to the zygomatic arch, Layer 3 is known as the temporoparietal fascia (TPF) and Layer 5 is the deep temporal fascia. Within these two layers, exists an areolar fascial layer termed the innominate fascia, which has also been referred to as the subgaleal fascia. This is an independent, vascularized tissue layer that may be used for reconstruction.[5] In the midface, Layer 3 is termed the SMAS containing the mimetic muscles and fascial extensions, while Layer 5 is the parotidomasseteric fascia. In the neck, Layer 3 is the superficial cervical fascia and platysma, while Layer 5 is the deep cervical fascia known as the investing fascia. Layer 3 is the essential layer that is suspended in deep plane neck lifting, while the plane transitions to directly over layer 3 in the midface. As suggested above, the superficial fascia has different names in different areas of the face and neck. In the forehead, Layer 3 is composed of the frontalis muscle in the frontal region, occipitalis muscle in the occipital region and as the galea aponeurotica in the parietal scalp between frontal and occipital regions. Laterally, this continues to the temporal region as the TPF mentioned previously.

The attachment of the layers to each other and underlying structures determines the type of plane that exists and the type of dissection that is required (i.e., blunt vs. sharp). The SMAS is adherent to the overlying subdermal tissues, dermis, and epidermis and should be kept composite and intact when possible. The glide plane exists under all mimetic musculature and is the true contiguous deep plane. However, it is important to note that our surgical deep plane is submuscular in the scalp during endoscopic plane brow lifting and submuscular in the region of the platysma, but it must remain supramuscular in the midface and lip for proper release and repositioning without nerve or muscle damage or alterations to facial mimetic function.

Deep Plane

Although the SMAS does not exist as a separate anatomical entity, the SMAS serves as the boundary of a surgical deep plane, deep to Layer 3 in the neck, brow, and lip, but on the superficial surface of Layer 3 in the midface over the zygomatic musculature. Generally, in the face, the SMAS lies between the subcutaneous adipose Layer 2 and the deeper fat and muscles located in Layer 4. The SMAS is attached to the underlying and surrounding deep fascia by fibrous connections discussed under the "Retaining Ligaments" Section.

The deep plane is the plane that divides the superficial soft tissue envelope, which is encompassed by the superficial cervical fascia, from the deep cervical fascia that encompasses the deeper tissue (mimetic muscles, nerves, etc.). The deep plane is an anatomic glide plane and the plane of greatest descent with age. The other logical advantage is that skin does not age alone and is that it ages exactly in parallel with its attached underlying subdermal structures. The authors have found that releasing in the deep plane permits for lifting and repositioning a greater level of repositioning with less resistance of underlying structures and distortion of muscle function.[6–8] Inevitably, techniques involving plication and imbrication of the SMAS layer can cause alterations in facial muscle dynamic in both static and dynamic expression and appearance. As will be elaborated below, the retaining ligaments of the face are consistent structures that stabilize the soft tissue planes. They are present in certain locations and may extend through all the concentric layers in the form of osteocutaneous ligaments and or more superficially in some areas such as the preparotid region where we encounter the "fixed SMAS" versus the "mobile SMAS" where the platysma glides over the masseter and underlying structures. The mobile plane typically exists on the underside of mimetic muscle bellies in the SMAS.

Dissection through different portions of the surgical deep plane requires variation in dissection technique. For instance, dissection in the mobile sub-SMAS or submuscular plane under the facial or cervical platysma can be performed in a blunt fashion. Contrary to this, sharp dissection is required to dissect through the boundaries of the spaces. The platysma is fixed laterally to the parotid fascia in the face and neck over the facial parotid and tail of parotid, respectively. In the neck, this zone is referred to as the cervical retaining ligaments.

Dissection in the midface over the zygomaticus musculature may be performed sharply or bluntly, depending on the surgeon's experience and preference. Blunt dissection in this region requires more force, as it is no longer in the submuscular glide plane but is rather in a directly supramuscular plane that is more adherent to the overlying subdermal fat/fascial layer. Directly caudal to the lateral portion of the zygomaticus, inferior to the lateral zygoma, exists a dense area of connective fibers called the zygomatic cutaneous ligaments. This dense region, also referred to as McGregor's patch, is a major hurdle in facelifting if not fully released or released in the right plane. If it is transected too superficially, the composite flap won't be adequately mobilized and midface lifting will fail. Excessively deep release will push the surgeon forward in a submuscular plane and potentially cause nerve or muscle damage to the zygomaticus complex or risorius. Dissection must then be continued anteriorly over the remaining zygomaticus and buccal fascia to allow the SMAS–platysma complex to fully rotate and release from the underlying structures. Dissection with complete release of the facial and cervical decussation zones is required to permit for unresisted manipulation and less potential negative sequelae related to muscle movement.

As mentioned, the term SMAS, although technically inaccurate when referring to the subdermal fat/fascial layer, has a surgical meaning, as it is the name given to a surgically created flap in the midface or along with the platysma as the SMAS–platysma complex. However, the surgical deep plane is an extension from the sub-SMAS layer as no distinct layer or aponeurotic sheet is present in the midcheek anterior to the parotid gland. A histological study found that Layer 3 is present only where flat mimetic muscles exist and over the posterior half of the parotid gland, without any clear aponeurotic layer in the in-between areas where the subcutaneous fat of the superficial fascia is in direct connection to the deep fascia.[9] Over the masseter muscle, the subcutaneous fat is in direct contact with the deep fat without an aponeurotic layer separating them. Similarly, anterior to this, the malar fat connects the buccinator to the dermis without a Layer 3. The surgically created flap of deep plane face and neck lifting is the platysma, SMAS, and the deep part of the superficial fascia with the superficial part of the deep fascia. The "deep plane" dissection becomes histologically "deep subcutaneous" in the anterior midface. "SMAS"-like layers can be created surgically by the dissection.

Decussation Zones and Retaining Ligaments

Retaining Ligaments

Throughout the evolution of SMAS and deep plane facelift surgical techniques, there has been increased attention on obtaining more thorough and durable improvements in the midface, jawline, and neck as an integrated unit. The retaining ligaments are important in understanding facial aging and surgical rejuvenation. They exist in predictable anatomic locations and are key landmarks in external facial anatomy and deep plane facelift surgery.[10–12] The retaining ligaments are considered obstacles to surgical maneuvers in facelifting and in turn, a key tenet of deep plane face and neck lift includes complete release of the facial and cervical retaining ligaments.

These fibrous structures are responsible for some of the shadowing seen with aging as they support facial soft tissue and resist gravitational pulling.[13] Retaining ligaments often serve as deep fibrous attachments that anchor between the underlying deeper layer (deep fascia and skeleton) to insert onto the dermis. Some of the facial retaining ligaments have been classified as osteocutaneous ligaments, which originate from the periosteum, versus the fasciocutaneous ligaments, which originate from the superficial/deep fascias, such as the zygomatic cutaneous ligaments and the masseteric ligaments, respectively. This decussation zone includes the zygomatic cutaneous ligament, i.e., McGregor's patch, which is a dense region of osteocutaneous attachments, and the buccal decussating ligaments. The transverse facial artery perforators can exist in, or in close proximity to this patch. The masseteric ligament connects the SMAS to the masseteric fascia; they separate the lateral cheek compartment and the premasseteric space over the inferior aspect of the masseter. In the neck, the cervical retaining ligament is the posterolateral overlap of the platysma on the parotid tail inferior to the gonial angle and superior to the sternocleidomastoid muscle and external jugular vein. The cervical retaining ligaments are dense connections to the parotid and not over the sternocleidomastoid muscle or external jugular vein. This explains why dissection of the platysma over the SCM can be done bluntly and easily in the mobile plane.

The main surgical relevance relates to the complete release of these retaining ligaments to achieve free manipulation during facelift surgery. It is generally accepted that releasing facial and cervical retaining ligaments allows greater mobilization of the SMAS–platysma complex. The general concept is that by releasing the tethered portions of the SMAS, the surgeon can mobilize an area distal to this tethered fixed plane. Release of decussation planes, such as the buccal decussation, existent between the overlap of facial platysma as it transitions to the fascial SMAS layer of the midface, furthers the ability to mobilize and improve the midface. The attachment of these presumed ligaments to underlying deep structures is not uniform. We dispute the prior belief that the jowl is secondary to osteocutaneous retaining ligaments that definitively require releasing during facelift surgery.

Mandibular Ligament

The mandibular ligament has been considered central in the lower facial aging process. It has been reported variably in respect to its position and extent. Commonly, the mandibular ligament has been classified as an osteocutaneous ligament, assumed arising from the anterior third of the mandible with direct insertion into the dermis.[10,11,13] Beyond this description, there have been two different thoughts regarding the plane of this ligament as being in the deep (subplatysmal) plane versus in the supraplatysmal subcutaneous plane, or both.[14,15]

Recently, a phenomenal histological analysis of the mandibular ligament confirmed that it is not a true facial retaining ligament, lacking dermal, or any supraplatysmal ligamentous attachments.[14] The true mandibular ligament exists only in the subplatysmal plane formed by the attachment of the depressor muscles to the anterior third of the mandible (platysma, depressor anguli oris [DAO], and depressor labii inferioris [DLI]). This study demonstrated that the only firm attachment of the mandibular ligament was the dense adhesions of the musculoaponeurotic layer of these three muscles to the mandible and that contrary to common belief, there is no definitive supraplatysmal component.

Facial and Greater Auricular Nerves

The facial nerve divides into an upper and lower division within the parotid gland with further division into peripheral branches, which exit the parotid gland at its anterior surface covered by the deep fascial layer, the parotidomasseteric fascia (►**Fig. 1**). The branches of the facial nerve all pass from deep to superficial as they travel toward the anterior face to innervate the facial mimetic muscles.

The parotidomasseteric fascia is a component of the deep cervical fascia found inferior to the zygomatic arch.[11,16] All muscles of the face are innervated by facial nerve branches on the deep surface of the muscle except for the mentalis, levator anguli oris, and buccinator. Hence, dissecting in this direction on the surface of the mimetic musculature helps protect the nerves from injury.

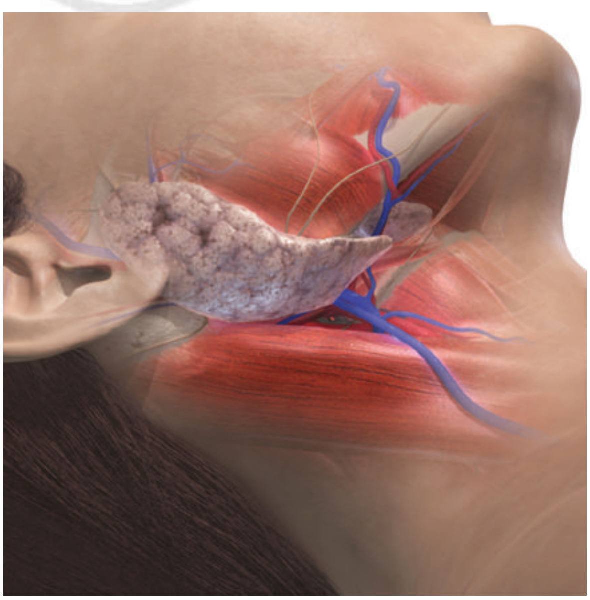

Fig. 1 Anatomy of parotid gland overlying the masseter with peripheral facial nerve branches exiting the anterior border.

The direction of travel of the frontal branch, also known as the temporal branch, can be estimated using Pitanguy line—a straight line connecting a point 1.5 lateral to the supraorbital rim to a point 0.5 cm inferior to the tragus.[16] After exiting the parotid gland, the frontal branch travels along the middle third of the zygomatic arch and transitions to Layer 3—deep to the superficial temporal fascia, and transitions superficially at the SMAS to innervate the orbicularis oculi and frontalis muscles. The frontal branch travels along with the anterior branch of the superficial temporal artery along the inferior temporal septum. The inferior temporal septum protects the frontotemporal nerve branches by providing a naturally thicker fascial separation between the temple space and the midcheek deep plane dissection. A deep temple dissection and deep plane midcheek dissection could therefore never be connected and dissection between the two zones must either transition from subperiosteal to subperiosteal, or subdermal to subdermal. High-SMAS techniques may be more prone to minor damage and reinnervation–regeneration and synkinesis in this region. The zygomatic branches exit the parotid inferior to the zygoma and parotid duct, traveling caudal to the zygomatic cutaneous ligament with the transverse perforators of the facial artery on the masseter. The zygomatic nerve gives branches to innervate the orbicularis oculi muscle, zygomaticus major, and minor muscles consecutively. Dissection should be performed with caution and superficial to the zygomatic muscle. The buccal branches are located in the lower premasseteric space anterior to the masseteric ligaments.[16] The marginal mandibular nerve exits the parotid at the platysma-auricular fascia as it travels along the inferior boundary of the lower premasseteric space. It travels anteriorly and exits the parotidomasseteric fascia as it crosses the facial artery and vein overlying the submandibular fascia. The marginal mandibular nerve becomes superficial to platysma once it reaches the DAO. Similarly, the cervical branches are deep to the platysma until at least 1.5 cm of the gonial angle. Afterward, it divides into several branches and travels superficially to innervate the platysma in the suprahyoid region.[16]

Greater Auricular Nerve

The most commonly injured nerve in facelifting is the great auricular nerve. It travels in the plane of the SCM fascia approximately 6.5 cm inferior to the external acoustic canal, referred to as McKinney point.[16] It travels as a single branch anywhere from 8 to 12 mm anterior to the anterior mastoid line, and thus, dissection in this area should be done carefully and should be done in a plane superficial to the SCM fascia.[2]

Layers of Fat

Generally there are two types of fat in the face: superficial and deep fat. The subcutaneous superficial fat is one of the two components of Layer 2. This consists of both hypodermal fat and SMAS fat within the subdermal fat/fascial layer. The hypodermal fat are smaller fat globules that fit within the reticular dermis, and larger fat globules that are deep to the former within the subdermal fat fascial layer. Similar to other tissues in the face, there is variability in the quantity and quality of fat in various areas of the face. The subcutaneous fat layer is thicker as you progress caudally from the cheek to the mandibular angle.[17] The superficial subcutaneous fat is not present in the eyelids, so this layer appears nonexistent, although the areolar portions become apparent lateral the canthus in the periorbital region over the orbicularis. There is a layer of superficial fat that is present superficial to the orbicularis oculi muscle superiorly on the eyelid that can be repositioned during surgery.[17]

The deep fat of the midface is positioned between the facial mimetic muscles. Layer 4 covers the deep fat compartments. In the midface, the deep fat compartments contribute to facial volume over the zygoma/maxilla. Centrally, there are three fat pads that lie between the zygomatic ligament and facial vein: the medial and lateral suborbicularis oculi fat, and the deep central fat compartment, superiorly and inferiorly, respectively.[17] The buccal fat pad is a continuation of the deep temporal extension, which overlies the temporalis muscle but is in a distinct capsule with different characteristics. The buccal fat consists of much larger, lobular cells than seen in the more superficial layers. These fat cells are considered to be more stem cell rich and are histologically comparable to the orbital fat.[18]

Mastoid Crevasse Anatomy

The outer mastoid fascia has previously been used as a suspension point for neck lifting. However, this relies on optimal patient anatomy; patients with mastoid tips that are shallow relative to the mandible obtain better gonial angle depth than patients with more prominent, broader, or more lateralized mastoid tips. A short mastoid position relative to mandible may also obtain a better lift, whereas a tall ramus and low mastoid may obtain minimal to no submental lift nor result in adequate gonial angle definition in some patients. The mastoid crevasse is a novel technique described by the primary author for deep plane neck lifting.[2] The anterior mastoid periosteum over the front side of the mastoid process is dissected and used as a strong area for fixation, with a notable mechanical advantage of using the fulcra around the gonial angle and hyoid to lift the submentum and submandibular content and tucking it medial/deep to the ramus and gonial angle. The three structures that attach to the anterior mastoid are the tail of the parotid gland, the sternocleidomastoid muscle, and the conchal cartilage. The mastoid process, and in turn the suspension point of the crevasse, is at a point superior to the mandible and hyoid. This ensures vertical lifting of the cervical deep plane to a point superior and lateral as well as deep in the *z*-axis, regardless in patients with more challenging anatomy for adequate lifting.

Anteriorly, the dissection separates the parotid from the mastoid and allows the tissue (parotid tail and capsule) to be compressed with the deep suspension, reversing much of the protrusion and blunting noted with age. Superiorly, dissection can continue superiorly to slightly elevate the conchal bowl to permit the highest vertical position on the anterior mastoid periosteum for the platysmal suspension.

Inferiorly, the platysma is dissected off of the parotid and off the sternocleidomastoid and external jugular vein inferior to that. Extensive inferior or caudal dissection is avoided to prevent dehiscence of the platysma. Although most diagrams of the platysma demonstrate a muscle that spans over the majority of the clavicle, this is only accurate in youth. In general, the lateral platysma atrophies and is nearly nonexistent lateral to the external jugular vein or lateral sternocleidomastoid muscle in older patients. The great auricular nerve travels adjacent to the external jugular vein in single or multiple branches, adjacent to the vein on either side, although in most cases the nerve exists on the lateral border of the vein. ►**Fig. 2** shows the anatomy around the mastoid process dissection. As the external jugular vein continues deep into the tail of the parotid as the retromandibular vein, the cervical sensory branches traverse at the lateral border of the platysma to a plane in and over the tail of the parotid fascia. The great auricular nerve may diverge into various anterior branches at any point in this course, whereas the posterior branches typically diverge much earlier near the midpoint of the sternocleidomastoid muscle.

In our recent analysis, the mastoid crevasse technique sparred facial nerve and greater auricular nerves. Several posterior branches of the greater auricular nerve were found along the mastoid fascia traveling 4 to 12 mm posterior to the anterior mastoid line.[2] The facial nerve branch to the posterior auricular nerve travels at the superior aspect of the anterior mastoid line deep to the ear canal and can be safely preserved.

Surface Anatomy of the Deep Plane

A mastery of the superficial anatomy and landmarks of the face is essential to understanding the deep facial structures and performing facial rejuvenation procedures. In the senior author's anecdotal experience, there are consistently identifiable superficial landmarks that correspond to underlying deep structures. This includes the zygomatic cutaneous ligament, buccal fat pad, zygomaticus major complex, and platysmal insertion deep into the face, which coincides with the masseter going deep into the buccal region at the inferior alveolar line. These can be identified by contour changes in the face and changes in pore density.

Similarly, the shadow or darkening commonly present in areas of the face such as the prejowl sulcus may be a consequence of volumetric depression in facial fat with aging. This occurs in both hypodermal fat, consisting of small fat cells nestled within the reticular dermis, and SMAS fascia, existent above the true SMAS, also vaguely called the subcutaneous fascia or tissues. This results in darkening of the skin tone as the subdermal fascia and fat deflates. The change in skin tone and reflection that occurs over time is a consequence of the change in light reflection as it penetrates down to the muscle layer instead of subdermal fat and volumized

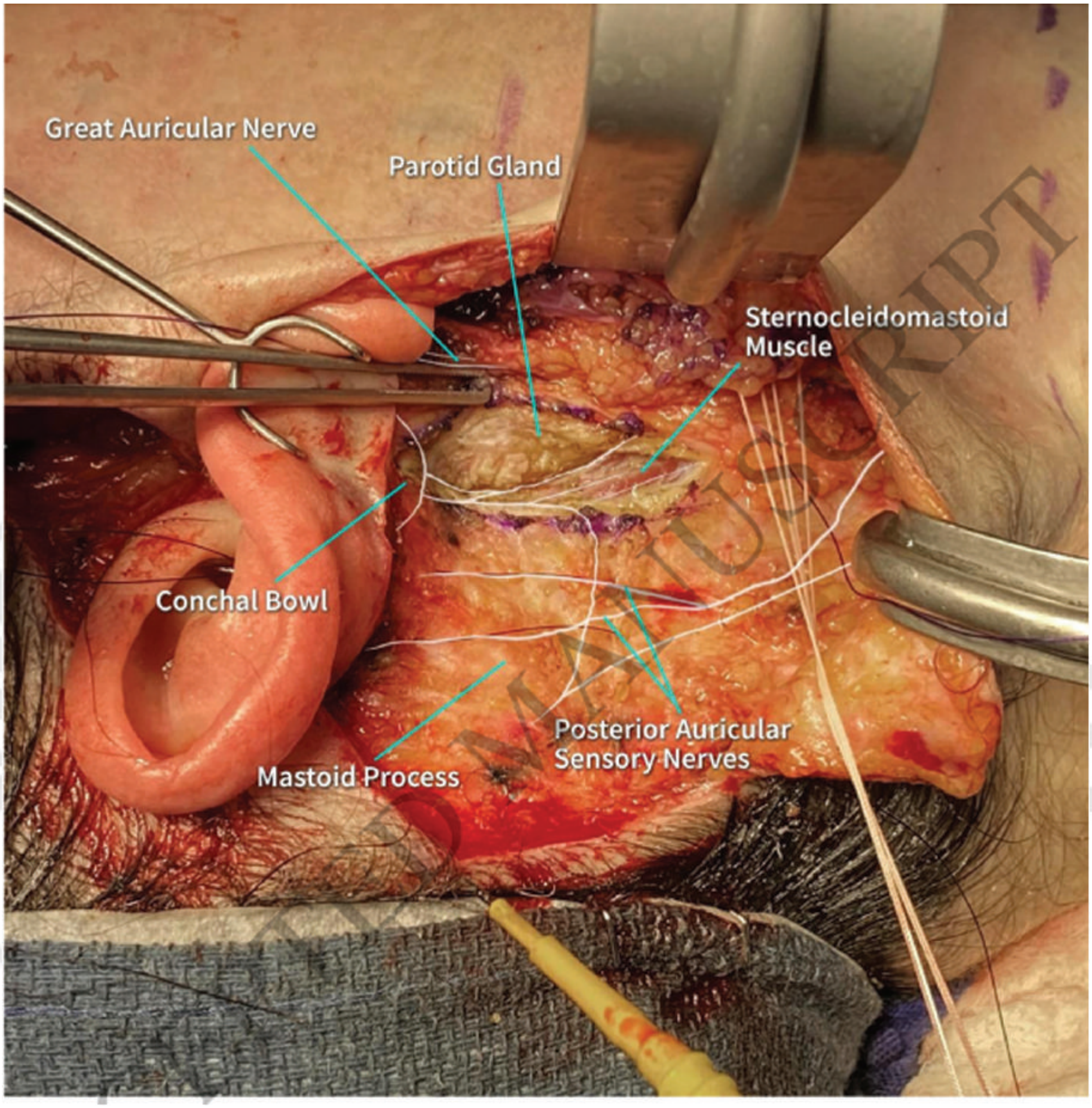

Fig. 2 Anatomy of postauricular/mastoid region.

subdermal fascial fat layers. A study found a maximum depth of 5 mm with red spectrum light suggesting that one's skin may be impacted by structures up to 5-mm deep.[19] Surgically, one can note the translucency of skin in the form of transillumination, conveying that everything seen through skin transillumination intraoperatively contributes to the overall skin tone. This is why the appearance of the shadow exists even when a photo is taken with flash lighting that would otherwise flood true shadows. The volumetric depression also contributes to the appearance of tethering when the surgeon pulls on the face. This depression is exaggerated with volumetric deflation and in the jowls worsens after midline platysmal plication, which medializes the skin around the anterior jawline.

Conclusion

We discuss deep plane face and neck lift anatomical and surgical terminology along with surgical implications. To evaluate and treat facial aging, understanding the anatomy and relationship between superficial and deep facial structures is critical to both optimizing facial rejuvenation outcomes and minimizing risk. The deep plane is the proper plane of dissection for facelift. Deep plane face and neck lifting is a beautiful dissection within intricate relation with soft tissue spaces, retaining ligaments, facial nerve, and mimetic muscles. Spatial awareness and comprehensive anatomical understanding of these structures is key to predictable and successful surgical outcomes.

Conflict of Interest

None declared.

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PREV NEXT

Affiliations

Globe Retropulsion and Eyelid Depression (GRED)—A Surgeon-Controlled, Unimanual Maneuver to Access Postseptal Fat in Transconjunctival Lower Blepharoplasty

To the Editor:

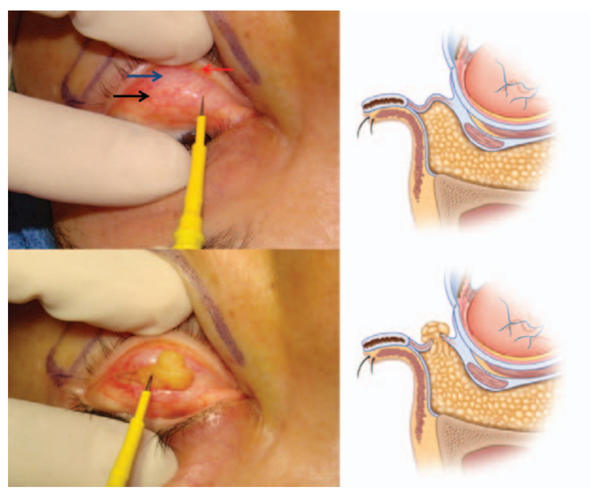
Accessing eyelid/orbital fat is a critical step in aesthetic lower blepharoplasty. Historically, fat was identified through an open infracilliary skin incision, which is both quick and direct. While this approach is straightforward and still a contemporary technique today, inherent to it is a skin incision and division of both the orbicularis muscle and orbital septum to enter the fat compartment. This transcutaneous surgical approach has been reported to lead to an increased incidence of postoperative eyelid malposition such as retraction or ectropion.[1–3] In the 1920s, transconjunctival lower eyelid surgery was described.[4] It fell in disfavor and was rarely employed until the later part of the 20th century when Tomlinson and Hovey[5] and Baylis et al.[6] reintroduced the concept for blepharoplasty surgery. Tomlinson advocated a preseptal dissection with division of the orbital septum to access the fat pads, while Baylis favored a more direct postseptal approach to fat, which leaves the orbital septum undisturbed. Since then, transconjunctival lower blepharoplasty (TCB) has become a common surgical procedure, which has reduced the incidence of lower eyelid malposition after surgery,[1,2] reported to be as high as 20% with the transcutaneous approach.[3]

Traditional techniques in TCB describe creating surgical exposure by inferiorly displacing the lower eyelid with some sort of rake or retractor, while protecting the globe with a corneal shield, Jeager eyelid plate, or similar device.[2,6] When globe retropulsion is added, eyelid/orbital fat is displaced anteriorly. This simplifies direct entry into the postseptal fat compartment.[6] These manipulations have been described as 2 person dependent (surgeon and assistant) and involve the use of instruments, which cover the eyelid and globe, limiting surgical exposure to only the conjunctiva.

In this letter, the "globe retropulsion and eyelid depression (GRED)" maneuver is described. This is an assistant independent manipulation, which involves simultaneous "unimanual" lower eyelid inferior displacement and globe retropulsion (over the closed upper eyelid) with 2 fingers of 1 hand by the surgeon only. The maneuver is quick, simple (with some experience), and reliably promotes direct entry to the clearly delineated postseptal fat compartment without obscuring the globe or lower eyelid from view. This is important because TCB is a more detailed and complex technique than its transcutaneous counterpart, especially when more contemporary adjuncts such as fat transposition[2] are added. As such, surgeons who perform TCB less frequently, have trepidation with manipulations so close to the globe, or are accustomed to, or prefer, the more traditional and direct transcutaneous technique, may avoid this approach. Identifying surgical steps that simplify and add precision to the transconjunctival technique promotes increased confidence and allays fears with the procedure. The GRED maneuver is such a step.

The lower eyelid is infiltrated transconjunctivally with 2 ml of 1% xylocaine with 1:100:000 epinephrine. Appropriate time is given for anesthesia and hemostasis to take effect. With the surgeon's nondominant hand, the lower eyelid is inferiorly displaced with the second finger (third digit), while simultaneously retroplacing the globe with direct gentle pressure with the same hand's index finger (second digit) or thumb pushing towards the orbital apex (GRED maneuver). The transconjunctival surface of the lower eyelid protrudes forward as eyelid/orbital fat is displaced anteriorly. The tarsus, fused conjunctiva/septum and retractor layer, and yellow fat visible beneath the more inferior posterior eyelid lamella become clearly visible (Fig., top). A perpendicular incision through the conjunctiva/retractors over the fat allows direct entry to the postseptal space and fat prolapses from the surgical wound (Fig., bottom). Fat can then be excised or repositioned as preoperatively planed in the standard way.

Simultaneous globe repulsion and inferior lower eyelid displacement improves surgical exposure in TCB because of unique and inerrant anatomical characteristics of the orbit. The orbit is a pear-shaped bony cavity, which houses the globe, extraocular muscles, and fat associated with these structures. As the intraorbital contents are pliable, the orbital walls rigid, and the external diameter of its opening larger than its apical dimensions, anterior–posterior pressure on the globe will force fat anteriorly. When the lower eyelid is inferiorly displaced, the anteriorly repositioned fat "bulges" forward, converting the concave or flat palpebral conjunctival surface into as convex shape with a more visible and clearly delineated anatomy (Fig., top). The yellow fat glistens through the conjunctiva making its exact postseptal location obvious. In the GRED maneuver, simultaneous globe retropulsion and inferior lower eyelid displacement are performed by 1 hand of the surgeon without assistance as 1 brisk manipulation, simplifying postseptal fat access. Also important is that retropulsion is performed with the upper eyelid closed (Fig., bottom) so that the globe gains a layer of protection.



The globe retropulsion and eyelid depression maneuver. **Top left,** Unimanual and simultaneous inferior lower eyelid displacement and globe retropulsion over the upper eyelid. Note clear delineation of the various segments of the posterior lamella. *Red arrow* is conjunctiva with overlying tarsus. *Blue arrow* is conjunctiva with fused septum/retractor layer (entry point for preseptal dissection). *Black arrow* is conjunctiva overlying yellow fat. This is appropriate incision point for postseptal entry to fat. **Top right,** Artists drawing of sagittal section of globe and lower eyelid showing fat bulging which is the appropriate incision location to access postseptal fat. **Below left,** Fat freely expressed by correct incision placement. **Below right,** Sagittal section artists drawing of the same (reprinted with permission Massry et al.[1]).

The authors would like to emphasize that no suggestion is being made regarding the efficacy of pre- versus postseptal transconjunctival access during TCB. There are those who prefer a preseptal dissection plane (incision just below tarsus) for surgery. This is a well-established approach,[3,5] which the authors believe is equally as safe and effective as postseptal surgery. With preseptal surgery, as dissection is between the orbicularis muscle and orbital septum, fat is accessed by septal incision. Traditional thinking in oculoplastic surgery is that preservation of the orbital septum is an important step in lower blepharoplasty to prevent middle lamellar cicatrix and eyelid malposition.[1,2] The authors challenge this belief when performing isolated TCB. In an ongoing comparative study of TCB only (without added skin excision, orbicularis muscle plication, or canthal suspension), involving one of the authors (G.G.M.), who performs all TCB with a postseptal approach, and Andrew Jacono, M.D., a facial plastic surgeon in New York, who performs all TCB with a prespetal approach, lower eyelid retraction did not occur after surgery in over 75 cases with each approach (manuscript in preparation). The authors believe that it is some combination of skin/orbicularis muscle and septal violation, which causes eyelid retraction not isolated septal division. Because preseptal surgery is not dependent on a heightened exposure of postseptal fat, the GRED maneuver is not as beneficial in this approach.

While the end result of the description of postseptal fat exposure by Baylis et al.[6] is similar to what is achieved with the GRED technique described herein, the authors prefer the GRED maneuver because it is not dependent on an assistant and does not obscure the eyelid or globe from the surgical field (with retractors and corneal protectors). Also, by simultaneously adjusting the degree of lower eyelid depression and globe retropulsion without dependence on an assistant, the surgeon can more precisely titrate the conjunctival entry point (critical in postseptal surgery) to access fat. One of the authors (G.G.M.) has been utilizing the GRED technique for the last 10 years and has not noted any intraoperative complications (to the globe or eyelids) related to the maneuver. For those who perform TCB in the postseptal plane, the authors suggest the GRED maneuver as a means of improving surgical precision and technique.

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ORIGINAL ARTICLES SPECIAL TOPICS

Regenerative Nanofat Membrane Development Process

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Abstract

Introduction Chronic wounds present a significant challenge in clinical practice due to complications like infections and prolonged healing times. Conventional treatments often fall short, necessitating advancements in wound healing strategies. This article introduces a novel approach using a combination of adipose-derived stem cells (ADSCs) from fat and growth factors from platelet-rich fibrin (PRF) to enhance wound healing outcomes.

Methods The Fakih-Manay fat membrane device was utilized to prepare fat membranes. Microfat was harvested and emulsified to produce nanofat, which was then combined with PRF to create a Nanofat-PRF membrane. The resulting membrane was uniform, versatile, and suture-friendly, making it ideal for various medical and surgical applications.

Results Between April 2019 and April 2024, 172 patients received treatment using a nanofat membrane. The membrane showed significant improvement in wound healing in various cases including diabetic foot ulcers, cleft palate surgeries, facial dermabrasion, skin necrosis, revision rhinoplasties, and post-cosmetic surgery complications. Postoperative follow-up after healing ranged from 1 to 16 months, showing high patient satisfaction and significant improvements in wound healing and no reported complications.

Conclusion The nanofat membrane presents a versatile and innovative approach to enhancing healing across a broad range of medical and surgical applications. This study provides the first evidence on the method for creating these membranes, demonstrating their clinical efficacy and safety, with no reported complications over a 5-year period.

Level of Evidence IV This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Fat membrane · Nanofat membrane · Wound healing · Adipose-derived stem cells · Platelet-rich fibrin · Regenerative medicine

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Introduction

Wound healing can be critical for patients and clinicians [1, 2]. Acute wounds can convert into chronic wounds that are onerous to manage because of their association with skin fibrosis. These chronic wounds, in turn, lead to infections, painful dressings, and prolonged hospitalization. This results in poor patient quality of life and high healthcare costs [3]. Hence, wound healing processes and new developments in this field need to be improved and should be encouraged [4].

In recent studies in regenerative medicine, platelet-rich plasma (PRP) and nanofat derived from a patient's own blood and fat, respectively, have shown promise. However,

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their liquid forms can be challenging to manage effectively when applied to wounds due to operational difficulties. To address this limitation, a method has been developed to combine nanofat with gelatinous platelet-rich fibrin (PRF). Therefore, this article highlights the preparation of a fat membrane, thereby enhancing its suitability and efficacy in wound healing applications.

Properties of Adipose Tissue

Microfat is composed of adipose tissue and adipose-derived stem cells. Nanofat, or filtered lipids, are made by the mechanical emulsification of microfat, which contains tissue stromal vascular fraction (t-SVF) and adipose-derived stem cells (ADSCs) [5]. ADSCs have important regenerative and rejuvenation properties [6–8]. The differentiation of ADSCs produces a large amount of type I collagen, smaller amounts of type V and type VI collagen, and proteins. It also regenerates fibroblasts and secretes greater amounts of cell matrix, all of which help to repair dermal breaks and reconstruct and rehabilitate the skin structure [9–12].

Properties of PRF

Cytokines from platelets, leukocytes, and the supporting fibrin membrane are the factors responsible for the therapeutic effects of PRF. Slow, prolonged, and controlled release of cytokines, along with the fibrin matrix acting as glue in PRF, is more efficacious than the uncontrolled and fast release of cytokines from PRP [13]. PRF includes glycosaminoglycans (heparin and hyaluronic acid) from blood and platelets. Cytokines have a strong affinity for glycosaminoglycans, which can support cell migrations and healing processes [14].

Therefore, considering the rich healing properties of PRF and ADSCs, we propose combining the two to form a large, thick membrane suitable for a wide range of medical cases, including chronic diabetic foot ulcers, burns, chronic wounds, and various cosmetic and reconstructive procedures. This membrane is easy to handle, can cover a large wound area, and can be secured with simple sutures.

Methods

Devices Required

(1) Fixed-angle centrifuge machine with plain test tubes to centrifuge the blood.
(2) Tulip Medical™ Nabil Fakih Master Face Set™ (Tulip Medical Products, San Diego, CA) to harvest and process the fat.
(3) Fakih-Manay fat membrane device for producing the fat membrane.

Method of Preparation (Fig. 2)

Preparation of Microfat and Nanofat

Harvesting the fat is initiated in the donor area through a small 2 mm incision. A modified Klein's tumescence solution is infiltrated slowly with a tumescent infiltrator of 2.1 mm × 20 cm. The desired amount of mixed fat with tumescent solution is harvested from subcutaneous fat manually in a "spokes-of-a-wheel" pattern using a Tonnard harvester, a 2.4 mm × 20 cm cannula with sharp holes of 1 mm diameter, in a 20-ml Luer-Lock syringe [15]. The harvested syringe is capped in a vertical position to decant for 4-6 min to separate the layers. The yellow adipose grafts (microfat) quickly separate according to their density from the underlying infranatant fluid, and a lipid layer forms on top. The tumescent solution is drained out, and the microfat is transferred to 10 cc syringes without the oil layer. A single wash with Ringer's lactate solution is performed to reduce residual local anesthetic solution and red blood cells. It is decanted for a second time, completing the microfat preparation [15].

The microfat emulsification process is carried out with 3 transfers. The cleaned microfat is loaded into 20 cc syringes and mechanically emulsified by shifting the contents 30 times back and forth between two 20 cc syringes connected to each other by a 2.4-mm Tulip transfer. This process is repeated 30 times back and forth with a 1.4-mm Tulip transfer and finally 30 times back and forth with a 1.2-mm Tulip transfer until the fat is liquefied, acquiring a pale-yellow appearance [15]. The emulsified fat is then passed one time through the nanotransfer block, which contains a double filter of 400 µm and 600 µm single-use cartridge net (Tulip Medical Products, San Diego, CA), into a 20 cc syringe containing nanofat.

Preparation of Platelet Plasma

The desired amount of venous blood is collected from the patient using an 18 G needle in a sterile plastic vacutainer for the preparation of autologous plasma, in 9-ml plain tubes without anticoagulant. The original amount of blood is divided equally into tubes, which are placed symmetrically around the rotor axis for proper balancing inside the fixed-angle centrifuge (HwLAB, Model HW12M, Zhejiang Huawei Scientific Instrument Co. Ltd., China; Brushless Motor; fixed-angle tubes; maximum rcf 2460 × g). The *G* force or relative centrifugal force (RCF) should be around 1300. RCF refers to the amount of force applied when using a centrifuge. To convert revolutions per minute (rpm) to RCF, or *g* force, use the following formula: $RCF = (rpm)^2 \times 1.118 \times 10^{-5} \times r$. Relative centrifugal force is dependent on the speed of rotation in rpm and the distance of the particles from the center of rotation. When the speed of rotation is given in rpm and the distance (r) is expressed in centimeters, RCF can be calculated.

For a quick calculation of the required RPM based on the radius of a fixed-angle centrifuge, ensuring a *G*-force of approximately 1341 with horizontal tubes, refer to Table 1. For the HwLAB Model HW12M centrifuge, with a radius of 7.5 cm and a desired *G*-force around 1341, the corresponding speed is approximately 4000 rpm. Thus, centrifugation is performed at 4000 rpm for 1 min at room temperature (22 °C). This process typically yields approximately 3.5 cc of plasma. Maintaining a G-force between 1340 and 1600 for a duration of 1 minute may allow the generation of identical membranes, depending on the centrifuge's radius and corresponding RPM.

Preparation of Fat Membrane (Fig. 1)

The Fakih-Manay fat membrane device (Fig. 2) is a sterile device that measures 5 cm (width) × 10 cm (length) × 1.5 cm (depth). The internal length can be altered depending on the needed membrane size with the help of a vertical stopper. The device allows us to prepare nanofat or microfat membranes.

The device is prepared according to the desired length by placing a vertical stopper. Within 1 min of plasma preparation, the liquid plasma is transferred quickly into the sterile Fakih-Manay fat membrane device (Fig. 3A) before it becomes a PRF membrane. Then, the prepared fat (nanofat or microfat) is poured over and blended with the plasma using a sterile rod (Fig. 3B).

The immediate appearance after pouring the supernatant is a transparent yellow fluid. As the plasma matures and transforms into PRF with the incorporation of nanofat, it takes on a yellowish color and develops a thick, gelatinous consistency as it settles (Fig. 3C). The fat-PRF membrane begins to form within 1 min and typically sets within 5–10 min (Fig. 3D). This structure is referred to as the nanofat membrane.

Note: Time is crucial in creating the membrane, as it requires agility between collecting the blood, placing it in the centrifuge, and then aspirating the liquid plasma before it becomes PRF. Within less than a minute after the centrifuge stops, all liquid plasma should be transferred into the Fakih-Manay fat membrane device and mixed with the nanofat. It is important that the plasma remains liquid, so it can be properly mixed with the nanofat.

Once the gel has set, the vertical stopper is removed, and the lid of the device is gently pressed into the container. This allows the device to uniformly compress the fat-fibrin gel without causing damage. This compression helps to convert the fibrin gel into a fibrin membrane by squeezing out excess liquid (Fig. 3E). The liquid squeezed out is collected by aspiration with a syringe (Fig. 3E). A dedicated tool with the described configuration is used to compress the fat-fibrin gel without slicing it, thereby increasing its density. The thick fat membrane formed is then gently removed from the container (Fig. 3F–H) and directly placed and sutured over the desired area. The Fakih-Manay fat membrane device has been acquired and being upgraded by Tulip Medical™ (Tulip Medical Products, San Diego, California, USA).

Preparation Protocol

We propose a protocol for acquiring the desired membrane measurements (Table 2).

Results

Between April 2019 and April 2024, a total of 172 patients were treated with a nanofat membrane. Among them, 148 (86%) were women, and 24 (14%) were men. The mean age was 35 years, with a range of 1 to 68 years. The membrane was intended to accelerate would healing or closure in all cases. The study was conducted in accordance with the Declaration of Helsinki. All patients consented to be included in the clinical case study to evaluate healing after using fat membrane. The consent was signed by the patient, the surgeon, and the medical commission of the hospital.

Of the treated patients, 129 (75%) had diabetic foot chronic wounds that had failed to heal after several months of treatment. Two (1,2%) patients were treated following cleft palate surgery using the Veau-Wardill-Kilner palatoplasty technique. Additionally, 20 (11,6%) patients were treated after facial dermabrasion, 12 (7%) patients for skin necrosis following vascular occlusion, and 4 (2,3%) patients for skin necrosis post-cosmetic surgery. In three (1,7%) revision rhinoplasty cases, the membrane was placed over the dorsum before closure. Two (1,2%) smoker patients, at high risk of skin necrosis, were treated post-facelift and neck lift before skin closure.

Defect sizes varied from 2 cm × 3 cm to 9 cm × 9 cm. The amount of nanofat required ranged from 1 ml to 10 ml, depending on the membrane size. Each fat membrane was tailored to match the defect dimensions and could be adjusted by cutting to the required size. Postoperative follow-up for the study was conducted every 2 days for the first 15 days, then monthly until complete wound healing was achieved.

Table 1 RPM values required for different radius settings in a fixed-angle centrifuge to achieve a *G*-force of approximately 1341

Speed (RPM)	Radius (cm) 4	5	6	7	8	9	10	11	12	13	14	15
1000	45	56	67	78	89	101	112	123	134	145	157	168
1500	101	126	151	176	201	226	252	277	302	327	352	377
2000	179	224	268	313	358	402	447	492	537	581	626	671
2500	280	349	419	489	559	629	699	769	839	908	978	1048
3000	402	503	604	704	805	906	1006	1107	1207	1308	1409	1509
3500	548	685	822	959	1096	1233	1370	1507	1643	1780	1917	2054
4000	716	894	1073	1252	1431	1610	1789	1968	2147	2325	2504	2683
4500	906	1132	1358	1585	1811	2038	2264	2490	2717	2943	3170	3396
5000	1118	1398	1677	1957	2236	2516	2795	3075	3354	3634	3913	4193
5500	1353	1691	2029	2367	2706	3044	3382	3720	4058	4397	4735	5073
6000	1610	2012	2415	2817	3220	3622	4025	4427	4830	5232	5635	6037
6500	1889	2362	2834	3306	3779	4251	4724	5196	5668	6141	6613	7085
7000	2191	2739	3287	3835	4383	4930	5478	6026	6574	7122	7669	8217
7500	2516	3144	3773	4402	5031	5660	6289	6918	7547	8175	8804	9433
8000	2862	3578	4293	5009	5724	6440	7155	7871	8586	9302	10017	10733
8500	3231	4039	4847	5654	6462	7270	8078	8885	9693	10501	11309	12116
9000	3622	4528	5433	6339	7245	8150	9056	9961	10867	11773	12678	13584
9500	4036	5045	6054	7063	8072	9081	10090	11099	12108	13117	14126	15135
10000	4472	5590	6708	7826	8944	10062	11180	12298	13416	14534	15652	16770
10500	4930	6163	7396	8628	9861	11093	12326	13559	14791	16024	17256	18489
11000	5411	6764	8117	9469	10822	12175	13528	14881	16233	17586	18939	20292
11500	5914	7393	8871	10350	11828	13307	14786	16264	17743	19221	20700	22178
12000	6440	8050	9660	11269	12879	14489	16099	17709	19319	20929	22539	24149
12500	6988	8734	10481	12228	13975	15722	17469	19216	20963	22709	24456	26203
13000	7558	9447	11337	13226	15115	17005	18894	20784	22673	24562	26452	28341
13500	8150	10188	12225	14263	16300	18338	20376	22413	24451	26488	28526	30563
14000	8765	10956	13148	15339	17530	19722	21913	24104	26295	28487	30678	32869

G Force

[a] All individuals coming within 1 m to inspect experimental setup and, in parentheses, all individuals that made attempts

[b] Proportion successful

Overall, patient satisfaction was high, with notable improvements in wound healing and cicatrization. For skin necrosis following hyaluronic acid-induced vascular occlusion, final wound healing occurred within an average of 3 weeks (range 2–4 weeks). In cleft palate cases, healing was faster, with complete closure typically within 2 weeks. For ear skin necrosis, after refreshing the skin borders and debriding the cartilage, a 2 cm × 1 cm nanofat membrane was applied and sutured; the final healing process took 2 months.

In diabetic foot patients, healing times ranged from 1 to 3 months for smaller defects, which had previously failed to heal for several months. Larger defects, such as a 9 cm × 9 cm wound, treated with two membranes, showed significant improvement following foot amputation and chronic infection with 5 months of non-healing, achieving complete closure in 6 months (Figure 4). Repeated membrane applications were performed only for larger diabetic defects over 5 cm × 5 cm (in one case, as shown in Fig. 4) to expedite healing. Smaller defects below 5 cm × 5 cm,

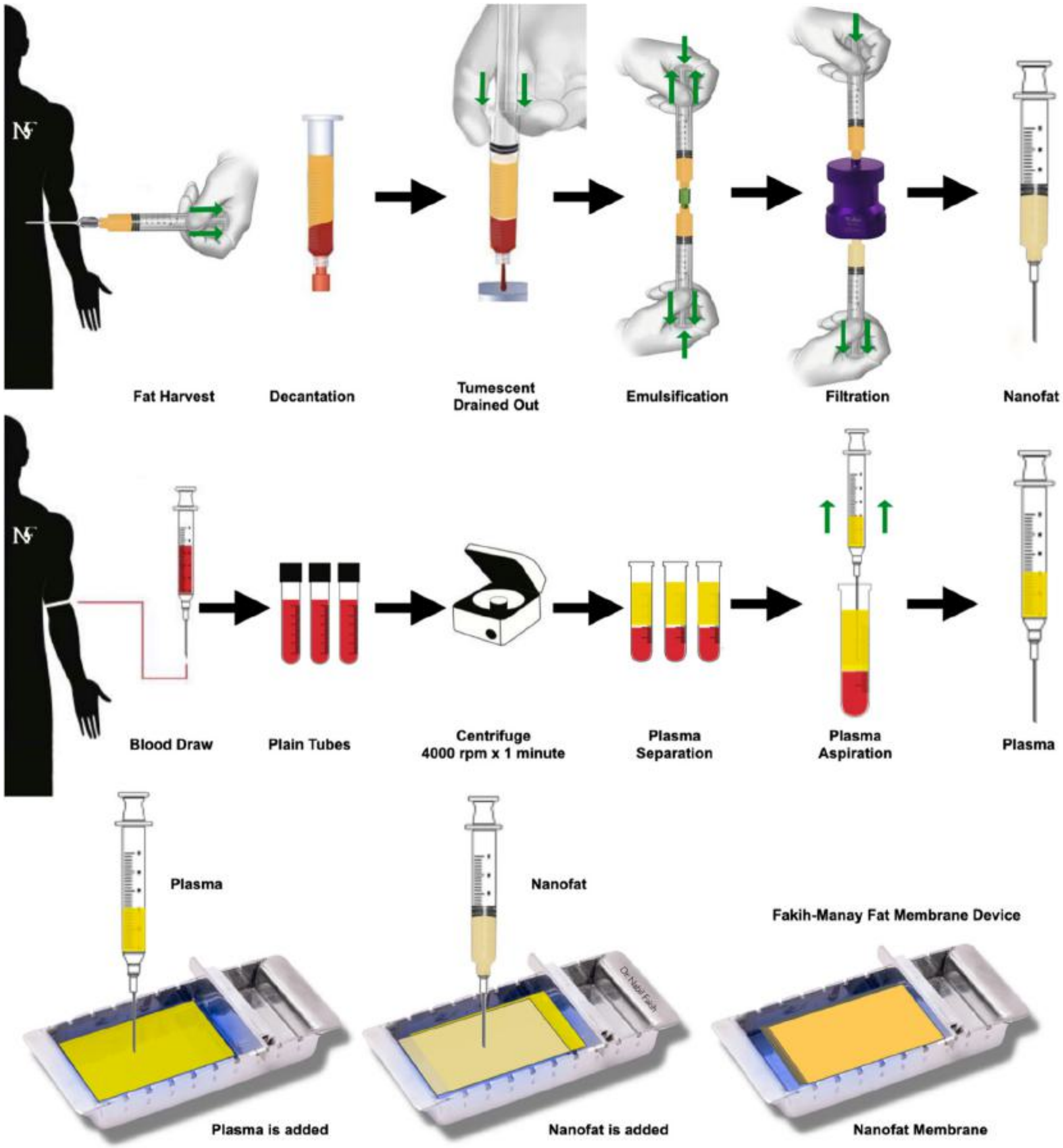

Fig. 1 Process of preparing the nanofat membrane. Preparation of nanofat (first row). Preparation of platelet plasma (second row). Preparation of the nanofat membrane (third row)

as well as cleft lips, dermabrasion, rhinoplasty, and facelift cases, were treated with a single application.

Stable results were observed after achieving healing, with a follow-up period ranging from 1 to 16 months post-healing. No complications were identified from the procedure (Figs. 4, 5, 6, 7, 8, 9 and 10).

Discussion

Currently, there are numerous publications documenting treatments for chronic wounds; however, no gold standard has been officially identified [7–10]. Managing acute and chronic wounds requires a comprehensive strategy aimed at optimizing healing and preventing complications. Key components for chronic or complicated wounds include debridement, which is vital for eliminating nonviable tissue, thereby promoting wound healing. Regular debridement, ideally performed weekly, is associated with improved outcomes [16, 17]. Off-loading is another critical

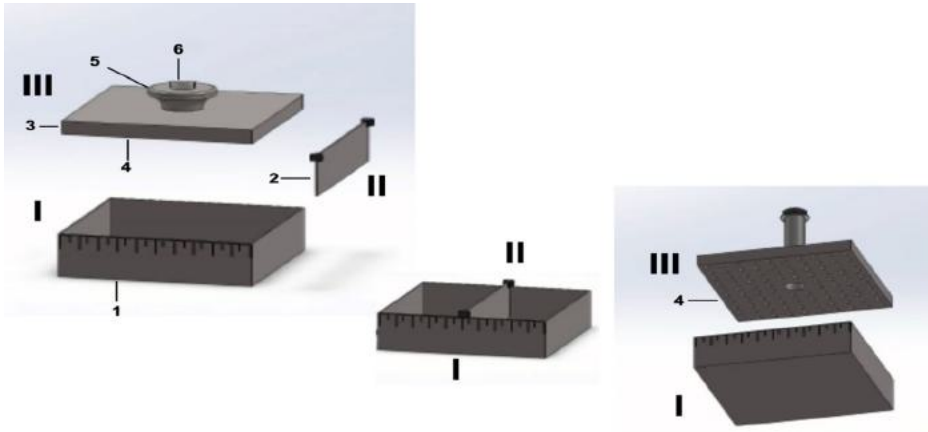

Fig. 2 Parts of the device: The device consists of 3 parts. Part I: A rectangular container measuring 10 cm × 5 cm × 1.5 cm, engraved with markings of a 10 cm scale on the front side [1]. Part II: A vertical accommodating stopper [2] measuring 2 mm 5 cm × 1.5 cm, which allows flexibility in the dimensions of the container. Part III: A compressing lid [3] measuring 9.9 cm × 4.9 cm × 0.5 cm, with a base featuring 153 pinhole perforations [4] and a connecting knob [5] with a Luer-Lock mechanism [6] on the lid to aspirate the excess plasma liquid

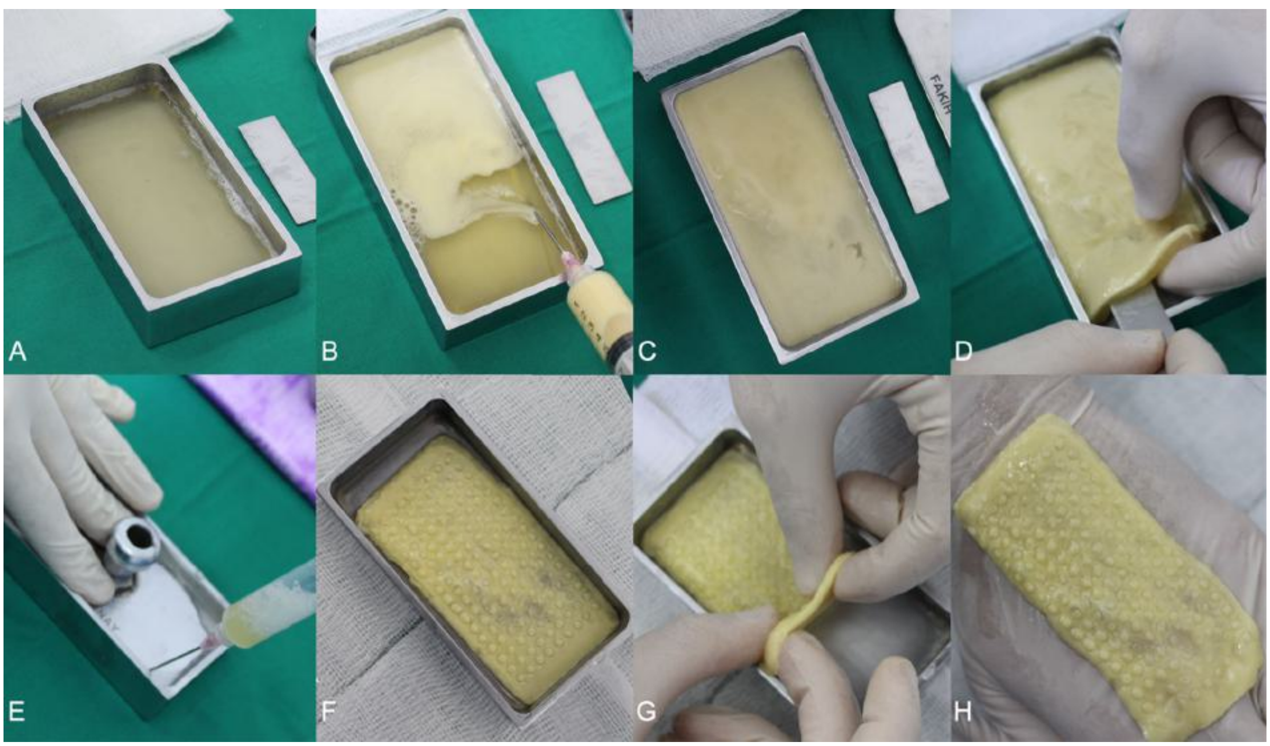

Fig. 3 Process of preparing the nanofat membrane. **A** Pouring plasma into the Fakih-Manay fat membrane device. **B** Pouring nanofat over the plasma. **C** Waiting for the PRF to form with the nanofat. **D** Shape of the nanofat membrane before compression. **E** Compressing the nanofat membrane and aspiring the plasma, which can be done through the Luer-Lock central area or by syringe aspiration of the plasma floating outside. **F** Shape of the nanofat membrane after compression. **G** Thickness of the nanofat membrane. **H** Nanofat membrane with dimensions of 10 cm × 5 cm

aspect in diabetic foot care, as it reduces pressure on the ulcer. Nonremovable devices, such as total contact casts or knee-high walkers, can lower pressure by up to 90%, making them more effective than removable options [18]. The selection of wound dressings should be tailored to the wound's specific needs; for instance, hydrogels are beneficial for wounds with low exudate, while alginates are better suited for high exudate situations. Other types of

Table 2 Protocol for preparing membranes based on desired measurements

Membranemeasurement(length × width)	Number of testtubes (9 ml)	ApproximatePlasmaAspiration (ml)	Quantity of fat (Nanofat orMicrofat) (ml)
1 cm × 5 cm	1	4.5	1
2 cm × 5 cm	2	9	2
3 cm × 5 cm	3	13.5	3
4 cm × 5 cm	3	18	4
5 cm × 5 cm	4	22.5	5
6 cm × 5 cm	5	27	6
7 cm × 5 cm	6	31.5	7
8 cm × 5 cm	7	36	8
9 cm × 5 cm	7	40.5	9
10 cm × 5 cm	8	45	10

dressings can include alginates, antimicrobial dressings, collagen dressings, film dressings, foams, gauze, hydrocolloids, and hydrogels [19, 20].

Emerging dressings, like PRF patches and placenta-derived products, have demonstrated potential in accelerating healing [21]. Hyperbaric oxygen therapy is sometimes used as an adjunct treatment [22] and in the treatment of skin necrosis following vascular occlusion after hyaluronic acid filler injection [23]. For complex wounds outside the facial area, negative pressure wound therapy has shown superior results in enhancing healing compared to traditional moist wound care [24]. In severe cases involving significant infection or vascular issues, surgical interventions such as revascularization or surgical debridement are often necessary [25]. Managing infections is also crucial, with treatments ranging from antibiotics to surgical procedures depending on the infection's depth and severity [26]. A multidisciplinary approach involving medical, surgical, and supportive care teams has proven effective enhancing overall outcomes [27]. Additionally, long-term management should emphasize maintaining blood glucose control, providing nutritional support, and ensuring regular monitoring to prevent ulcer recurrence and manage complications in diabetic foot patients [28]. For facial and chronic wound healing, local flaps, skin grafts, tissue expansion, keratinocyte grafts with skin substitute coverage, and healing by secondary intention are typical approaches [29–31]. In the management of skin necrosis following vascular occlusion from hyaluronic acid, surgical debridement of necrotic tissue [32–34], aspirin, vasodilators pills, antibiotics, collagenase creams, hyperbaric oxygen therapy, and daily surgical follow-up [23] are common practices. Recently, some authors have suggested injecting nanofat into the wound to accelerate healing [35] as a potential option.

The advent of fat grafting or lipofilling, initially introduced by Neuber in 1893 and popularized by Coleman, has revolutionized surgical strategies for soft tissue augmentation and more recently for regenerative procedures [36]. The application of this technology holds promise for long-term effects [37].

Each fat graft contains a significant amount of ADSCs, which play a crucial role in this regenerative technology. These cells are typically implanted into the superficial layer just beneath the dermis to replace lost tissue volume while simultaneously inducing collagen production by stretching dermal fibroblasts, thereby improving skin texture and thickness [38].

Nanofat is produced by mechanically emulsifying microfat, which contains t-SVF and ADSCs [5]. ADSCs exhibit important regenerative and rejuvenation properties [6–8]. They regenerate fibroblasts and secrete larger quantities of cell matrix, aiding in the repair of dermal breaks and the reconstruction and rehabilitation of skin structure [9–12].

Post-nanofat injections, studies have demonstrated improvements in elasticity, attributed to increased synthesis of collagen and elastin, as well as remodeling triggered by stem cells from adipocytes destroyed during the emulsification process [5]. In 2013, Tonnard et al. performed nanofat grafting for the first time in 67 cases for rejuvenation of perioral skin, sun-damaged skin of the breast cleavage, dark lower eyelids, and glabellar skin, noting significant changes attributed to stem cells [5]. Xu et al. showed that after 4 weeks of injecting nanofat, there was an increase in dermis thickness and neo-vascularization in photoaged skin [39]. A study by Chen et al. demonstrated that autologous nanofat transplantation promotes diabetic foot wound healing in rats [40]. Additionally, Tran VVT et al. conducted a systematic review on the effects of

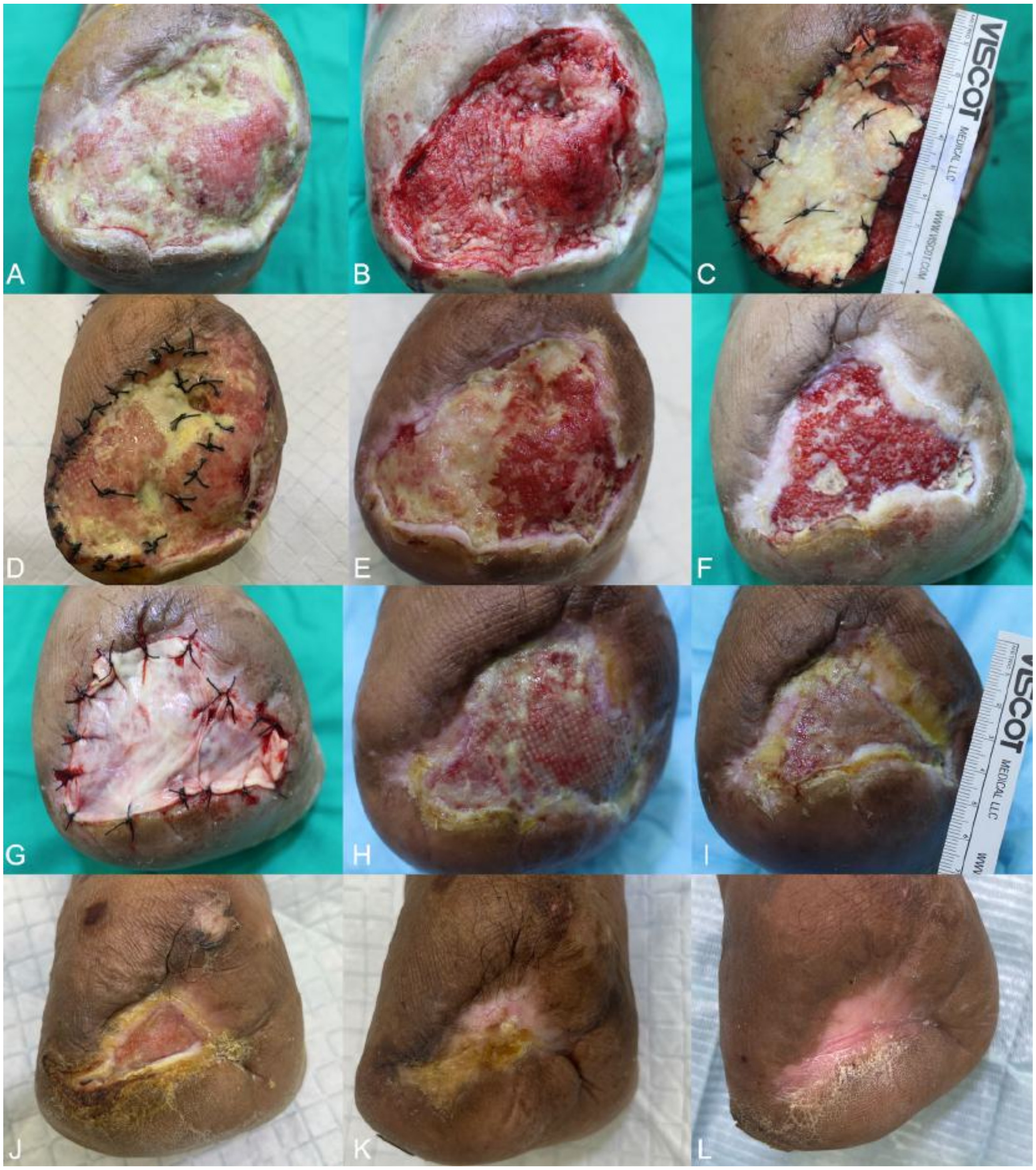

Fig. 4 A 55-year-old male patient with known diabetic type II presented with chronic non-healing ulcer following foot amputation and debriding. **A** Preoperative wound failing to heal. **B** Debridement of the wound. **C** Nanofat membrane 8 cm × 3.5 cm sutured into the wound. **D** 1-week post-operative, before suture removal. **E** 2 weeks post-operative. **F** 1-month post-operative. **G** Another nanofat membrane 7 cm × 5 cm was used and sutured at 1 month. **H** 2 months post-operative from first membrane. **I** 3 months post-operative from first membrane. **J** 4 months post-operative from first membrane. **K** 5 months post-operative from first membrane. **L** 6 months post-operative from first membrane

nanofat in plastic and reconstructive surgery, concluding that nanofat grafting alone shows potential benefits in scar treatment and anti-aging, supported by conclusive histological evidence [41].

The addition of autologous PRP has been considered very effective, and several studies have already demonstrated improvements in wound healing and fat grafting survival in both reconstructive and esthetic cases [42, 43].

However, in 2001, Choukroun et al. first described PRF, which combines platelets and released cytokines in a fibrin clot [44, 45]. PRF is an autologous blood product concentrate prepared by centrifugation, primarily composed of

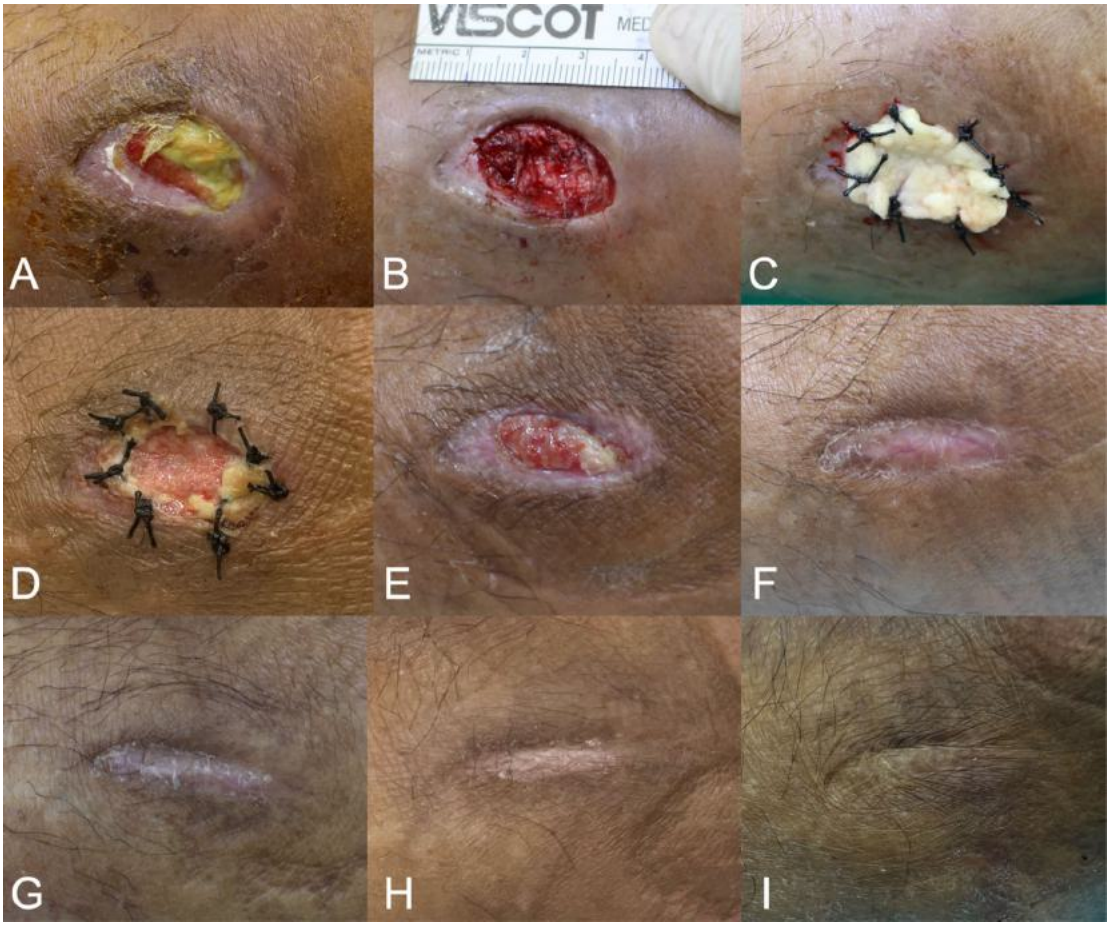

Fig. 5 A 45-year-old male patient with uncontrolled diabetes type II and a chronic non-healing wound on his right leg for the past three months. **A** Preoperative wound failing to heal. **B** Debridement of the wound. **C** Nanofat membrane 3 cm × 1.5 cm was sutured into the wound. **D** 1-week post-operative, before suture removal. **E** 2 weeks post-operative. **F** 1-month post-operative. **G** 3 months post-operative. **H** 6 months post-operative. **I** 12 months post-operative

platelets, fibrin, leukocytes, cytokines, and stem cells within a fibrin matrix. Leukocytes play a significant role in influencing growth factor release, immune regulation, anti-infective activities, and matrix remodeling during healing [46].

PRF has shown superior efficacy compared to PRP, attributed to the presence of fibrin which significantly increases the concentration of growth factors compared to conventional PRP [47]. Several studies demonstrated that the slower release of growth factors and cytokines in PRF results in better healing outcomes and epithelialization compared to PRP [48–51].

PRF can be used alone or with grafting materials to accelerate bone regeneration [52]. It promotes angiogenesis, immunity, and epithelialization during the healing process and soft tissue maturation [53] and has been extensively used in various dental treatments with highly satisfactory results [51, 54, 55].

Moreover, PRF offers advantages such as low cost, high safety, and ease of extraction, making it potentially widely applicable in the medical field [56–59]. Whitman and Marx pioneered the use of PRF in bone tissue repair in the 1990s, using it as a drug/cell carrier for controlled release with positive effects [56, 57].

Studies have also suggested that PRF can promote microcirculation connectivity, inhibit inflammation, and reduce apoptosis rates. Menchisheva et al. have confirmed the significantly positive effects of PRF in wound treatment within a month in clinical settings [60]. Over the past decades, PRF has been utilized in dermatology, orthopedics, and plastic surgery, particularly in the treatment of various chronic wounds.

Limido et al. demonstrated that using nanofat combined with PRP on wounds created in mice resulted in faster healing and increased vascularization. This was attributed to the fact that the grafted nanofat contained a significant

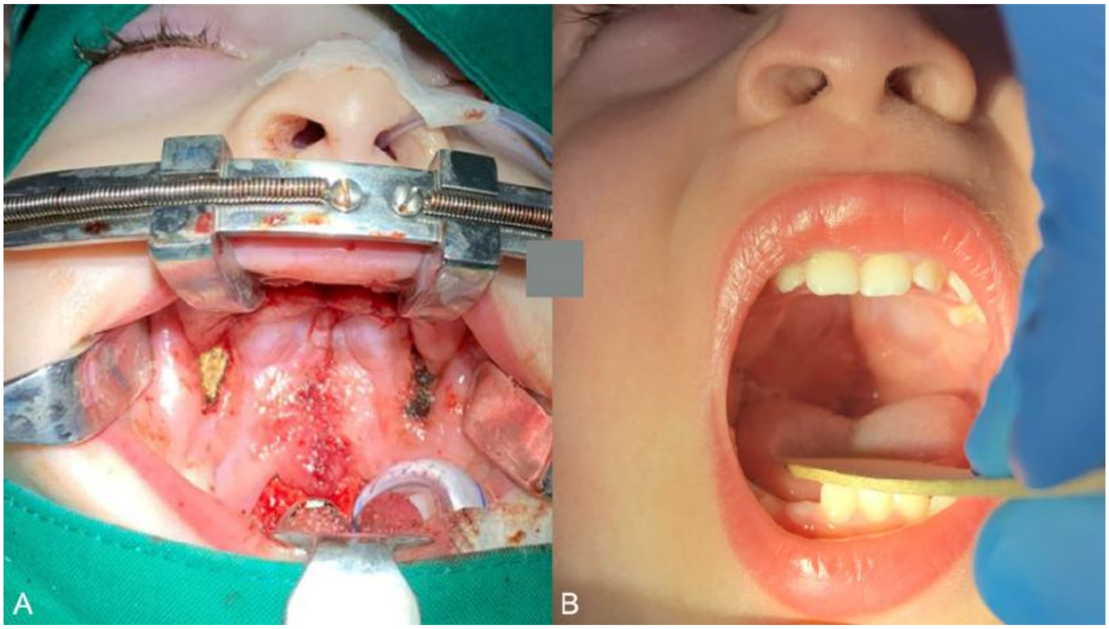

Fig. 6 A 12-month-old male patient with a cleft palate. **A** Preoperative wound after the Veau-Wardill-Kilner technique, with the lateral parts left without mucosal closure and covered with a nanofat membrane 1 cm × 1 cm. **B** 6 months post-operative

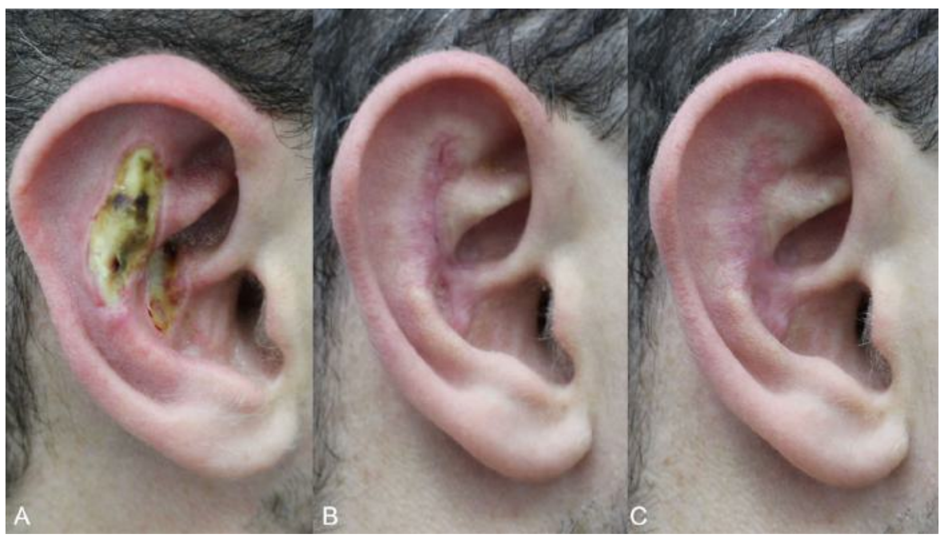

Fig. 7 A 30-year-old male patient with skin necrosis after otoplasty (Chong-Chet technique). **A** Preoperative wound at 2 weeks of surgery (**B**) 2 months post-operative of nanofat membrane 2 cm × 1 cm. **C** 3 months post-operative

fraction of viable GFP+ vascular and lymph vessel fragments, which interconnected with the GFP- vessels of the host tissue. This interaction facilitated enhanced vascular integration and contributed to the accelerated healing observed in the study. Moreover, the switch from inflammatory M1- to regenerative M2-polarized macrophages was promoted in PRP–nanofat-treated wounds. As a conclusion, the nanofat–PRP-treated wounds exhibited accelerated vascularization and wound closure when compared to controls [61].

Wei concluded in their study involving 62 patients that mixing nanofat and PRF and injecting it via cannula significantly improved skin texture, elasticity, pore size, moisture, and reduced facial tissue depression. The study reported an overall satisfaction rate of above 90% among the patients [62].

In 2018, Liang et al. conducted a study comparing the combination of PRF and nanofat to the hyaluronic acid filler [63]. They injected 103 patients with PRF and nanofat, while the other group of 128 patients were injected using hyaluronic acid filler. It was shown that nanofat contained CD markers like CD29, CD44, CD49d, CD73, CD90 and CD105 which was analyzed using flow cytometry. Nanofat could be differentiated into adipocytes,

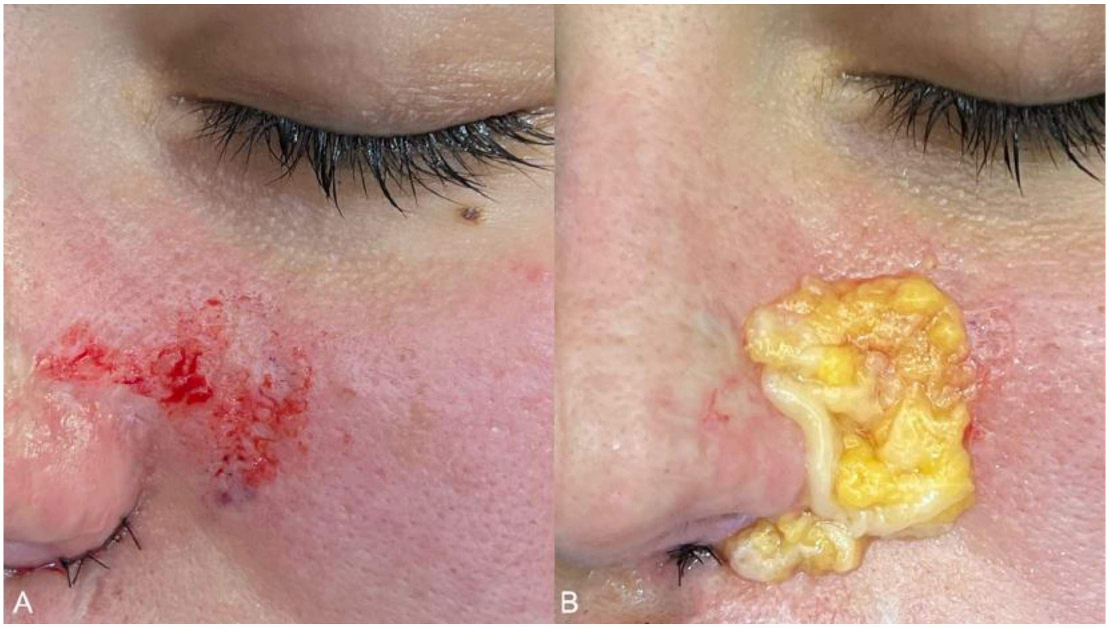

Fig. 8 A 28-year-old female patient with skin scars after skin necrosis due to vascular occlusion after filler injection (**A**) preoperative wound after dermabrasion to resurface the scar (**B**) immediate post-surgical nanofat membrane 2 cm × 3 cm to cover skin after dermabrasion

Fig. 9 A 56-year-old female patient without a history of smoking or previous rhinoplasty experienced vascular occlusion with skin necrosis after injection of polycaprolactone filler (Ellansé® [Sinclair Pharmaceuticals, London, UK]). Hyaluronidase (1500 IU) was administered under sonographic guidance, accompanied by aspirin, and antibiotic therapy. **A** Three-quarter view of skin necrosis affecting the nasolabial fold, alar rim, sulcus, and tip of the nose at 90 h after filler injection. **B** Three-quarter view immediately after treatment, showing intra-arterial injection of hyaluronidase guided by echography, area flooding, and injection of nanofat, i-PRF (injectable PRF), and nanofat membrane suture on the affected area after dermabrasion. **C** Lateral view of the sutured nanofat membrane 2 cm × 2 cm. **D** Three-quarter view at 2 weeks post-healing. **E** Three-quarter view at 1-month post-healing. **F** Lateral view at 1-month post-healing

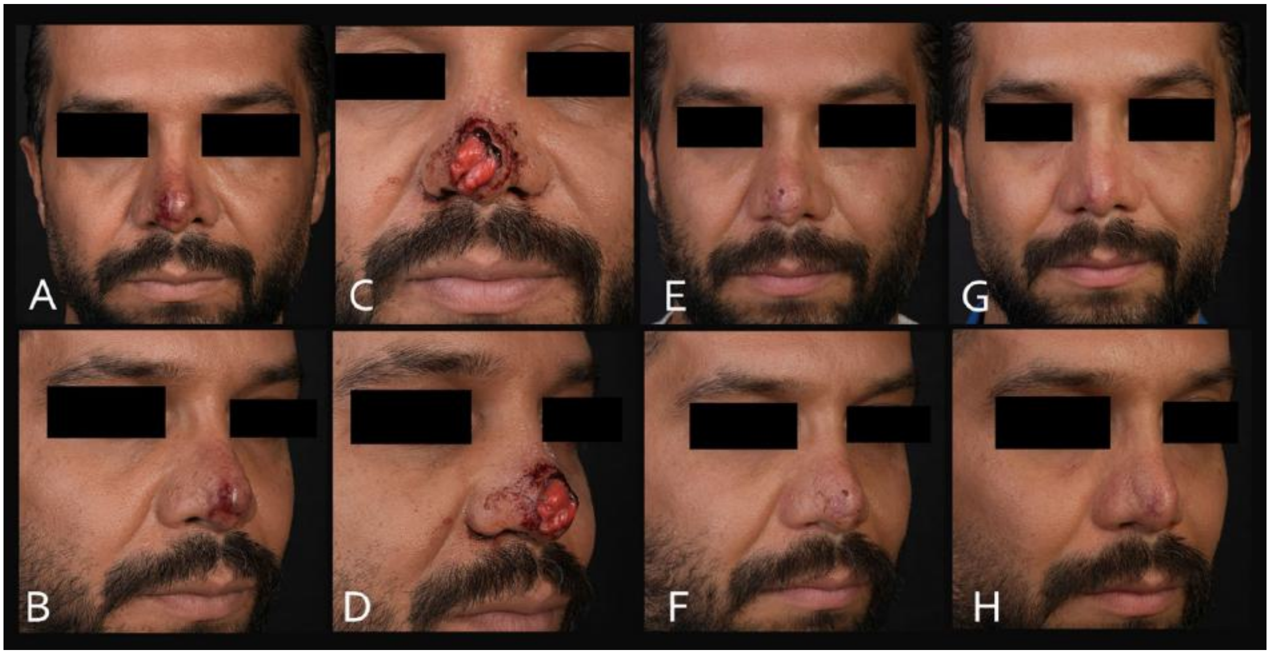

Fig. 10 A 38-year-old male patient 94 h after receiving a 0.3 ml hyaluronic acid filler injection in the nasal tip. Hyaluronidase (4500 IU) was administered under sonographic guidance, accompanied by aspirin, toxin, and antibiotic therapy. The images depict the progression of the affected area: (**A**) Profile view of the necrosis area; (**B**) Three-quarter view of the necrosis area; (**C**) Profile view of microfat membrane after dermabrasion of the affected area; (**D**) Three-quarter view of microfat membrane after dermabrasion of the affected area (**E**) Profile view 1-week post-treatment; (**F**) Three-quarter view 1-week post-treatment; (**G**) Profile view 1-month post-treatment; and (**H**) Three-quarter view 1-month post-treatment

osteoblasts and chondroblasts and they released large amounts of VEGF, bFGF, EGF and other growth factors, while PRF boosted the proliferation of nanofat along with providing the growth factors. It was concluded that injecting PRF and nanofat excellently improved the facial texture than the hyaluronic acid filler.

Eshghpour et al. demonstrated the versatility of PRF by highlighting its ability to be sutured in various surgical procedures, significantly reducing healing time and post-operative complications [64]. Similarly, Mohanty et al. utilized PRF for reconstructing benign hyperkeratotic lesions of the oral mucosa, emphasizing its efficacy in clinical healing and its secure fixation through suturing [65].

Based on studies demonstrating accelerated healing with both nanofat and PRF, and considering that the membrane can be sutured, the Fakih-Manay Fat Membrane device is proposed to create these fat membranes. This system can produce membranes ranging in size from as small as 1 cm × 1 cm up to 10 cm × 5 cm. It is designed for wide application in medicine, particularly for covering large wounds and providing an optimal biological dressing for wound healing.

Additionally, a fat membrane that combines ADSCs from fat and growth factors from PRF has been proposed to synergistically enhance healing. ADSCs and growth factors in the membranes exhibit anti-inflammatory, anti-fibrotic, anti-apoptotic, and immunomodulatory effects [66]. One key advantage of using these membranes over conventional dressings is that they do not require frequent follow-ups, dressing replacements, or investment in costly materials such as negative pressure foams. In contrast to other dressings (e.g., collagen dressings, hydrocolloids, and hydrogels), which may require more frequent changes and longer hospital stays, these membranes accelerate the healing process and provide additional benefits. Our results show significant improvement, particularly in patients with chronic non-healing diabetic foot wounds, compared to traditional treatments. Notably, our diabetic foot cases were referred to us after several months of treatment failure or extended hospital stays. This approach has the potential to eliminate the need for secondary surgical interventions, thereby reducing patient comorbidities associated with additional procedures. Moreover, the membranes can be sutured in place, avoiding the discomfort and displacement issues associated with some dressings.

Regarding the application process of the nanofat membrane, the treatment area is first measured to determine the appropriate size for the membrane, which is then prepared accordingly and adjusted to the size. The treatment area is then debrided and cleaned before the membrane is placed over it and sutured in place. A paraffin gauze dressing is applied over the membrane and kept in place for 7–10 days. The patient is prescribed antibiotics for 7 days to prevent infection. For diabetic patients, close coordination with an endocrinologist is emphasized to maintain blood glucose control, provide nutritional support, and ensure constant evaluation of diabetes management. In the study, postoperative follow-up was conducted every 2 days for the first 15 days to monitor the membrane's disintegration process. After the study period, the standard protocol involves exposing and cleaning the area between days 7–10, by which time the membrane has fully disintegrated, and the sutures are removed. Continued coverage with paraffin gauze is recommended until the healing process is complete. In cases of larger defects, an additional membrane may be applied after one month to accelerate healing, with further membranes potentially recommended on a monthly basis if necessary.

Regarding financial costs, the initial investment includes the instruments needed to create the membrane, fat harvesting equipment, and a centrifuge. These are one-time expenses, while recurring costs involve affordable blood collection tubes (1–8 tubes), surgical fees under local anesthesia, and the non-reusable filter to create nanofat. The membrane requires minimal follow-up, as it disintegrates within 7–10 days, after which any paraffin gauze can be used for coverage. Although our study involved extensive follow-up, the necessary follow-up generally consists of suture removal at 7–10 days and reassessment at one month, with additional evaluations only if further treatment is needed. Given the accelerated healing benefits and cost-effectiveness of this approach, it presents a valuable option for wound management. Accelerating wound healing in medicine directly reduces costs associated with time, management, and materials.

In reconstructive surgery, such as burns and other cases of skin loss, the fat membrane can significantly expedite recovery. In cosmetic surgery, it is beneficial for treating tissue necrosis or preventing its occurrence in affected skin areas. The aspirated residual liquid, containing growth factors, can be utilized after suturing the membrane to enhance healing further.

All the findings discussed in this article can be extrapolated to the use of microfat membrane by employing microfat instead of nanofat. We are currently investigating its application in revision rhinoplasties and other facial plastic surgery indications. The choice between microfat and nanofat membranes depends on the specific indication. Nanofat membranes are preferred for enhancing healing processes in superficial treatments, such as dermabrasion and minor skin defects, or for internal applications like rhinoplasty or facelifts. In contrast, microfat membranes are used to both accelerate wound healing and provide volume correction, particularly in procedures like rhinoplasty and eyelid surgery.

A study demonstrated that using diced macrofat enriched with PRF produced favorable outcomes in the nasal region [67]. However, this technique differs from the membrane-based approach, which involves mixing liquid plasma with microfat or nanofat to create a liquefied product that can be shaped into a membrane and even sutured. What truly distinguishes this method is the novel protocol developed to standardize the creation of a functional membrane suitable for a wide range of clinical applications. The concept of combining nanofat or microfat with liquid plasma to form a PRF–nanofat or microfat membrane was first introduced by the authors in 2019 at various conferences.

Immediate centrifugation of PRF, within 2 min, markedly enhances its biological properties compared to delayed processing. For example, a 6-min delay results in 29% smaller PRF membranes with fewer leukocytes and platelets, reducing their healing potential. The presence of growth factors such as VEGF and TGF-β is also diminished in delayed samples, leading to a reduced stimulation of fibroblasts, which are essential for tissue repair [68]. The focus in our study on limiting centrifugation to just 1 min at a speed of 4000 rpm allows for the collection of liquid plasma, which can then be mixed with fat to create a PRF–fat membrane. Aspirating the liquid plasma and combining it with the fat requires an additional minute, ensuring the entire process remains within the optimal timeframe.

In the context of fat graft survival, PRF plays a vital role in promoting vascularization, regulating collagen production, and preventing apoptosis. Yu et al. explored various PRF-to-fat ratios (1:5, 1:10, 1:15, 1:20) and found that a 1:10 ratio yielded the best outcomes for fat retention and overall survival [69]. This group showed superior retention rates, increased microvessel counts, and better graft outcomes compared to other ratios. Notably, while PRF did not significantly affect long-term adipogenesis (as PPAR-γ expression remained stable), its impact on early vascularization (through VEGF-A upregulation) and on reducing fibrosis and apoptosis (via lower BAX and COL1-A1 expression) was evident [69].

The proposed PRF-to-fat ratio in this research is approximately 1:4.5, differing from the 1:10 ratio suggested by Yu et al. This variation may be due to the membranes being prepared for both external and internal use, as opposed to being injected into the same area as in Panxi Yu's study. However, further studies are needed to determine the optimal PRF-to-fat ratio protocols for maximum efficacy. Histological evaluations of these membranes are planned, along with investigations into the best membrane preparation ratio.

It is important to note that our protocol is designed for a fixed-angle centrifuge, not a swing-bucket centrifuge, as the timing and RPM requirements differ between the two. A swing-bucket centrifuge operates with horizontal spinning, while a fixed-angle centrifuge maintains the samples at a set angle during rotation.

Further research is necessary to validate the technique of microfat membrane and nanofat membrane. Comprehensive studies involving larger patient populations and diverse clinical settings would provide valuable insights into the generalizability and applicability of these techniques across various procedures. A limitation of this study is the absence of a control group. However, the primary objective of this article is to demonstrate the process of creating the membrane and to share the case results. Another limitation is the percentage of PRF in relation to nanofat required for optimal healing. Future studies will be directed toward evaluating these aspects. Nevertheless, our study represents the first evidence of clinical efficacy and safety of fat membrane with no reported complications over a 5-year period.

Conclusion

The nanofat membrane presents a versatile and innovative approach to enhancing healing across a broad range of medical and surgical applications. By combining fat with platelet-rich fibrin (PRF), this technique has demonstrated effectiveness in treating acute and chronic wounds through the stimulation of self-regenerative cells. This study provides the first evidence on the method for creating these membranes, demonstrating their clinical efficacy and safety, with no reported complications over a 5-year period. The Fakih-Manay fat membrane device offers a straightforward and reliably reproducible method for creating fat membranes, supporting its potential as a valuable tool in clinical practice.

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Declarations

Conflict of interest The author N.F-G is consultant for Tulip Medical™ (Tulip Medical Products, San Diego, California, USA). The article was sent to Tulip Medical before publication to ensure they were informed and to obtain their prior consent.

Informed Consent All patients included in this study provided written informed consent for accessing their patients charts and extracting their data for the purposes of this study. No charts were accessed if patients declined their participation in this study.

Animal and Human Rights All treatments were performed in adherence with the Declaration of Helsinki and in accordance with the standards of good clinical care following local guidelines and regulations. This article does not contain any studies with animals performed by any of the authors.

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Review Article

Mandibular Ligament and the Prejowl Sulcus Explained

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Abstract

The exact relationship between the jowl and the mandibular ligament and causes for jowling remain unclear in the literature. The anatomic basis for the jowl is multifactorial and disparities in descriptions of the mandibular ligament and prejowl sulcus have resulted in variations in its management. The aim of this paper was to clarify the anatomy and aging around the prejowl sulcus and the mandibular ligament and review our experience with its management in facial rejuvenation. We performed a retrospective blinded review of patients in a high-volume private practice comparing patients who underwent mandibular ligament release in a subdermal plane during facelift with those who solely underwent fat grafting of the prejowl sulcus with facelift. Blinded surgeons graded 25 patients who had undergone mandibular ligament release and 25 patients who did not. Patient photographs were scored on a 1 to 4 graded scale of correction on the degree of jowling and prejowl sulcus depth and color. We also performed a literature review to describe the anatomy of the mandibular ligament and its implications for jowls, and techniques to address it in facial rejuvenation. Patients who had fat grafting with minimal or no release of the skin around the prejowl sulcus or mandibular ligament had a greater degree of correction of their jowls in their postoperative photographs than those who had a mandibular ligament release without fat grafting ($P = .046$). Adverse sequelae were also lower in the group with less skin dissection around the mandibular ligament. Our findings support the theory that the appearance of tethering and depression in the prejowl sulcus is more likely the cause of atrophy in the subdermal soft tissues than a consequence of ligamentous contracture. Volumetric replenishment with fat grafting provides a more direct solution to the cause of the issue, providing more universal improvements with less risk. Surgeons should consider volumetric fat grafting with or without subsequent subdermal release if needed.

Level of Evidence: 4

4
Therapeutic

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To properly understand facial aging, a thorough understanding of the planes, layers, structures, and attachments of the face is crucial. The jowl is a central feature of facial aging and a significant area of concern in patients considering facial rejuvenation surgery. It is generally regarded as a soft tissue bulge at the labiomandibular crease posterior or lateral to the mandibular ligament. It has been attributed to various etiologies, including the gravitational descent of the neck, accumulation of fat in the neck, gravitational descent of surrounding facial fat pads, laxity of facial retaining ligaments, skin ptosis, submandibular gland hypertrophy, and surrounding facial fat volume loss.[1-6] Despite this, the

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exact anatomy and anatomical changes that occur with aging that result in the jowl formation in each individual case may vary substantially.

The mandibular ligament has been considered an integral part of jowl anatomy and facelift surgery. This region has been incorrectly deemed an osteocutaneous retaining ligament.[2,7,8] Subsequently, release of the mandibular ligament has been suggested during facelift surgery. A recent study focused on further clarifying the anatomy of the mandibular ligament and its use as a vehicle in facial rejuvenation.[9] By literature review and anatomic analysis, we determined that the mandibular ligament was not a true osteocutaneous ligament, and that a more accurate description of the mandibular ligament was the combined attachment of the platysma, depressor labii inferioris (DLI), and the depressor anguli oris (DAO) with dense connective tissue between the periostium and the underside of the muscles along the lower mandible (Figure 1, Video). A critical goal of aging face surgery is to reverse the changes that occur with age. In our experience, we have noted that the ligamentous attachments of this area do not seem to contract with age. Rather, there is a darkening of the regions and depression caused by thinning of the subdermal fat–fascial layer. This volume loss causes a collapse in the region with exaggerations in tethering during lifting if the volume is not corrected. The appearance of tethering may also be exaggerated by platysmal plication and medialization of the prejowl skin.

The jowl and jawline are a significant area of concern in patients considering facial rejuvenation surgery of the lower third of the face. Considering the new anatomic studies and inconsistent improvements in the jowls from facelift surgeries, the optimal management of this region remains controversial among surgeons. The jowls have also been inaccurately described as containing an isolated jowl fat pad, although anatomic studies have described no difference between the skin and subdermal fat and fascial contents of the jowls and the skin directly above and posterior to the jowls along the jawline.[9] This inaccurate description of the jowls has led practitioners to rely on liposuction of the jowls for reduction of the aforementioned fat pad, potentially leading to volume loss and depressions in the area once the face is lifted. The mandibular ligament within the prejowl depression has been classically described as a facial retaining ligament that should be released during deep plane facelift surgery to address the jowl. The aim of this paper was to give a better understanding of the changes in this region that occur with age and to describe our approach to the jowl and mandibular ligament along with our treatment algorithm for its management in patients undergoing facial rejuvenation surgery. We aimed to better clarify the misclassification of the mandibular ligament and review our experience with its management in facial rejuvenation by comparing patients with classical release of the mandibular ligament with those who underwent lipofilling to address this region.

METHODS

We performed a retrospective review of the primary author (B.T.)'s results, comparing those who had undergone facelift with mandibular ligament release with those who had fat grafting to address the prejowl sulcus and jowls. We also performed a literature review summarizing previous studies that described relevant mandibular ligament anatomy and management in facial rejuvenation surgery.

Patients and Treatment

This was a retrospective review of patients who presented to the primary author (B.T.)'s private practice in Beverly Hills, CA, between 2013 and 2024. Patients were included if they were requesting and underwent surgical correction of the lower third of the face (including the jowl). A random cohort of 25 patients were selected who had undergone mandibular ligament release alone during the facelift for jowl correction, and 25 patients were selected who had undergone fat grafting without subdermal release. Patients were included if they had at least 3 months of follow-up. All patients in this study gave full informed consent to be included in the analysis and publication. Patients were randomly selected from a list of patients who had given consent to be included in research during the study period. An online random calendar date generator was employed to select patients for study inclusion. All treatments and photographs were taken during routine surgery for the primary author and no experimental studies were performed on patients, in accordance with the Declaration of Helsinki.

The primary author's facelift technique has been previously published.[10] This was a modified extended deep plane face and neck lift. In most patients, the procedure was performed under twilight sedation with total intravenous anesthesia. The local anesthesia included 50 mL of 2% lidocaine, 50 mL of 0.5% bupivacaine, 2.5 mL of 1:1000 epinephrine, 250 mL of normal saline, and 5 mL of sodium bicarbonate. Fat grafting alone can be performed under local anesthesia with regional blocks and/or Pro-Nox (Carestream America, Lake Mary, FL). Then the patient's face was prepared with antiseptic solution. Markings were drawn with the patient in the upright position before surgery. Correlation with palpation was performed once the patient was lying supine. Fat grafting was performed before any other procedures and before injection of anesthetic solution. In the prejowl sulcus specifically, fat grafting was done in a subdermal fat plane to most directly address the atrophic changes noted with age. This was performed deep to the hypodermal fat attached to the reticular dermis and just superficial to the plane of the mimetic musculature and platysma. Our injection technique entailed a retrograde fanning and tunneling technique with a 20G cannula

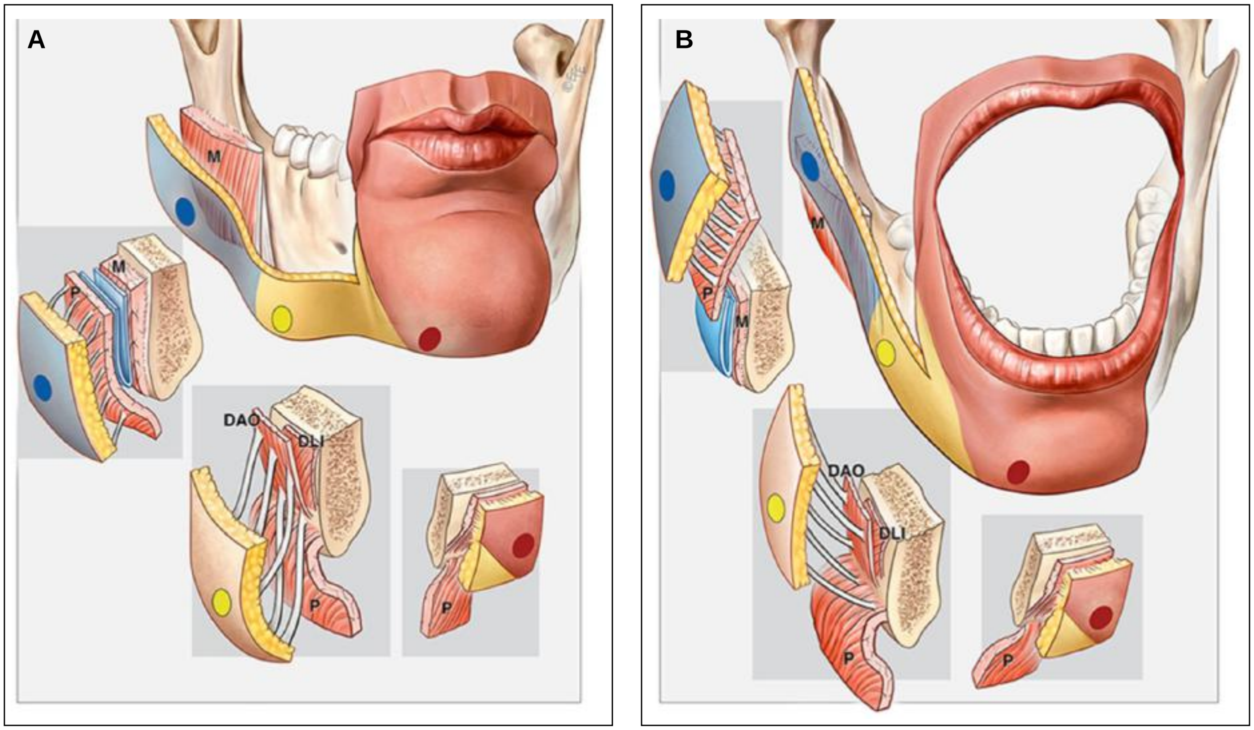

Figure 1. (A) Anatomy of the mandibular ligament. This illustration demonstrates how the different areas across the mandible react to opening of the mouth. In the subplatysmal plane are the attachments of the platysma, DLI, and DAO to the anterior third of the mandible. The platysma attaches most caudal, the DLI attachment most cephalad, and the DAO in between these 2 muscles. (B) At the premasseter space (blue), the platysma glides over the masseter without further skin gliding with mouth opening. At the mandibular ligament (yellow), mouth opening requires the skin to glide over the mandible-muscle complex at the common mandibular attachment of the platysma, DLI, and DAO. At the perioral adhesion zone (red), it results in composite en bloc movement of the mandible, lower lip muscles, and skin. Reproduced with permission from Minelli et al.[9] DAO, depressor anguli oris; DLI, depressor labii inferioris; M, masseter; P, platysma.

(SL20 by Tulip; Tulip Medical, San Diego, CA) at an insertion point 1 to 2 cm proximal to the prejowl sulcus (Video).

If subdermal release was needed, this was performed judiciously, with care to avoid trauma to the skin or overaggressive dissection, which could compromise the blood supply to the dermal plexus around the submental incision. Dissection was typically performed with Metzenbaum scissors to push forward in a deep subdermal plane while retracting with a double-prong skin hook for countertension. The tips of the scissors should push forward and not into the skin where they might compromise the dermal plexus resulting in clinical or subclinical ischemic remodeling. Cautery in the subdermis was performed conservatively or not at all. This region possessed several vascular arcades which might bleed following dissection and predispose patients to more ischemia in the submental region and submental incision.[10] To avoid excessive cautery, netting sutures might be placed and left in place for 3 days for hemostasis.[11]

Twenty-five patients who had undergone facelift surgery without mandibular ligament release were included in the study, along with 25 patients who had undergone facelift without mandibular ligament release and solely had volumization of the hypodermal fat plane to address the mandibular ligament region. Blinded surgeons rated the preoperative and postoperative photographs on a 1 to 4 grade scale as follows: (1) No jowl, no notable prejowl sulcus, prejowl sulcus bright; (2) jowl minimal, prejowl sulcus minimal, prejowl sulcus dark; (3) jowl moderate, prejowl sulcus moderate, prejowl sulcus dark; and (4) jowl large and present, prejowl sulcus deep, prejowl sulcus dark. Dark was defined as darker than the jowl and chin, and bright was defined as the same color. Color changes were noted from the absence or presence of fat beneath the translucent dermis.

RESULTS

Fifty patients were randomly selected and included in our analysis. Twenty-five patients were selected for whom the primary author (B.T.) had performed mandibular ligament release during the facelift, between the years 2013 and 2019, and 25 patients were randomly selected who underwent lipofilling alone without mandibular ligament release during facelift surgery between 2020 and 2024. There were no differences in baseline patient demographics between the 2 groups (mean age 57 years; 88% female; $P > .05$).

The mean preoperative score for the prejowl sulcus region based on the described scale was 3.1 in the mandibular ligament cohort and 3.3 in the cohort of patients without mandibular ligament release and with lipofilling treatment alone ($P = .3$). The mean volume of grafted fat to the mandibular ligament region in patients who underwent lipofilling treatment alone was 0.78 mL (±0.33) to each side (Table 1). All patients had bilateral fat grafting. The postoperative grade was improved in those who underwent lipofilling, vs those who underwent mandibular ligament release (1.2 vs 1.5; $P = .03$). Patients who underwent lipofilling without mandibular ligament release had greater degrees of improvement in their jowls, prejowl sulcus, and coloration by the grading scale. Specifically, the patients with lipofilling alone had on average a 2.0 degree of change in their preoperative vs postoperative grade, and those who underwent mandibular ligament release alone had a 1.6 degree change ($P = .046$).

In a review of over 1000 patients in the primary author's practice, induration was noted in 10% of patients who underwent mandibular ligament release, and in 2% of patients who underwent lipofilling alone, without mandibular ligament release. Submental skin breakdown similarly occurred in 10% of patients with mandibular ligament release alone, vs 1% in patients who did not undergo mandibular ligament release.

Table 1. Volume of Fat (ml) Grafted to Each Mandibular Ligament Region

Patient	Volume of fat to mandibular ligament (mL)
1	1.0
2	0.5
3	1.0
4	1.5
5	1.0
6	0.3
7	1.0
8	1.0
9	1.0
10	1.0
11	0.5
12	1.0
13	1.0
14	1.0
15	0.2
16	0.4
17	0.5
18	0.5
19	1.0
20	0.2
21	0.5
22	1.0
23	1.0
24	0.8
25	0.5
Average	0.78 (±0.33)

DISCUSSION

In this study, we analyzed our experience and the potential benefit of treating patients with lipofilling in lieu of mandibular ligament release, or to decrease the amount of mandibular ligament dissection needed. During the primary author (B.T.)'s high-volume experience, it became apparent that the prejowl sulcus darkens and depresses over time, suggesting that the primary issue in this region may be fatty and fascial volumetric depression and collapse rather than ligamentous shortening. In our journey in facial analysis, since we began lipofilling, the extent and frequency of mandibular ligament release in our practice has decreased substantially with surgical outcomes. Immediate correction of the appearance of tethering and depression following lipofilling correlates with this belief. Results were observed over a 10-year experience, in which patients between 2013 and 2019 (over 1000 cases) were treated predominantly with mandibular ligament release, vs approximately 80% of patients between 2020 and 2024 being treated primarily with lipofilling of the prejowl sulcus (approximately 900 cases). With fat grafting, our results have visibly improved, and postoperative sequelae have decreased by minimizing dissection in this region. Although the photographs included in our study were limited in that they were from 3-month follow-up, the results observed persisted in the primary author's extensive practice over prolonged durations.

Many surgeons release the subcutaneous attachments routinely during facelift surgery, whereas others do not.

In the primary author's practice, the majority of the improvement of the jowl comes from lifting of the facial soft tissues, lifting of the neck, and volumization in facelift surgery. Before this evolution, similarly in the primary author's practice it was standard to release the mandibular ligament during facelift surgery. This finding has been supported by recent and previous anatomic reviews. The authors noted ongoing degrees of darkening in the prejowl sulcus, and complications that arose with subdermal dissection in this region. With lipofilling, reexpansion of this area resulted in less collapse of skin and subcutaneous fibers, while improving changes in skin tone that result with aging. It appeared that lipofilling obtained an immediate and more comprehensive improvement in the prejowl sulcus. In addition, color correction to a brighter skin tone was noted in patients who were lipofilled, much more so than in those patients solely receiving mandibular ligament release. This apparent improvement along with repetitive experience in dissection of this region in patients treated with mandibular ligament release led to the conclusion that the mandibular ligament region was neither an osteocutaneous ligament nor a true facial retaining ligament. The ligamentous attachments resided on the underside of the muscle and remained unchanged over time, and the depression above was more directly the result of thinning and atrophy of the subdermal fat and fascial layer with age.

Mandibular Ligament Anatomy

This article specifically focused on dispelling the inadequacies in the literature regarding the lower facial retaining ligaments surrounding the jowl (ie, the mandibular ligament). In brief, we dispute the previous belief that the jowl is secondary to osteocutaneous retaining ligaments that definitively require release during facelift surgery. Rather, we pose that dissection may be limited to release skin tethering as needed, and that the most appropriate approach may rely on volumization of the collapsed prejowl sulcus.

The mandibular ligament has been considered central in the lower facial aging process. The mandibular ligament was first described by Furnas as the anterior delineation of the "jowl" area.[7] Since the time of its inception, it has been reported variably with respect to its position and extent. Commonly, the mandibular ligament has been classified as an osteocutaneous ligament, assumed to arise from the anterior third of the mandible with direct insertion into the dermis.[1,2,7,8] Beyond this description, there have been 2 different thoughts regarding the plane of the ligament in the pathophysiology of the jowl, as being in the deep (subplatysmal) plane vs in the supraplatysmal subcutaneous plane, or both.[9,12,13] The lack of a consistently agreed understanding of the jowl and mandibular ligament has hindered understanding and management of this region during facelift surgery.

Recently, a phenomenal histological analysis of the mandibular ligament confirmed the lack of dermal or any supraplatysmal ligamentous attachments.[9] The true mandibular ligament exists only in the subplatysmal plane formed by the attachment of the depressor muscles to the anterior third of the mandible (platysma, DAO, and DLI; Figure 1). The platysma attaches most caudal on the mandible, followed by the DAO, and then the DLI with the most cephalic attachment. Interestingly, the DLI was confirmed to be entirely continuous with and part of the platysma layer. In this study we demonstrated that the only firm attachments of the mandibular ligament were the dense adhesions of the musculoaponeurotic layer of these 3 muscles to the mandible and that, contrary to common belief, there was no definitive supraplatysmal component. They found no histological difference in the subdermal plane; specifically there was no difference between the subcutaneous retinacula cutis fibers connecting the skin to the platysma overlying the mandibular ligament and the surrounding tissues. In fact, the cutis septa were longer (not shorter, or tethering) in the jowls. This explanation is more logical and would allow for the less tethered movement of the tissues in the subcutaneous layer. This is necessary to allow for jaw mobility largely independent from the skin, allowing the gliding of the mandible and muscle attachment underneath as shown in Figure 1. With these findings, we see that the mandibular ligament is not a facial retaining ligament, which may lead us to a better understanding of what happens in this zone with age. A more accurate differentiator in the analysis of jawline anatomy would reveal characteristic differences between two zones: the area between the gonial angle and jowl/prejowl sulcus junction and the area between the junctions, encompassing the prejowl sulcus and chin. The important anatomic differentiators between these two regions explains many of the patterns we see with aging. The volume along the majority of the jawline, between the gonial angle and prejowl sulcus, has a greater volume and thickness than the prejowl sulcus and chin. This region has a thicker subdermal fat–fascial layer between the muscle and the skin, as well as substantial volumetric contributions from components deep to the platysma between the bone and the muscle. The deeper components lay deep to the sub-platysmal plane and are comprised of the parotid gland, masseter, facial artery, and surrounding fatty lymphatic compartments. This provides stark difference to the prejowl sulcus, which has no volumetric contributors deep to the muscle layer and experiences thinning of the subdermal fat–fascial layer to a greater extent than the postjowl subdermis. Mimetic muscles are directly attached to the overlying subdermal fat–fascial layer and skin, and in the prejowl sulcus, this area is more fixated and less mobile, while the postjowl platysma and overlying fat–fascia and skin are more mobile and descend more notably with age. These characteristics

Figure 2. (A) Preoperative photograph of a 46-year-old female with darkening in the prejowl sulcus and mandibular ligament region. (B) Three months after fat grafting to prejowl sulcus and mandibular ligament, demonstrating improvements in jowl and prejowl sulcus from fat grafting without subcutaneous mandibular ligament release.

Figure 3. (A) Preoperative photograph of a 47-year-old female patient. (B) One year post facelift with mandibular ligament release and without fat grafting correction of the jowl and prejowl sulcus. Prejowl sulcus demonstrates residual indentation and darkening after surgery.

contribute signficantly to the disparities noted in the pre- and postjowl regions.

Given the proposed etiology of prejowl sulcus depression in this article, release in a subperiosteal plane would likely provide limited or no improvement. The release in the subdermal plane appears to be more effective and it does not represent a release of an osteocutaneous ligament. Rather, the release in a subcutaneous plane directly mobilizes dermal connections of the anterior jowl above the musculoligamentous attachment of the platysma, DLI, and DAO. This differs from nearby tissues, where there is gliding of the platysma over the deeper plane.

Implications in Rhytidectomy

Jowling is 1 of the major reasons patients pursue facelift surgery. The jowl forms as a consequence of a multitude of changes in the aging face. It is multifactorial, secondary to soft tissue descent of the face, descent of the neck, volumetric deflation of the lateral cheek and prejowl sulcus, and contracture of the depressors.[1-6] Jowls are situated in the subcutaneous layer as redundant tissue with overlying skin entirely in the supraplatysmal plane. Histological studies have reported that the mandibular ligament underlies the jowl partly, and does not border it anteriorly.[9] The jowl is bordered anteriorly by the dermal adhesions of the lower lip muscles. As jowling increases with aging, the prejowl sulcus presents as the diamond-shaped zone of deflation that forms just anterior to the jowl. This diamond-shaped depression exists on the border of the mandible laterally and caudally on the underside of the mandible. The anterior extent points toward the submental crease.

The role of facial retaining ligaments in facial aging has been inconsistently described. Some authors suggest that facial retaining ligaments remain taut while unsupported soft tissue descends.[7,8,13,14] This theory rationalizes changes seen in facial aging presenting as prominences and depressions.[1,12,15] Conversely, others suggest that the laxity of facial retaining ligaments results in gravitational descent of lax surrounding soft tissues. There is also a volumetric depression in facial fat with aging. This occurs in both hypodermal fat consisting of small fat cells nestled within the reticular dermis, and superficial musculoaponeurotic system (SMAS) fascia, existing above the true SMAS, also vaguely called the subcutaneous fascia or tissues. This results in darkening of the skin tone as the subdermal fascia and fat deflates. As previously suggested, the shadow present in the prejowl sulcus is commonly a result of subdermal atrophy and changes in reflection of light, rather than simply shadowing caused by blockade of light.

Along with the jowls, the management of mandibular ligament and prejowl sulcus must be analyzed and treated as an integral part of jowl correction. The evaluation of the prejowl sulcus is necessary to provide volume as needed within a depression or to release tethering that may occur and prevent smooth redraping along the jawline. It has previously been suggested that maximal lifting cannot be done without release of the mandibular ligament, among other retaining ligaments in the face and neck.[7] It is important to realize the true evolution of the prejowl sulcus with age, which is commonly described as the mandibular ligament not contracting, shrinking, or increasing in its tethering over time. In fact, much of what appears to be tethering upon lifting the face manually is actually collapse in the prejowl sulcus that becomes apparent when pulling against adherent surroundings. With this in mind, we have obtained more consistent improvements with minor volumetric grafting of the prejowl sulcus, combined with a more conservative release of tethering as needed. Upon injecting volume to the prejowl sulcus, typically with fat, one notes immediate improvement in coloration and shadowing as well as substantial resolution of collapse and appearance of tethering.

When proceeding surgically, the prejowl sulcus and jowl must be analyzed for contour, surrounding contributors, and color. As described above, the shadow or darkening commonly present in the prejowl sulcus may be a consequence of subdermal fat and fascial atrophy resulting in a change of the perceived skin tone due to the change in light reflection that reaches the deeper and darker muscular layers when the subdermal fat and fascia atrophy. For this reason, volumetric grafting to the prejowl sulcus may brighten this area in a majority of cases before dissection. It is our preference to perform fat grafting at the beginning of the case for several reasons. First, fat likely has a higher likelihood of survival when left out of the body for minimal amounts of time. It is also more predictable and precise to inject fat before any dissection of planes, swelling, or placement of tumescent solution. We cannot assume that any exact percentage of fat will survive. In fact, the amount grafted may grow in rare cases following weight gain or hormonal or metabolic changes, and even from surrounding formation of granulation tissue.

This allows the fat to be precisely placed, while obtaining palpatory feedback with the opposite digits to ensure adequate correction of the volumetric deficits above and below the jawline. In many patients, this maneuver alone may preclude the need for sharp dissection and release of the subcutaneous fibers.[10] Figure 2 demonstrates results from volumetric correction of the prejowl sulcus with fat grafting without mandibular release in patients from the primary author's practice. Figure 3 demonstrates preoperative and postoperative images of a patient after facelift surgery with mandibular ligament release without fat grafting correction of the prejowl sulcus, demonstrating residual indentation and darkening of the mandibular ligament region.

It is our belief that it is unnecessary and potentially harmful to perform direct liposuction of the jowls above the jawline. The jowls are not an isolated pocket of fat that would require liposuction. The jowls have never been demonstrated to consist of an isolated fat pad requiring reduction. Rather, the jowl descends with facial and neck ptosis combined and becomes more notable with volumetric depression in the prejowl sulcus. The fat in the jowl region is simply a continuation of identical amounts of fat located at the level of the subdermal fat and fascial layers found in the immediate vicinity above, behind, and below. Minimal liposuction of the neck and inframandibular region may be performed, but liposuction at or above the jawline is a common cause of postsurgical divots, darkening of skin, and depression noted after a vertically vectored face and neck lift.

We believe that the release of the supraplatysmal attachments may be beneficial when there is a contour depression still remaining after appropriate volumization and lifting. Iatrogenically, midline platysmaplasty may result in tethering of the skin at the mandibular border after face and neck lifting is performed. Certainly if medialization of the prejowl region occurs with midline platysmaplasty,

Video. Video demonstrating fat grafting technique to mandibular ligament region.

the need for subdermal release of tethering may increase despite appropriate volumetric restoration. These patients may require some subdermal release to alleviate any notable indent or tethering. The need for this is tested after volume replacement has been performed followed by midline submental platysmaplasty, if that is being performed. If vertical manipulation of the face demonstrates tethering and/or a defect in the sulcus, subdermal release is performed. In cases without aggressive submental platysmal plication and medialization causing tethering of the prejowl skin, we have been able to proceed without subdermal release of the mandibular ligament region.

Aside from improved results and greater frequency of improved results, we have been able to minimize the minor sequelae caused by more significant subdermal dissection in this region. The issues noted are increased rates of bleeding, increased rates of seromas on the anterior jawline, induration from dermal trauma, ischemia in the prejowl sulcus, and ischemic changes around the submental incisions. Induration was noted in approximately 10% of patients who underwent mandibular ligament release, which was treated with 5-fluorouracil (5-FU). Typically 1 to 3 5–FU injections were required, which were resolved in approximately 90% of the primary author's patients within 6 months. In a review of patients between 2019 and 2024, there were approximately 20 cases (2%) of induration. Injections of concentrated triamcinolone were avoided because this was a high-risk area for tissue atrophy, telangiectasia formation, and discoloration. Triamcinolone might be administered in dilute amounts or in a mixture with 5-FU, especially in recalcitrant cases of hypertrophic scarring or keloid formation.

Fat grafting alone causes little downtime. Minimal erythema, ecchymosis, and petechiae can be expected for the first 5 to 10 days. Similar skin changes can be expected at the site of fat harvesting. The procedure is well tolerated, and on a review of cases the typical patient had little pain. The patient was asked to sleep slightly elevated to avoid fluid migration and facial edema. With makeup, patients could easily resume their activities after 48 hours. There were no activity restrictions postoperatively. If facelift was performed, the patient was again asked to sleep slightly elevated to minimize facial edema for the first week. Patients might place ice packs or cold compresses to help with comfort and swelling. Patients were allowed to wash their hair on Day 4. At 2 to 3 weeks the patients were told they would be "disguisable" or "presentable" with makeup. Light exercise might resume at 3 weeks, with exertion at 6 weeks. At 3 months, the patients were told they would be "event or wedding ready." Patients sprayed Argentyn Silver (Natural Immunogenics, Sarasota, FL) to clean their incisions. Then, they placed bacitracin ointment for the first 3 days, then replaced the antibiotic ointment with a scar healing cream.

Lesser invasive treatments such as volumization with injectables and radiofrequency might also be administered outside of facial surgery. Major improvements may be obtained by placing hyaluronic acid fillers into the subdermal plane of the prejowl sulcus, placing neurotoxin into the DAO region, and by performing a bipolar radiofrequency treatment over the area.

CONCLUSIONS

Aging occurs in all planes, and to most appropriately treat this aging we must accurately be able to assess the variable contributions to the aging face. Superficial and deep plane facelift techniques have evolved substantially, yet parts of the anatomy still raise questions and debate. In the case of the mandibular ligament, we believe volumetric depression to be a leading cause of the tethering noted in the prejowl sulcus and that this tethering may be exaggerated by submental platysmal plication. In this study, we propose that surgeons consider volumetric grafting with or without subsequent subdermal release in patients who demonstrate the described darkening and depression. Patients without volumetric depression or darkening may not need volumetric augmentation, and mandibular ligament release may be performed in the subdermal plane as needed. The jowl and prejowl sulcus have many contributors. For maximal improvement and proper management of patient expectations, all potential factors should be considered.

Supplemental Material

This article contains supplemental material located online at www.aestheticsurgeryjournal.com.

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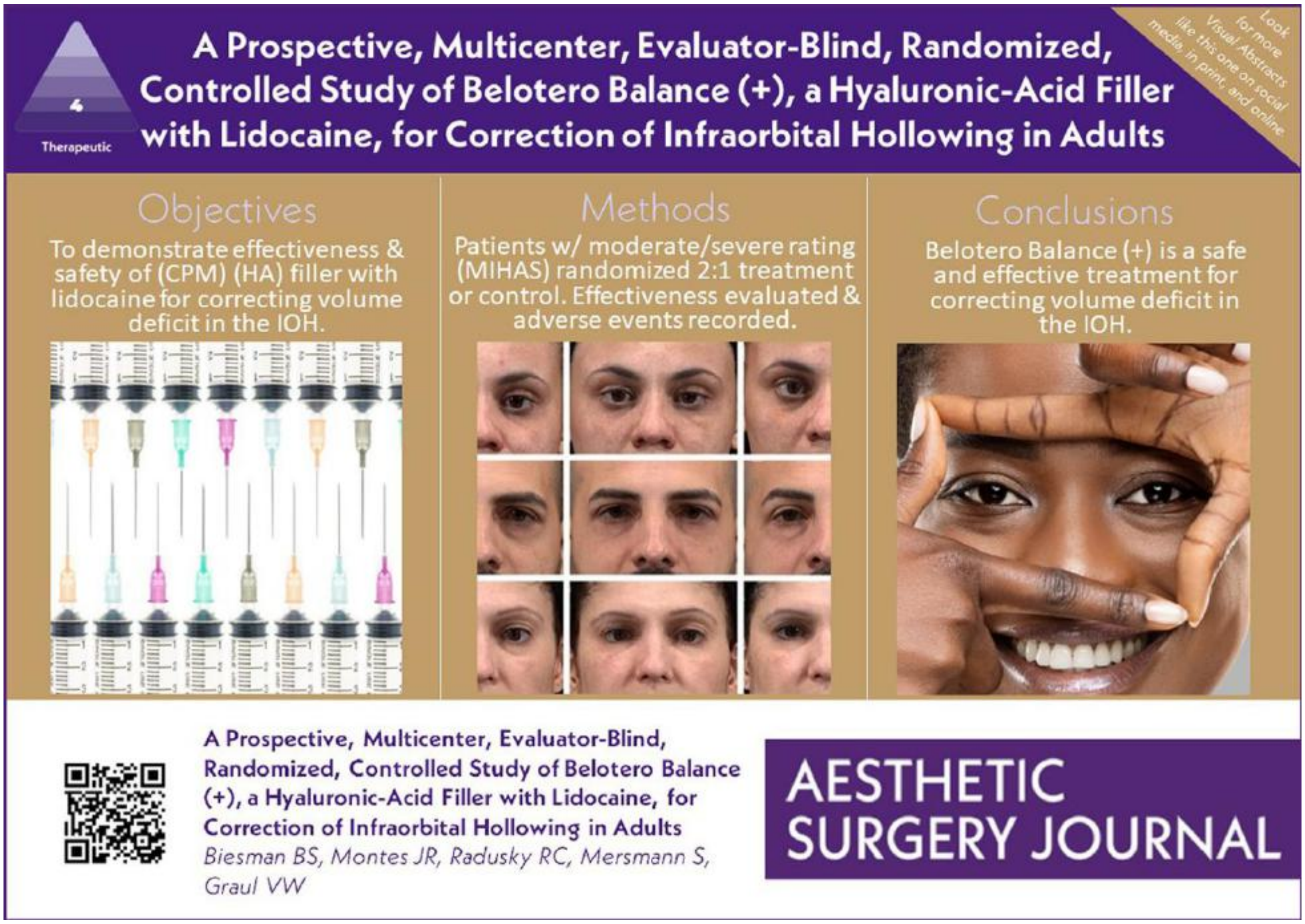

Facial Surgery

The Mastoid Crevasse and 3-Dimensional Considerations in Deep Plane Neck Lifting

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Abstract

Background: Advances in face and neck lifting involve release of tethering points along the superficial musculoaponeurotic system–platysma complex to freely manipulate the deep natural glide plane in the face and neck.

Objectives: The aim of this article was to determine a combination of deep plane techniques for addressing the face and neck and to elucidate, for the first time, a measurable endpoint for the gonial angle. Analysis of deep plane tethering and decussation zones was also undertaken.

Methods: Extended deep plane surgery performed in 79 patients (158 hemifaces; age, 30-75 years; 95% female), over a 3-month period, was reviewed. Patients were followed for 1 year. Measurements were performed systematically during deep plane face and neck lifting.

Results: Before intervention, the mean [standard deviation] gonial depth was 9.4 [3.6] mm on the left and 8.3 [2.7] mm on the right. The mean depth created below the gonial angle when measuring the traditional suspension to the anterior mastoid was 15.8 [3.3] mm on the left and 13.7 [2.5] mm on the right. The distance postoperatively when measuring the gonial depth after performing the crevasse technique was 23.2 [2.2] mm on the left and 22.5 [2.5] mm on the right. This represents a mean increase in the advancement of 7.4 mm on the left and 8.8 mm on the right (average, 8.1 mm) which was demonstrated to be statistically significant bilaterally ($P < .0001$).

Conclusions: The deep plane techniques described here aid manipulation of the deep plane and deep neck space, while also providing measurable endpoints and more effective modes of fixation by utilizing the mastoid crevasse. The use of techniques that release tension and allow redrape produce the most natural and well-balanced results.

Level of Evidence: 4

4
Therapeutic

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In the authors' experience, recent advances in deep plane face and neck lifting, using extended modified deep plane techniques, have demonstrated superior results for midface volumization and neck contour improvements with less reliance on fat grafting, implantation, or other ancillary measures.[1,2] In line with recent discussions in the literature,[3,4] we have found that liberation and manipulation of the cervicofacial gliding plane, termed the deep plane, permits a greater level of lifting in both the face and neck with

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less resistance and entanglement of underlying structures. More importantly, the neck and face are treated and lifted as a single unit, providing a more uniform, natural, and durable result.[5-7] Nevertheless, certain regions remain untreated and unmastered in select patients with more challenging anatomy.

Various resistant anatomic attributes have spurred debate and discussion over proper diagnosis and treatment.[8-11] The most complex aspects for surgeons appear to include the approach to anterior digastric fullness, submandibular gland prominence, deepened prejowl sulci, and a low or anterior hyoid and larynx.[9] This article seeks to provide additional insight and reasoning as well as a methodical algorithm to address these challenges. We will also introduce modifications of existing techniques along with novel approaches to the submandibular triangle, parotid gland, and gonial angle that will provide clear and substantial improvements in the appearance of the anterior and lateral neck.

Proper deep plane release of the platysma in the submentum allows direct visualization and assessment of the midline deep fat and lymphoid tissue, anterior digastric muscles, submandibular glands, position of the hyoid bone, as well as the prehyoid and perihyoid soft tissues.[2,12-14] Each of these items may be assessed and treated appropriately prior to closure of the platysma by plication methods.[2,3,7] In this article we will provide our approach to each individual component and describe proper manipulation of the anterior platysma to help avoid surgical failures. For the lateral neck we will review the aging and prominence of the parotid gland which commonly coincides with loss of definition around the gonial angle. Release of the muscular-fascial decussation zones in the face and neck allow free manipulation of this region, permitting use of the mastoid crevasse technique discussed in this article.

The introduction of this technique provides a better conceptual understanding of vectorial aging of the neck, proper vectorial lifting of the neck, recompartmentalization of ptotic and bulging cervical triangles, and a measurable endpoint to determine the success of gonial angle improvements intraoperatively. These new techniques may be easily implemented and added to the surgical arsenal of any superficial or deep plane surgeon.

METHODS

The surgical techniques used to treat the anterior neck, lateral neck, and face will be reviewed in this study along with several endpoints used to determine success. Various intraoperative measurements were performed during extended deep plane face and neck lifting surgery in a total of 79 patients, providing 158 hemiface measurements. These patients were treated in a routine fashion over a 3-month period from August 2021 through November 2021 in the practice of the primary author (B.T.). Patients were followed for 12 months following the procedure and were seen postoperatively at 1 week, 3 weeks, 6 weeks, 3 months, 6 months, and 12 months at minimum. The remaining 72 Patients underwent a modified extended deep plane face and neck lift, like those previously described by the primary author, while using the more novel advances and will be the focus of this article.[1,2] Intraoperative measurements were taken during routine surgery for the primary author and no experimental studies were performed on patients, in accordance with the Declaration of Helsinki. One patient undergoing an isolated neck lift required a minor revision to treat banding at the cervical angle. A total of 200 surgeons were surveyed regarding routine measurement of the gonial angle in their practice. The survey was administered orally at a meeting by show of hands.

Analytic endpoints of our study include the following intraoperatively and postoperatively: persistence vs absence of anterior digastric fullness; prominence vs resolution of submandibular gland fullness; assessment of a smooth submentum vs indentations or defects; resolution of jowls and prejowl sulcus; laryngeal position; cervicomental angle and length; resolution vs persistence of cervical banding in one-quarter and three-quarter views; ear position and shape; parotid gland prominence and resolution; gonial angle depth and shape; and lifting provided to the lower neck and clavicular region. Written informed consent was obtained from all patients that their photographs could be used for research purposes. There were no complications to report. Inclusion criteria included any patient undergoing the technique proposed within that time point and granting consent for study.

Patient Selection

Indications for surgery included banding of the neck, overall drooping of the neck, submental fullness, obtuse neck with a low hyoid, jowling, and other causes of drooping or excess fullness in the neck. A total of 10% of cases were performed under local anesthesia and 90% using total intravenous anesthesia. Contraindications included propensity for bleeding and patients who would benefit equally from a noninvasive radiofrequency device. Patients who required submandibular gland reduction were placed under total intravenous anesthesia to avoid discomfort.

Patients without any facial complaints or skin excess underwent an internal neck lift, called the “weekend lift” (7/79), in our practice, while the remaining 72 underwent the Auralyft, which is a modified, extended deep plane face and neck lift. The “weekend lift” involves a submental incision with manipulation of the deep submental space and a platysmal plication combined with a postauricular incision to lift the lateral platysma to the mastoid crevasse. Skin is typically not excised, and a radiofrequency treatment is performed on the face and neck with a Profound device (Candela Medical, Wayland, MA). Profound radiofrequency skin tightening was performed after crevasse measurements were taken. This tightening is isolated to the skin and dermis but does not have an effect on the deep crevasse and does not affect the measured depth as that is performed prior to the profound treatment, on the operating table. Ancillary procedures such as eyelid surgery were also performed on a large subset of patients, although these procedures would not have any effect on the neck measurements recorded in this study.

Surgical Technique

The surgical technique of the Auralyft (modified extended deep plane face and neck lift) will be detailed as performed by the primary author. The procedure typically takes 2 hours and is performed under local or total intravenous anesthesia in most cases. Local anesthetic is injected using a combination of 50 mL of 2% lidocaine, 50 mL of 0.5% bupivacaine, 250 mL of normal saline, 2.5 mL of 1:1000 epinephrine and 5 mL of sodium bicarbonate. The solution is then tinted with 2 mL of cyanocobalamin for safety and identification. Tranexamic acid in solution is avoided in large flap surgery due to the risk of cytotoxicity and vascular compromise but may be given intravenously without much concern.[15]

Platysmaplasty and Submental Contouring

Submental incision and platysmaplasty is performed in roughly 90% of patients. Submental work is performed in nearly all revision or secondary lifts, for patients with severe laxity and banding, exaggerated midline descent that would not be corrected with facelift alone, lengthening of the cervicomental distance, laryngeal setback, low hyoid position, and for submental volume contouring. Liposuction is rarely performed to avoid the contour irregularities, skin darkening, and worsening of platysmal banding seen with overaggressive fat removal. The submental incision is placed along the internal mandibular border rather than using a nearby crease. The incision is typically 2 to 4 cm in length depending on access and the length of the neck and may be curvilinear (Supplemental Figure 1). Placement in this location avoids the chance of migration of the incision to the neck or chin following facelift or chin implant placement.

An incision is made along the submental marking, and the supraplatysmal plane is opened with sharp dissection initially, then immediately converted to blunt dissection. Dissection is carried inferiorly to the thyroid cartilage and laterally as far as the dissection can reach easily. Excessive caudal skin delamination is avoided to maintain a healthy blood supply to the watershed zone of the skin around the cervicomental angle. The medial platysmal borders are pulled towards the midline to measure laxity. The borders of the platysma are then elevated by means of monopolar electrocautery followed by blunt dissection. There is no transition to the subplatysmal plane. The subplatysmal entry is as described with entry below the earlobe and anterior to about 6 to 8 cm. Caudal to the hyoid, care must be taken to avoid bleeding from anterior and accessory jugular vein laceration. Laterally, the dissection continues towards the lateral hyoid at the level of the lateral fascial sling of the digastrics. At this point the submental and submandibular triangle fullness is evaluated, looking at the anterior digastric muscles, submandibular glands, and fatty lymphoid tissue in Levels 1a and 1b (Figure 1). The sequence of reduction is of utmost importance. The central structures are more easily reduced and are more likely to be overreduced. When lying supine, the lateral compartments, such as the submandibular triangle, may appear much less ptotic than when sitting the patient upright. For this reason, the primary author strongly recommends beginning reduction with the lateral tissues and remaining more judicious with the medial or central tissues. The central submental compartment should always remain slightly fuller than the anterior digastrics and lateral triangles to avoid midline defects.

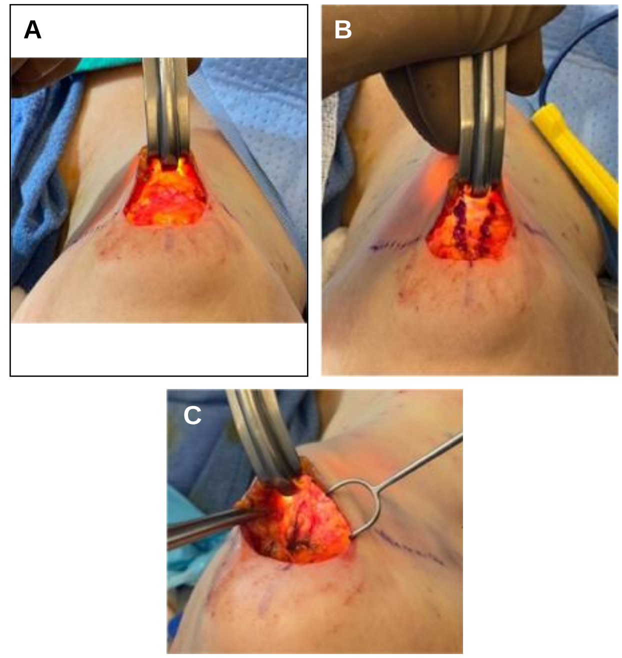

Figure 1. Neck dissection of a 42-year-old female. (A) Blunt elevation is completed, and fat is maintained attached to the skin above. (B) The medial edge of the platysma is marked on both sides for dissection and for future plication. (C) Next, each side is elevated, exposing the digastric on both sides and the glands.

It is important to note that reduction of midline structures dictates the necessity to reduce lateral structures. Failure to do so may result in a relative appearance of ptosis of the lateral structures such as the submandibular glands.

Although the submandibular glands more often become ptotic than hypertrophic with age, there remains debate about whether or not to perform a submandibular gland reduction.[1,16-18] For simplicity, in our practice, a submandibular gland reduction is performed if the gland is pushing medially or inferiorly past the sling of the digastric, if the circumference of the neck at the hyoid appears too broad, if the gland is sitting inferior to the hyoid or mylohyoid, or if volumetric reduction is required when the platysma would appear too weak to suspend the submandibular contents (Figure 2). Sufficient reduction of the submandibular gland often requires resection of the deep lobe in addition to the superficial lobe. Although the primary concern with aging may be submandibular gland ptosis, elevation of the platysma alone may not correct the ptosis in some cases. The creation of dead space in the submandibular triangle and submentum may provide less resistance to central plication and lateral lifting. A reduction of roughly 30% to 50% of the gland is performed in 50% of our patients reviewed over the past 3 years. Reviewing photographs taken prior to adoption of submandibular gland or digastric reduction techniques would indicate that only 10% of our patients actually needed any sort of reduction to obtain an excellent result.

To perform reduction, the most medial and inferior portion of the gland is delivered from the capsule, injected with local anesthesia, atraumatically pulled medially, and partially resected by needle tip electrocautery for cutting and bipolar electrocautery for hemostasis (Supplemental Figure 2). Irrigation is intermittently performed to minimize heat dispersion to the surrounding nerves that may occur from cauterizing a fluid-filled gland. Reduction is performed until the bottom of the gland is level with the mylohyoid, cephalic to the hyoid, or deep to the mandible. The risk of bleeding increases with more lateral and cephalic dissection as the vessel caliber increases. It is important to note that resistance to mobilization of the gland is caused by the vessels within the gland and not due to any ligamentous attachments. In the 260 cases reviewed in the primary author's practice there have been no sialomas or subplatysmal hematomas without the use of neurotoxin, a subplatysmal drain, or gland imbrication. If more substantial gland resection is performed or large salivary cysts are present, a drain may be used. Although fluid collection may not occur, submental edema and submandibular gland fullness may ensue from reduction of the digastric or submandibular glands.

Fullness or bowing of the anterior digastric muscles may also occur in a subset of patients. This is likely more common in patients with hyperactive chin flexion caused by dental-alveolar prominence but may be present in any patient. Plication of the digastrics is avoided in almost all cases to avoid medialization of the submental contents, although this is a valid option to graft over a traumatic prior surgical defect when needed in rare cases. Complete resection should also be avoided to prevent any change in function or loss of support of the underlying mylohyoid muscles. Anterior digastric reduction is typically performed by strip excision of the outer half of muscle by means of bipolar electrocautery and trimming with scissors; a monopolar approach may result in excess bleeding and twitching of the surrounding muscles and nerve to the mylohyoid (Supplemental Figure 3).

Reduction of fatty lymphoid tissue in Levels 1a and 1b may also be performed. Complete excavation of Level 1a is generally avoided to prevent a midline defect and exaggerated prominence of the submandibular triangle and digastric muscles postoperatively. The midline submentum should remain slightly fuller than the paramedian submentum as the midline will tuck internally more easily following platysmal plication. Bipolar electrocautery is typically used to avoid bleeding from well-vascularized lymph nodes. If the lymph nodes are in excess or enlarged over 10 mm or darkened, they should be sent for biopsy. Caution must be taken with deeper dissection to avoid any trauma to the hypoglossal nerve or distal cervical branches to the platysma that may affect the smile. Dissection from medial to lateral all the way to the external jugular as the lateral border of the deep cervical fascia with partial myotomy and spreading with scissors will help avoid or identify these distal cervical branches in the dissection.

After the lateral volume has been addressed, the midline can be contoured. Midline banding and blunting of the cervicomental angle may be a consequence of platysmal descent or an obtuse line along the deep cervical fascia. To address the cervical angle, the submental deep cervical fascia is grasped and pulled towards the chin while a horizontal fasciotomy is performed across the prehyoid deep cervical fascia to expose the hyoid periosteum (Figure 3). This forms a discontinuity of the subhyoid and submental deep cervical fascia, permitting tighter approximation of the platysma during plication. In effect, banding is decreased while the cervicomental distance is lengthened and the cervicomental angle is sharpened. The horizontal fasciotomy is a very simple and powerful technique providing multiple immediate and long-term benefits. Caution must be taken to avoid excavating the prehyoid tissues in a patient with a prominent larynx and thyroid cartilage. Excessive removal of tissue may result in a prominent Adam's apple after lifting, causing an exaggerated contour defect in either sex or a masculinized appearance in women. If this occurs, a strip of fat may be transposed from the submentum into the suprahyoid or infrahyoid space into any deficit prior to platysmal plication to ensure the thyroid cartilage remains at the anterior level of the hyoid in the sagittal plane.

Platysmaplasty is then performed according to a classic platysmal plication technique.[19,20] The consequences of platysmaplasty on vertical facelifting must be considered.

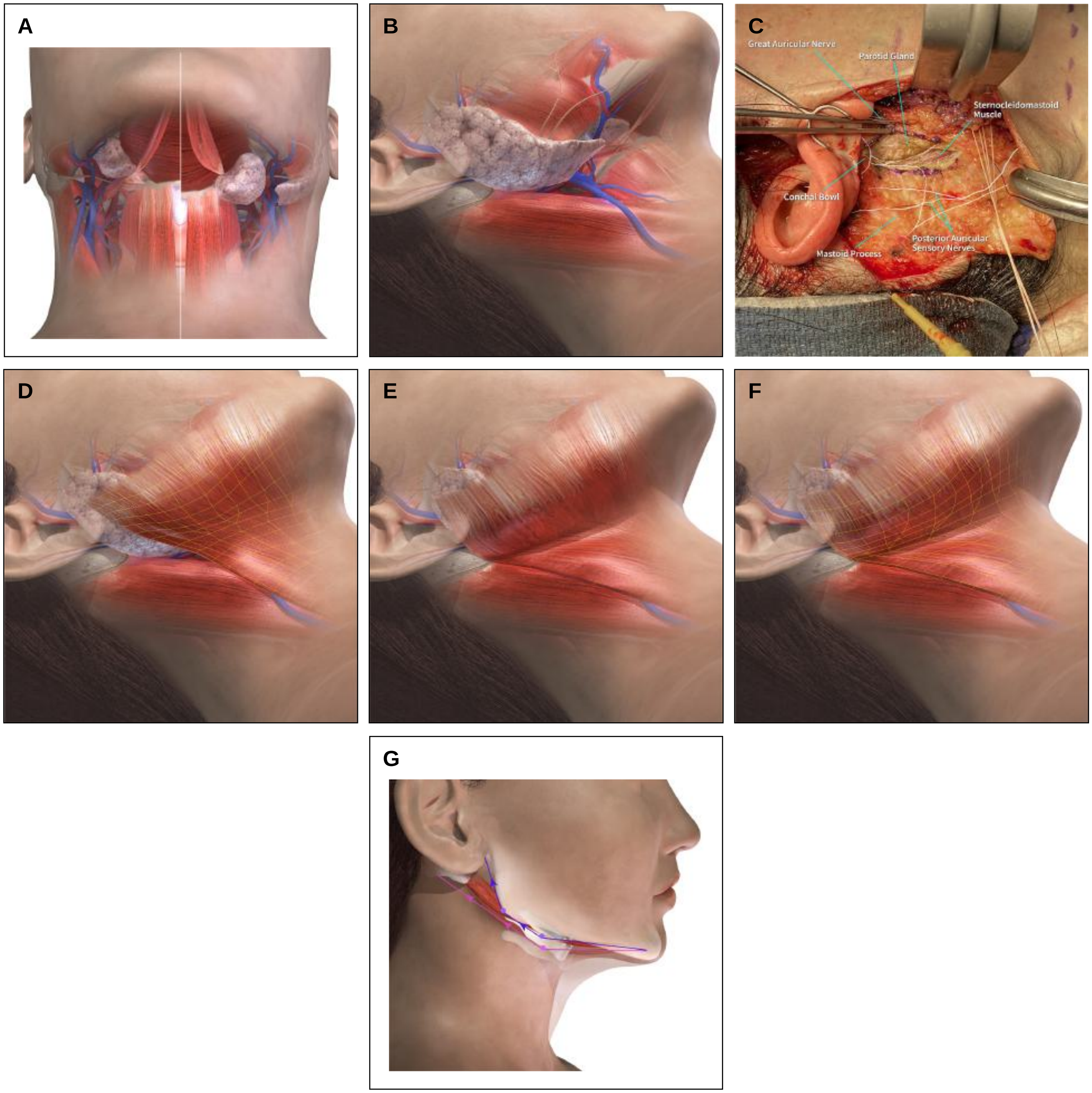

Figure 2. (A) Demonstration of neck dissection with digastrics and glands exposed on either side. (B) Overlay of relevant surgical anatomy prior to deep plane lift. (C) Additional overlay of relevant anatomy at the mastoid process and dissection of the parotid, highlighting the course of the greater auricular nerve and posterior auricular nerves in a 42-year-old female. (D) Vector and plane of tissues prior to surgical intervention. (E) Overlay of manipulated structures with inset of platysma at the mastoid crevasse. (F) Vector and plane of tissues after surgical intervention. (G) Demonstration of a lateral view of gonial angle before and after platysmal inset with overlay of pertinent anatomy and platysmal inset within the mastoid crevasse.

Cadaveric studies have demonstrated that plication platysmaplasty may limit the extent of vertical lifting in the face.[21,22] We believe that this effect is less exaggerated during submental platysmaplasty and more prominent as a consequence of infrahyoid platysmaplasty. The submental platysma naturally converges towards the chin, while the infrahyoid platysma diverges as it attaches to the clavicular heads. Hence, pulling the divergent platysma to the midline may medialize the body of the platysma and limit vertical lifting to a much greater degree (Figure 4).

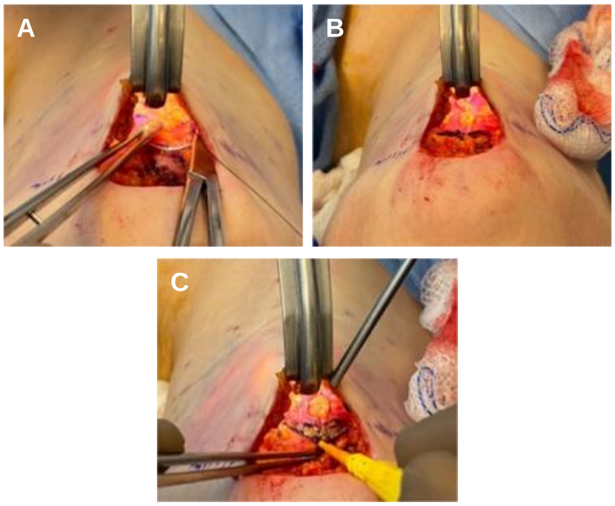

Figure 3. (A-C) Platysma closure and platysmal window of a 42-year-old female. The platysma is closed with buried figure-of-eight mattress sutures. If there is any midline platysmal banding after the platysma is closed, this is disrupted with a full or partial myotomy akin to a platysmal window less than 1 cm on each side. This must be caudal to the hyoid.

To perform the plication, the platysmal edges are pulled across the midline and minimal trim of the edges is performed only as needed. Suture plication is then performed with buried 3-0 nylon sutures beginning in front of the hyoid and then advancing towards the chin with 3 or 4 buried figure-of-eight sutures. Tacking to the prehyoid fascia must be avoided as this will tether the natural gliding separation of the deep plane and may alter the sensation of swallowing. If the platysma is tethered to the hyoid and larynx, the entire neck will move during deglutition and the patient may experience a choking sensation for an extended period of time.

The benefit of infrahyoid or prelaryngeal plication is that the thyroid cartilage and larynx can be repositioned posteriorly. This helps avoid prominence of the thyroid cartilage in patients requiring softening. Laryngeal setback can also have a profound effect on circumferential narrowing of the throat and neck while effectively lengthening the cervicomental distance. The benefits of laryngeal setback are quite profound, as it shortens the anterior-posterior dimension of the neck and makes the appearance of the entire larynx less broad and more delicate and defined. Cervicomental distance can be lengthened without the use of a chin implant, which also keeps patients more feminine and delicate. The benefits of laryngeal setback or prelaryngeal platysmal plication must be weighed against the drawbacks of limiting vertical facial lifting.

Once corset platysmaplasty is completed, the cervicomental angle is assessed with palpation to check for midline banding which may occur in some patients. If a band is palpated, it is transversely incised by performing a medial, oblique, partial myotomy bilaterally, caudal to the level of the hyoid (Supplemental Figure 3B, C). The platysma is then reinforced with interrupted 3-0 PDS sutures just distal and proximal to the angle only if needed. In some patients, the distance of travel of the platysma increases substantially after submental contouring is performed. The distance from the clavicle to the chin may be shorter in an obtuse neck than in a well-defined and angulated neck. In these patients, partial myotomies may be performed to lengthen the platysma. This is performed by pulling up on the platysma and gently incising the lower, medial third of the platysma with a Metzenbaum scissor while keeping the deeper platysmal fascial layer intact to envelope the vessels and deep neck contents. The lateral two-thirds of the platysma should not be interrupted to avoid loss of integrity of the lateral platysma during the vertical lifting portion. If any dehiscence of the platysma has occurred in the superior portions, running plication may be performed to void herniation of tissues after lifting.

Lastly, the mandibular ligaments and prejowl sulcus are analyzed. If there is a defect present in the sulcus, fat grafting can be performed at the beginning of the case or prior to dissection. The mandibular ligament is not a facial retaining or osseocutaneous ligament and has been erroneously described in the past. A more accurate description would demonstrate that the dense connections in this region occur between the platysma and bone. The appearance of tethering that occurs superficially is more likely a direct result of fat or superficial musculoaponeurotic system (SMAS) atrophy and collapse or simply tethering of the skin from platysmal plication and medialization. Hence, passing a 20G cannula using a subdermal fanning technique while grafting fat into superficial tunnels may reinflate and expand the collapsed region of the mandibular ligaments and obviate the need for comprehensive release or dissection. The shadow present in the prejowl sulcus is commonly a result of subdermal atrophy and changes in reflection of light, rather than simply shadowing caused by blockade of light. For this reason, volumetric grafting to the prejowl sulcus may brighten this area in a majority of cases. If vertical manipulation of the face demonstrates tethering in this region, subcutaneous release is performed only as needed. This must be performed judiciously with care to avoid trauma to the skin or overaggressive dissection, which could compromise the blood supply to the skin around the submental incision. Release is typically performed with a Metzenbaum scissor to push forward in a deep subdermal plane while placing tension with a double-prong skin hook. The tips of the scissor should push forward and not into the skin where they may compromise the dermal plexus resulting in clinical or subclinical ischemia. This region possesses several vascular arcades that may bleed following

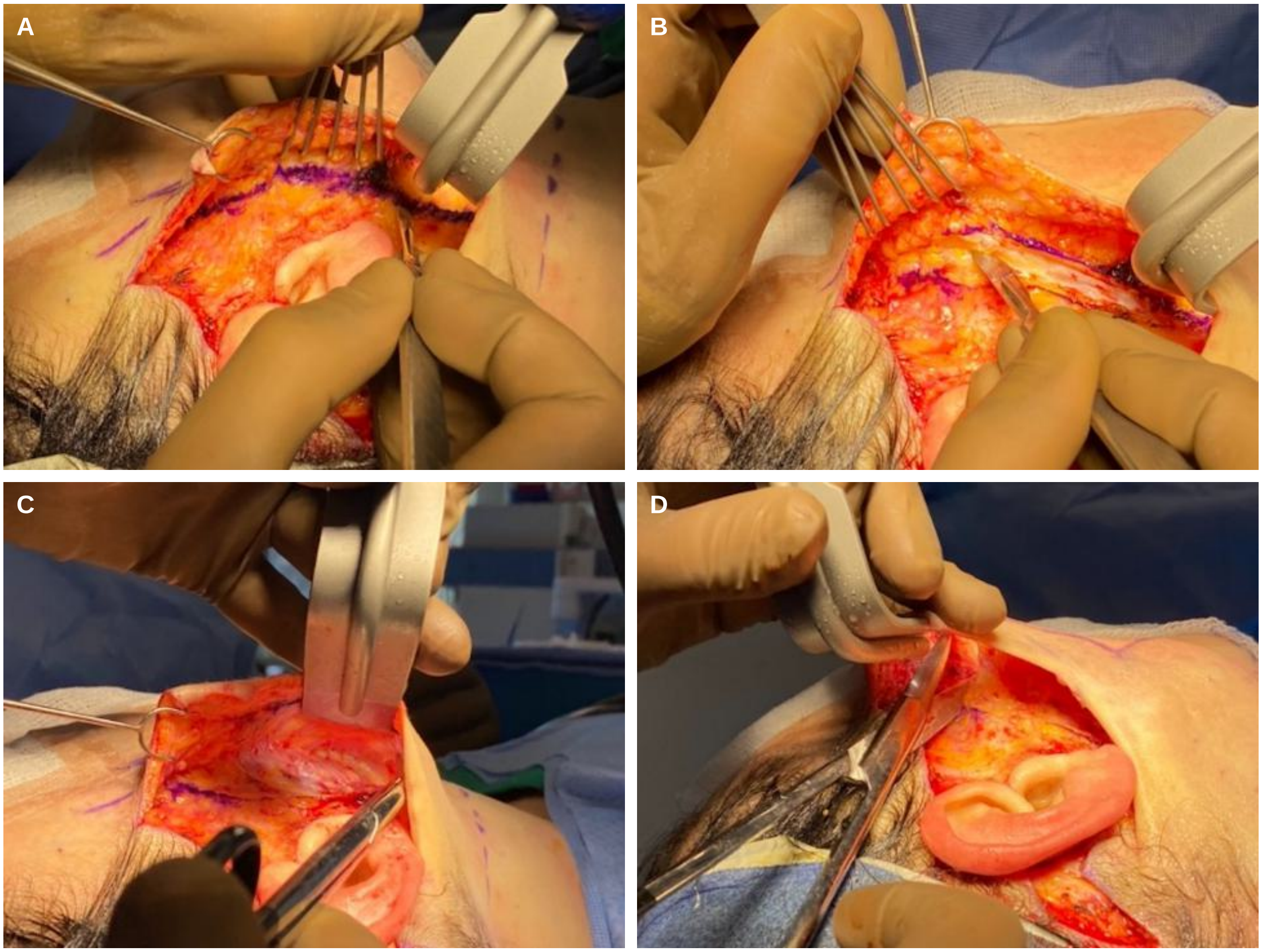

Figure 4. (A-D) Deep plane entry in a 42-year-old female. The deep plane entry line is incised. The platysma is elevated in the deep plane anteriorly to the level of the facial artery and inferiorly to release off the external jugular vein. The facial superficial musculoaponeurotic system is elevated off the zygomaticus muscles.

dissection. Cautery in the subdermis must be performed conservatively.

Vertical Face and Neck Lift

Incision markings are made followed by reference markings for the deep plane entry point and Pitanguy's line. The entry design in our practices has been modified using the "sailboat modification" to improve the positioning of the deep plane entry point (Supplemental Figure 8C). Assuming the platysma at the gonial angle will lift toward the pretragal line, an SMAS entry line is drawn to mirror the incision line roughly 2.5 cm away at a roughly 70° angle. This maximizes the composite area of the flap by minimizing the regions of skin-only dissection assuming the entry line will lift to touch the incision line or as close as possible, insetting like a puzzle piece. Limiting the amount of skin dissection may decrease ischemic effects on the distal flap including discoloration, decrease the amount of telangiectasias forming postoperatively, decrease operative dissection time, improve volume along the zygomatic arch and lateral flap, lower the chance of damaging the zygomaticus muscle complex, and make the SMAS thicker laterally providing easier entry and a better shelf for suspension (Supplemental Figure 5).

Incisions are made with a #10 scalpel around the temporal tuft following down the prehelical crease. The incision is placed in an immediate pretragal crease when present or in a retrotragal line when absent or in patients with poorer skin quality or previous scarring. Incision placement on each side is independent of the opposite side. The incision then follows around the earlobe directly in the crease following posteriorly in the postauricular sulcus and crossing to the hairline as the mastoid flattens. The posterior limb incision follows the occipital hairline around 2.5 to 3.5 cm in

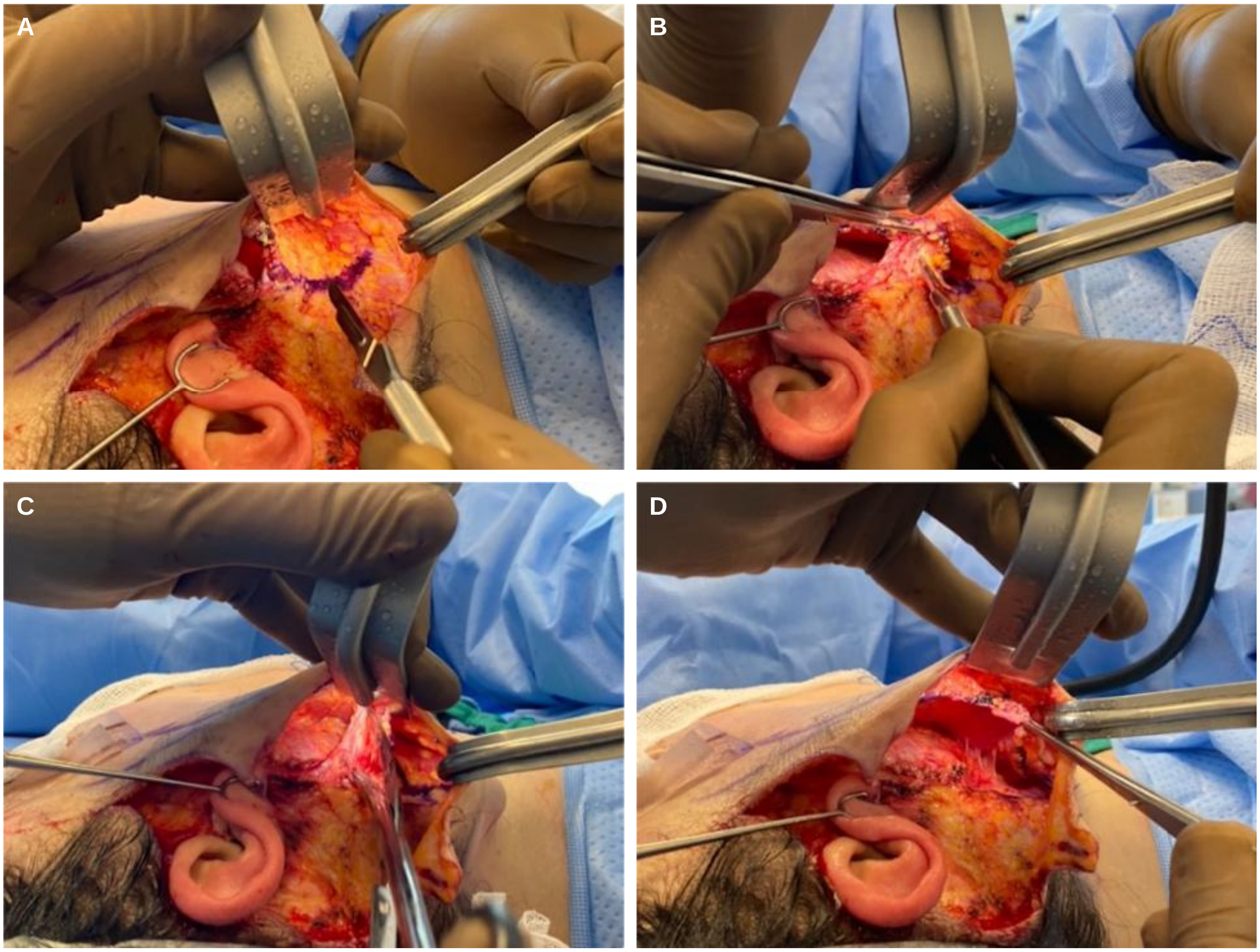

Figure 5. (A-D) Platysmal border in a 42-year-old female. The lateral border of the platysma is marked and incised through the cervical retaining ligament connections over the parotid capsule. The dense fibers terminate inferiorly over the external jugular vein. The fibrous attachments over the parotid are incised sharply then spread through bluntly to create the platysma flap.

most patients. Incisions extending into or tangential to the occipital hairline are avoided to prevent hairline distortion and limitations in vertical lifting and redistribution.

The skin flap is elevated in a subdermal plane, leaving hypodermal fat on the reticular dermis to avoid violating the dermal plexus. Elevation of skin is performed with a #10 scalpel followed by dissection with a microdissection scissor and tension using an Andersen bear-claw retractor and countertension provided by an assistant. The facelift flap is generally thought to be a random flap with the only axial blood supply being the perforator of the transverse facial artery, which is commonly transected, but may be preserved in some cases (Supplemental Figure 6). The postauricular skin is then elevated and connected to the facial skin dissection around the earlobe. The subcutaneous dissection then continues bluntly using a Steven's Kaye scissor to bluntly spread the supraplatysmal plane in the right hand while using a lighted facelift retractor in the left hand. The dissection is carried directly on the platysma until midline without violating the platysma. If a submental procedure was performed, the 2 cavities would be connected at this point.

Next, the "sailboat line" of the deep plane entry point is incised with a #10 scalpel with the right hand while the left hand retracts the flap upwards with an Andersen bear claw multiprong retractor. Superiorly, care is taken to avoid incision of the zygomaticus musculature by beveling the #10 scalpel in an upward direction. A thick flap should be created to avoid maceration of the deep plane shelf (Figure 5). The deep plane is then entered and elevated beginning at the lateral border of the facial platysma where risk of injuring nerve or deeper structures is low.[23] Typically, this is considered the fixed portion of the SMAS-platysma complex, where the lateral platysma is

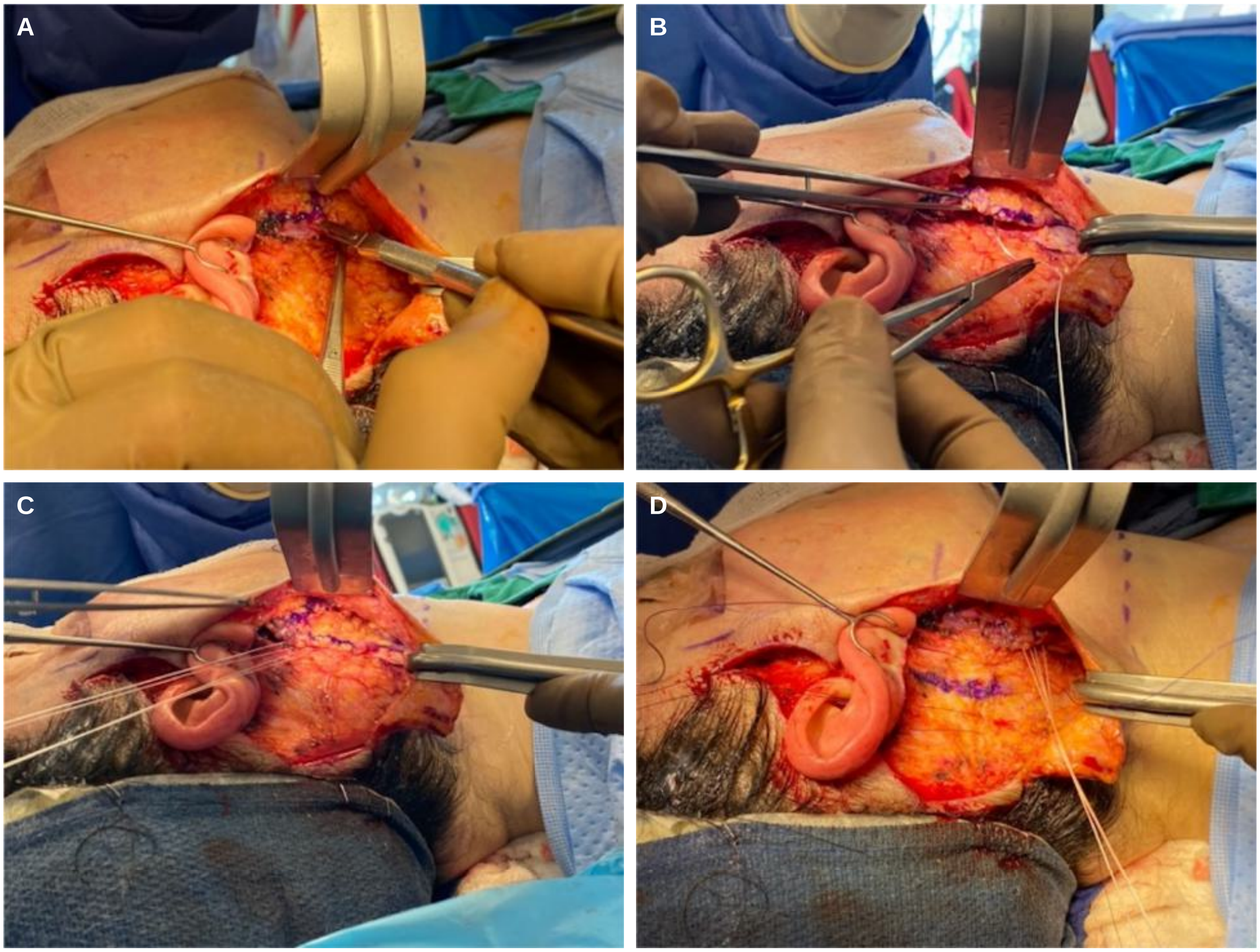

Figure 6. (A-D) Platysmal inset in a 42-year-old female. Myotomy is made in the shape of the gonial angle and then the platysma is redraped. Note the 3 marked structures in (D): the anterior mastoid line is marked in bold marker, and the great auricular and posterior auricular branches are marked with black monofilament.

overlying the parotid gland. Blunt dissection is performed with vertical spreads of the Steven's Kaye scissor in the right hand while holding the flap superiorly with facelift retractor in the left hand. Blunt dissection continues anteriorly over the masseter, which is considered the deep glide plane or mobile portion of the SMAS-platysma complex where the masseter and platysma muscles must move independently of each other without any connections. Dissection ceases at the anterior border of the masseter near the facial artery, then continues inferiorly into the neck. Retrodissection is performed from medial to lateral on the underside of the platysma to elevate it off the tail of the parotid inferior to the mandible and sternocleidomastoid (SCM) muscle, inferior to the tail of the parotid. The decussation plane of fibers that exists between the lateral platysma over the parotid tail fascia are referred to as the cervical retaining ligaments. These dense fibers are found over the parotid and not over the SCM as described in previous publications. Elevation of the cervical retaining ligaments allows for mobilization of the fixed platysma from off the parotid tail and provides a dense area of tissue to be utilized for suspension relative to the remainder of the weaker, more friable platysma muscle. A marking pen is then used to delineate the lateral border of the platysma and cervical retaining ligament from the tail of the parotid, extending inferiorly to the external jugular vein, where the retaining ligament terminates to a mobile plane again (Figure 6). The incision line is then scored with a long-handled #15 scalpel to score the outer portion of the platysma and retaining ligaments. Care must be taken to avoid damage to the greater auricular nerve which may lay over or lateral to the external jugular vein. Broad strokes are used to score the lateral platysmal border until reaching the underside of the deep fascia. Blunt dissection performed by making vertical spreads with the Steven's Kaye scissor is then used from top down to release the cervical retaining ligaments from the parotid tail, continuing inferiorly over the SCM and external jugular vein where the mobile platysma elevates off easily. The dissection terminates medially at the level of the facial artery generally. A lateral approach to the submandibular gland is possible but is avoided in our practice to minimize trauma to the cervical facial nerve branches which penetrate the platysma and travel superficially at a more lateral point than the marginal mandibular branch. Great care is taken to avoid cervical facial nerve branch dissection and trauma.

The midface dissection is performed next. The "sailboat" modification to the deep plane entry point provides a thicker flap laterally that begins over the lateral extent of the zygomaticus muscles. Care must be taken to avoid transection of the lateral zygomaticus musculature, which may cause a strain and dimpling with smiling or smile block.[24] Although a primary concern of facelift surgery is to avoid nerve damage, muscle damage likely occurs more often and goes unrecognized. If partial or complete transection occurs, the muscles may be anastomosed with running absorbable sutures. Midface release is achieved by performing blunt dissection to enter the sub-SMAS plane directly on top of the zygomaticus and orbicularis musculature. Although there is often no defined SMAS at this level, entry at this point guarantees dissection into the sub-SMAS plane. The orbicularis overlaps the zygomaticus muscle slightly at the point where the SMAS layer thins and tapers off over the orbicularis. Dissection is carried in an inferomedial vector while suspending the face using a lighted facelift retractor in the left hand with blunt vertical spreads in the right hand created with the Steven's Kaye scissor. Tactile feedback aids in maintaining the proper plane of dissection as the SMAS release continues towards the nasolabial fold, terminating before arriving at the fold. At this point, the buccal decussation zone is the only remaining area that needs to be released to connect the sub-SMAS pockets of the neck and midface. The lateral extent of the zone has been referred to as McGregor's patch or the zygomatic cutaneous ligaments.[25] This is a dense region of osteocutaneous fibers extending from bone to skin and anteriorly along the maxilla. Although release of this zone may occur at the level of skin or deeper along the bone, we believe the most effective release to occur at the level of the deep plane, allowing mobilization and repositioning of the SMAS and superficial malar fat pad. Incision is performed with strong retraction of the left hand and facelift retractor while turning the scissor tips flat and sharply incising through roughly a 1 cm × 1 cm patch until palpable release of the reticular fibers is achieved. The transverse facial artery perforator exits somewhere around this region or anterior and inferior to the patch in 1 to 2 branches in most cases. This artery provides a segmental blood supply to an otherwise random facelift flap and is difficult to preserve in most cases. If it is transected, we recommend bipolar cautery to avoid facial hematoma. Elevation then continues anteriorly along the line of the parotid duct, through the buccal decussation plane. The buccal decussation zone contains interweaving fibers of SMAS and platysma at their junction point. These fibers must be released off the buccal capsule to permit full mobilization of the midface flap. Dissection typically terminates at the anterior extent of the buccal capsule, where platysmal fibers are seen diving deep and inserting into the SMAS. If the buccal fat is protruding or proptotic, it may be reduced and reinserted into the buccal space. If the buccal fat is transposed or left to hang freely outside of the capsule, it may cross the deep plane and tether to the SMAS and skin layers. This may cause a bulge and irregular movement with facial animation. A small shelf is then made along the sailboat entry line, typically 5 to 7 mm deep, to provide a ledge for suspension. At this point the cavity is irrigated with a dilute antibiotic and sodium hypochlorite solution followed by hemostasis using bipolar electrocautery.

The facial flap is then repositioned and suspended along the shelf of the SMAS-platysma complex. Then 5 to 6 sutures are placed, typically 3-0 nylon along the lateral platysma, 4-0 nylon at the central flap, and 5-0 nylon sutures along the upper midface sailboat flap. A large variety of suture materials may be used for the deep plane suspension. The sutures are positioned towards the individual patient's vector of greatest distraction or elevation, opposing the vector of aging for that particular patient. In primary facelifts, the average vector of suspension is around 70% from the Frankfort horizontal plane, and all the sutures lift at nearly the same angle. Horizontal mattress sutures are then placed through the flap shelf and suspended to a secure location in Lore's fascia, also referred to as the temporal parotid and tympanoparotid fascia (Supplemental Figure 6).[26-29]

The sutures must be tied down consecutively and free of tension. Placing tension in dermal or SMAS sutures may cause vascular compression of the dermal plexus and compromise both proximal and distal to the suturing point. Once the facial flap has been suspended, we continue with the lateral platysma manipulation. It has been our observation that proper 3-dimensional (3D) vectoring is more important and powerful than the metric of lateral distraction of the platysma. A great deal of focus is placed on creating depth around the gonial angle, while giving the greatest amount of lift and recompartmentalization to the submandibular triangle and lower neck. The cervical retaining ligament patch is moved vertically, posteriorly, and deep to maximally manipulate and restore neck contours. The average vectors of lift of the platysma are greater than the facial SMAS lift, typically ranging between 80° and 95° relative to the Frankfort horizontal plane. Classically, the platysmal

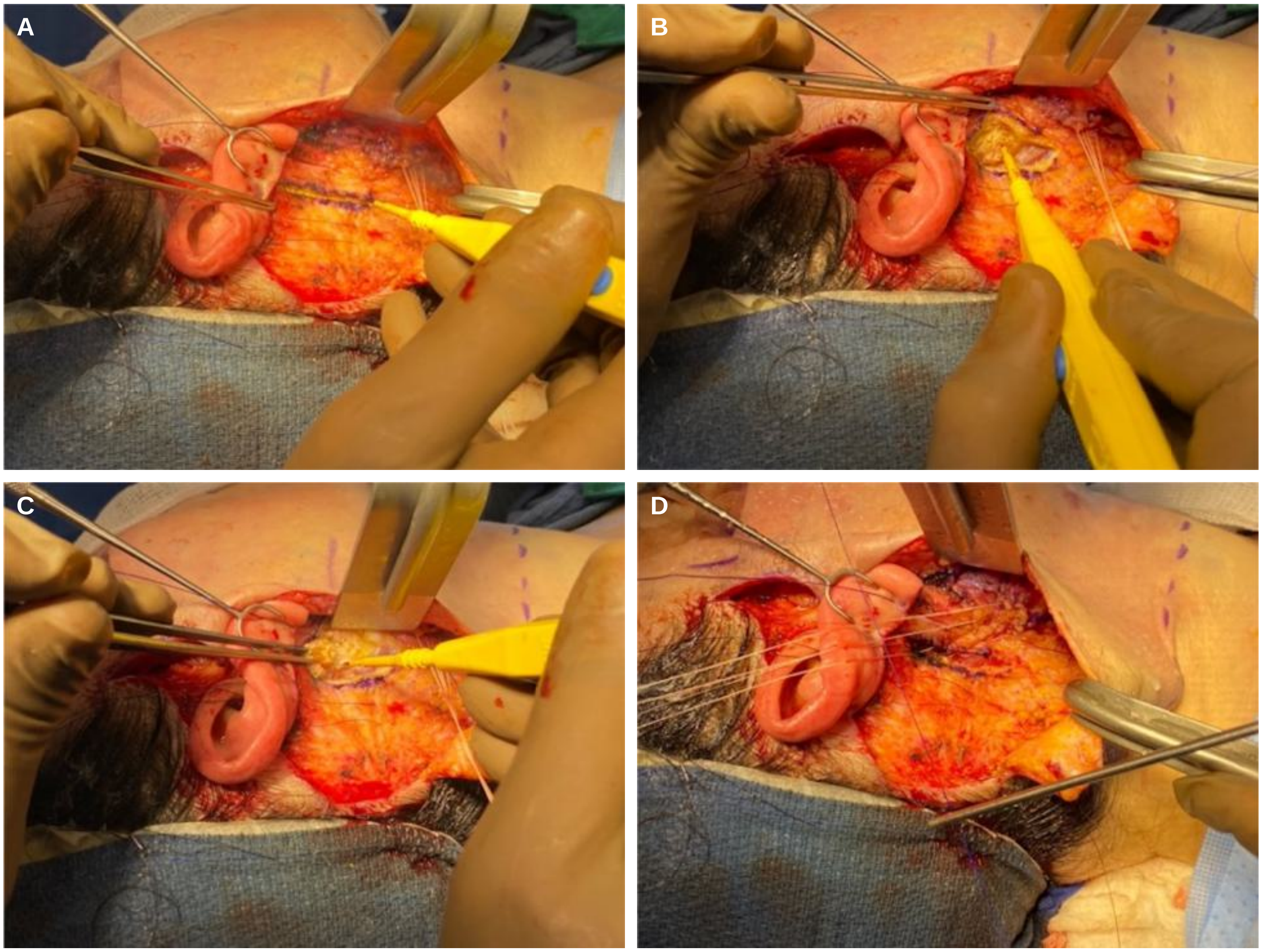

Figure 7. (A-D) Mastoid crevasse in a 42-year-old female. Here we have exposed the parotid tail and sternocleidomastoid muscle, which sit on the anterior and inferior border of the mastoid tip, respectively. The line may continue to elevate the conchal bowl. The parotid tail may be excavated under the parotid fascial capsule containing the great auricular nerve and the capsule is left intact. The platysma is then inset vertically into the crevasse, following an angle with respect to the Frankfort horizontal line shown.

flap is elevated and overlapped onto the lateral mastoid fascia using a myotomy or transposition flap. Although this may provide a strong area for fixation, it may blunt the gonial angle in patients with a broad mastoid bone and fail to fully restore the submentum as it most often will provide a less-vertical vector than needed (Figure 7). To overcome the structural limitations of lifting over the mastoid, the primary surgeon has developed a technique named the mastoid crevasse which has substantially improved surgical outcomes in a large variety of patients. The mastoid crevasse is formed by making a vertical incision by needle tip monopolar electrocautery along the anterior mastoid line. An incision is made down through the mastoid fascia to expose the anterior wall of the mastoid tip (Figure 8). The mastoid tip is bordered by the parotid tail anteriorly, conchal bowl and ear canal superiorly, and the SCM inferiorly. Anteriorly, this dissection frees the parotid tail from the mastoid, allowing the parotid and surrounding tissues to be compressed back into the deep pharyngeal space. Superiorly, the conchal bowl can be elevated very slightly to enable a more vertical repositioning of the platysmal cervical retaining ligaments, allowing a more substantial correction of the inferior neck and submandibular triangle. Inferiorly, the dissection stops at the SCM to avoid greater auricular nerve damage.

If parotid hypertrophy is present, a minor tail of parotid reduction may be performed at this point to reduce the tail of the parotid, although this may introduce a minor risk of sialoma and should only be performed as needed. The fascia overlying the parotid tail is elevated along with the great auricular nerve contained in that fascia. A minor amount of parotid tail tissue can safely be excavated from underneath the retracted fascia. The primary author limits parotid excision to the anterior border of the great

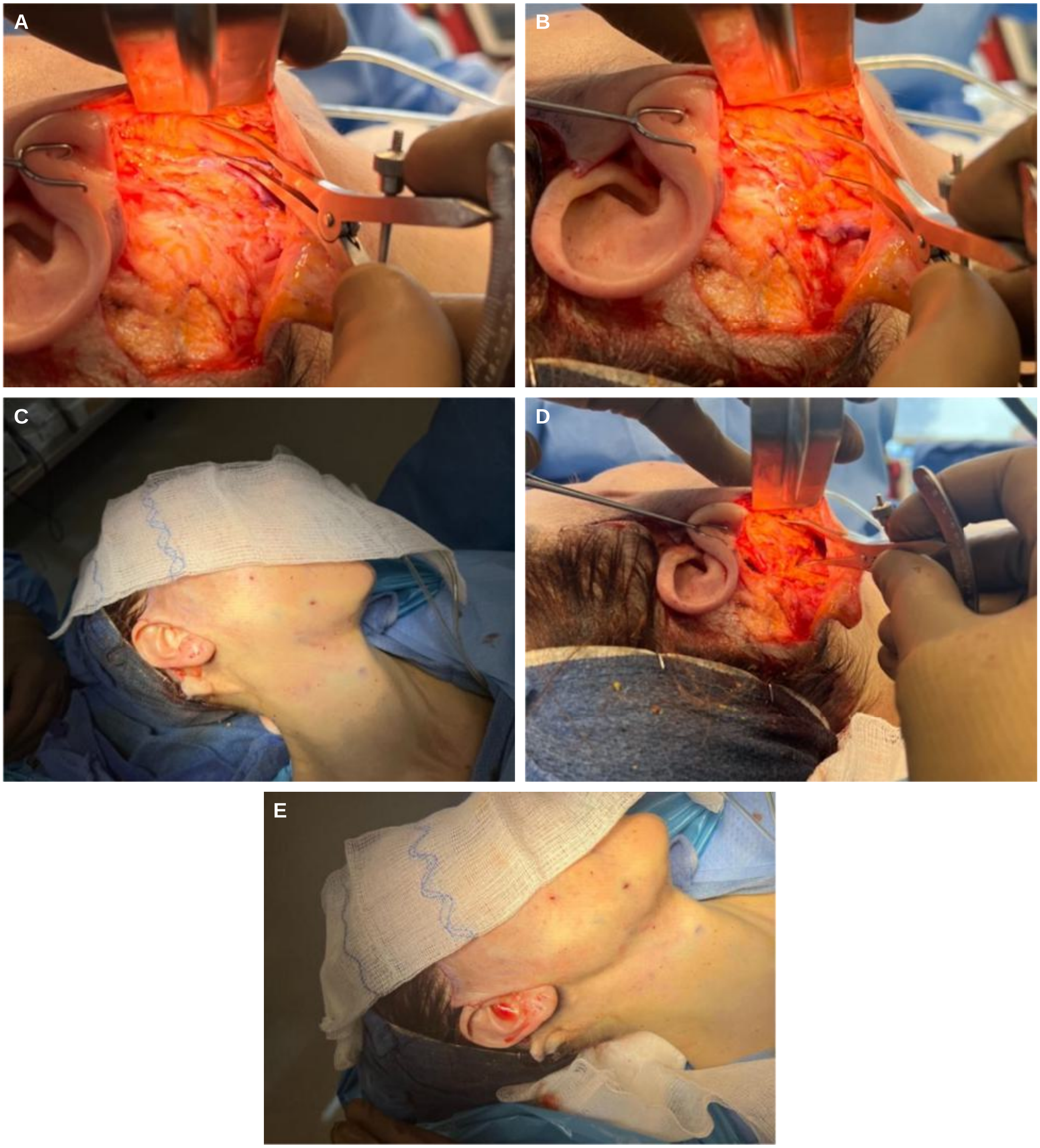

Figure 8. Mastoid crevasse creates more depth at the gonial angle than mastoid sutures (A-D). Here we demonstrate the study measurements in a 42-year-old female. (A) The depth of the gonial angle is measured at 6 mm before anything has been done; (B) the mastoid suture technique deepens the gonial angle to 11 mm, with the corresponding exterior image of the jawline improvement (C). (D) After the crevasse technique, the depth is 22 mm, with a corresponding improvement of the exterior appearance with improved definition of the gonial angle (E).

auricular nerve while avoiding any excision deep to the mastoid tip to avoid any heat dispersion to the facial nerve as it exits the skull at the stylomastoid foramen. A minor removal provides increased collapsibility of the parotid and provides less resistance to platysmal lifting and inset of the parotid tail into the deep pharyngeal space. The fascia should remain intact to lessen the risk of parotid gland exposure and potential sequelae. If the tail of the parotid reduction is performed, netting sutures are placed over the mastoid line following skin closure and left in place for 3 to 4 days.

Exposure of the anterior mastoid line allows inset of the platysma into the anterior mastoid rather than onlay over the mastoid. This provides a better position of fixation with substantially improved gonial angle depth and vertical platysma movement. The increase in gonial angle depth typically necessitates a greater surface area or distance of travel of the platysma around the gonial angle. To lengthen this area or relieve compression around the angle, a partial or full myotomy may be performed.[30] The primary author prefers performing partial myotomies or fasciotomies to maintain the integrity of the platysma and the cervicomental angle suspensory ligament.[30] It is important to maintain continuity and integrity of the inframandibular platysma, which directly elevates the hyoid and submental contents. This also aids in better encapsulation of the parotid gland and tail, giving the face a much more delicate appearance from frontal views, which is invaluable in patients with parotid hypertrophy. The partial myotomy is performed by pulling the lateral platysma flap superiorly and deep while scoring the shape of the gonial angle and mandible to retain the SMAS-platysma complex volume on the mandible while allowing the inframandibular platysma to inset and mobilize in a superior, deep, and posterior vector. In patients with a tall ramus, myotomy should be avoided and the platysma should only be scored as needed following suspension. This will help maintain the structure and integrity of the inframandibular platysma, which exerts its support on the submentum and submandibular triangles. The cervical retaining ligament zone of the lateral platysma is then engaged with two 2-0 Mersilene or silk sutures. The sutures are then placed on the anterior mastoid wall in a horizontal fashion to avoid inadvertent deep travel of the suture and needle. The placement should be as vertical as possible, possibly extending deep to the conchal bowl. This vertical movement performed deep to the mandibular angle exerts a much greater force of elevation on the hyoid and submandibular contents. This maneuver has a major mechanical advantage over standard mastoid suspension techniques, by forming a pulley system (Figure 2G). The inframandibular platysma is tethered deep to the gonial angle, which serves as a lateral pulley or fulcrum, which has a secondary movement against the lateral hyoid and tertiary pull against the chin. The goal is to affect a movement roughly 1 cm in the *x* axis, 1 cm in the *y* axis, and 1 cm deep in the *z* axis as opposed to trying to move 2 to 3 cm in a superolateral axis. This results in a more substantial elevation of the hyoid as it now swings vertically to or above the level of the chin and mandibular border. With the hyoid in a more internal and superior position, a greater correction of anterior digastric slope and bowing is achieved, with restoration of the submandibular triangle contents towards the floor of mouth, resulting in a negative submentum submentum.

The sutures are tied sequentially, insetting the platysma into the anterior mastoid tip. Any excess fat in the infragonial region is trimmed as needed. At this point, the gonial angle depth may be analyzed and measured to assess proper positioning and success. Gonial angle depth should be a routine measurable endpoint in face and neck lift surgery. At this point there should exist a contiguous line from the hyoid to the mastoid that is narrower and deeper than the line of the chin to the mandible. The facial platysma should lay comfortably with no tethering or tension around the gonial angle, the inframandibular platysma should wrap around the infragonial region tucking in the parotid tail and suspending the contents of the submentum and submandibular triangles, and the cervical platysma should have elevated the medial platysmal bands superolaterally while relieving lower ptosis of platysma and skin over the clavicles. Limiting skin dissection in the neck actually improves the gains achieved in skin quality relative to techniques that utilize greater dissection (Figure 5D). There should be no tension on or around the soft tissues of the ear, ensuring prevention of pixie ear or inappropriate rotation of the ear postoperatively.

At this point the suspension is complete and excess skin is trimmed without any tension or tacking sutures. A tension-free closure at all points helps ensure minimization of scarring (Supplemental Figure 7). Dermal sutures are avoided, if possible, to limit ischemia that may be caused by constriction of the dermal plexus. A #10 French round drain may be placed in the neck bilaterally overnight and 5-0 nylon netting sutures may be placed in the neck to avoid any minor fluid accumulation (Supplemental Figure 8). The suction tubing is mainly used to aid in redistribution of skin rather than in prevention of hematoma. Netting sutures are only placed in the noncomposite areas of the neck where skin was elevated, and they are removed after 72 hours. A soft headwrap is placed overnight with great care to avoid compression at the cervicomental angle.

RESULTS

Standard measurements of the depth below the gonial angle were taken intraoperatively in 72 patients (68 female,

Table 1. Average Gonial Angle Depth and Rate of Parotidectomy

	Preoperative (mm)	Postoperative 1 (mm)	Postoperative 2 (mm)	Parotidectomy (n, %)
Left (n = 78)	9.4 [3.6]	15.8 [3.3]	23.2 [2.2]	12 (15%)
Right (n = 78)	8.3 [2.7]	13.7 [2.5]	22.5 [2.5]	15 (19%)

Measurements are mean [standard deviation]. Post 1 is measuring the depth after traditional fixation of platysma to outside of mastoid fascia, post 2 is after creation of the mastoid crevasse and inset onto the anterior medial border of the mastoid.

4 male) treated in a 3-month period from August 2021 through November 2021 in the primary author's practice. The patients ranged in age from 32 to 72 years (although the primary surgeon has performed deep plane neck lifts on patients between 25 and 85 years old in his practice). All patients had follow-up at 1 week, 6 weeks, 3 months, and 12 months. Gonial angle depth was defined as the difference in height of the lower posterior border of the mandible to the deepest point 10 mm caudal to that point with the patient in supine position. The positions of the anterior and posterior auricular nerve branches were also measured relative to the position of the anterior mastoid line to assess safety. These measurements were routine, and no experimental studies were performed on patients, in accordance with the Declaration of Helsinki. A Castroviejo caliper was used to measure the gonial angle depth in 3 different positions. Position 1 was taken prior to elevation of the SMAS-platysma flap. Position 2 was taken following full deep plane release as described earlier along with partial myotomies, followed by standard suspension overlay on the mastoid fascia. Position 3 was measured following creation of the mastoid crevasse and inset of the platysma into the anterior mastoid. In total, 237 data points were acquired from the 79 patients bilaterally with an angled Castroviejo 40 mm graded caliper. For measurement acquisition, the upper arm of the caliper is placed directly at the inferior posterior border of the mandibular angle, while the lower caliper is placed at the deepest point within 10 mm of that to most accurately assess the gonial angle depth. If the tail of the parotid was reduced, this was recorded.

The mean [standard deviation] gonial angle depth of the 79 patients included in our database following primary suspension and platysma-mastoid onlay on the left side was 15.8 [3.3] mm while the mean depth after performing the crevasse technique with deeper platysmal inset was 23.2 [2.2] mm. Twelve patients (15%) received left-sided parotid tail reductions. The mean gonial angle depth after primary suspension onlay on the right side was 13.7 [2.5] mm, whereas the mean gonial angle depth after mastoid crevasse inset was 22.5 [2.5] mm. Fifteen patients (19%) received right-sided tail of parotid reductions (Table 1, Supplementary Table 1). In no patients was the gonial angle depth identical and symmetric.

Across the 79 patients included in the database, the average increase of gonial angle depth from traditional suspension of the platysma on the anterior mastoid was 5.9 mm, while the overall average gain in gonial angle depth after utilizing the suspension and inset of the platysma into the mastoid crevasse was 14.0 mm (Table 2). The gain in gonial angle depth with the mastoid crevasse technique was 8.1 mm ($P < .0001$). Changes in the hyoid position and submentum from position 2 to position 3 were universally observed but not recorded in this study (Supplemental Figure 10A, B).

Measurements of the auricular branches were also taken (Figure 2C). The great auricular nerve most often was found to travel in the plane of the SCM fascia as a single branch anywhere from 8 to 12 mm anterior to the anterior mastoid line. Between 2 and 3 posterior branches were typically found traveling along the mastoid posterior to the base of the lobule. In 99% of cases, the branches traveled from 4 to 12 mm posterior to the anterior mastoid line. In 1% of cases a minor branch was noted over the anterior mastoid line and was easily avoided with proper retraction. The main trunk of the facial nerve was absent along the anterior mastoid dissection in 100% of cases. Postauricular facial nerve motor branches could be found at the superior extent of the anterior mastoid line and were preserved.

In addition, 200 surgeons were surveyed in person at an international interdisciplinary conference. The only question of the survey was: "Do you measure the gonial angle or have a method of measuring the gonial angle during face or neck lifting surgery?" One of the 200 (0.5%) of the surgeons claimed they had assessed the depth of the gonial angle, demonstrating the lack of assessment of this important, measurable endpoint.

The patients' results and outcomes were reviewed retrospectively over 12 months of follow-up (Figure 9). Submental and submandibular ptosis and fullness were treated appropriately in 99% of patients. One patient required revision. One patient had temporary paresis lasting longer than 2 weeks around the lower mouth unilaterally, which resolved by 2 months. There were no cases of skin slough or epidermolysis. Three patients demonstrated an ischemic reperfusion response on the postauricular mastoid skin flap as diagnosed by visualization of minor vesicles and surrounding erythema after postoperative day 2. These resolved spontaneously with no sequelae. No facial hematomas occurred. Three minor cervical unilateral hematomas formed and were treated with drainage and netting sutures.

Table 2. Average Differences Between Techniques

	Traditional technique, postoperative 1 vs preoperative (mm)	Crevasse, postoperative 2 vs preoperative (mm)	*P*-value	Average gain (mm)
Left	6.4	13.8	<.0001	7.4
Right	5.4	14.2	<.0001	8.8
Overall	5.9	14.0	<.0001	8.1

Post 1 is measuring the depth after traditional fixation of platysma to outside of mastoid fascia, post 2 is after creation of the mastoid crevasse and inset onto the anterior medial border of the mastoid.

One seroma formed and was treated with drainage and netting sutures. There were no submandibular or parotid salivary leaks, and there was no incidence of gustatory sweating or first bite syndrome. There was zero incidence of ear rotation or pixie ear deformity. Representative before and after (12-month follow-up) photographs are shown in Supplemental Figures 9 and 10.

DISCUSSION

This article provides an advanced deep plane surgical technique detailing a novel approach to increasing definition and depth around the gonial angle; there are, to the authors' knowledge, no published articles describing the technique discussed herein. This technique simultaneously provides more effective vectors of lift to improve hyoid, digastric, and submandibular gland elevation, and suspension as well as improvements to the skin of the inferior neck and clavicle without reliance on skin delamination. This is the first article to recommend intraoperative analysis of gonial angle depth as a measurable endpoint and goal in face and neck lift surgery. Our results have been improved substantially by focusing on proper vectorial lifting of the platysma with inset into the anterior mastoid rather than onlay over the mastoid as classically performed.

Our measurements of primary suspension techniques over the mastoid fascia have demonstrated that patients with a shallow or atrophic mastoid tip with less lateral projection obtain better gonial angle depth than patients with broader, larger, or more lateralized mastoid tips. The mastoid crevasse technique overrides anatomic variations by allowing inset of the platysma to the anterior wall of the mastoid, which increases the depth of the gonial angle substantially. This technique also provides release of the parotid tail, which sits on the anterior mastoid in all patients. Release of the parotid gland and capsule allows the gland to be compressed easily into the deep pharyngeal space, correcting for the protrusion and widening associated with aging or hypertrophy. Performing platysmal scoring or partial myotomies of the outer platysma at the gonial border rather than a full myotomy helps to maintain platysmal integrity along the gonial angle and lateral neck. This technique improves definition and delicacy around the gonial angle by tucking in the parotid gland around the ramus of the mandible (Supplemental Figure 10). This is especially helpful in patients with parotid hypertrophy, including Asian patients and patients with thyroid eye disease who commonly display glandular hypertrophy. Minor parotid tail reduction can safely and easily be integrated into the surgical plan as well when needed without cause for unnecessary facial nerve dissection in a healthy patient.

Suspension to the anterior mastoid periosteum also provides a more secure suspension point for the platysma in a more effective vertical vector. Vertical lifting of the platysma into the anterior mastoid is generally performed in the range of 85° to 90° relative to the Frankfort horizontal line, utilizing mechanical advantages akin to using a pulley system. This provides a more appropriate lift of the submental platysma, anterior digastric muscle, hyoid bone and submandibular glands (Figure 2, Supplemental Figure 7D). This also allows the surgeon to sling the inframandibular platysma around the gonial angle to obtain a negative vector submentum where the submental and submandibular contents are located above the horizontal plane of the mandible.

This study also demonstrates safety of dissection along the anterior mastoid regarding motor and sensory nerves as well as gland function and complications. In the near future additional studies will help provide the average angle or vector of lift of the facial SMAS, facial skin, and cervical platysmal suspension using this approach. These studies help establish a baseline and at least 1 anatomic benchmark, analyzing gonial angle depth following mastoid crevasse inset, for measuring outcomes in the lower face and neck. We hope that this helps demystify outcomes-based research in lower face and neck rejuvenation procedures.

CONCLUSIONS

Modified extended deep plane face and neck lifting techniques focus on release and redraping of soft tissues rather than pulling, tightening, or stretching. Elevation off of the mimetic musculature avoids dynamic changes and alterations in facial muscle function and appearance while decreasing tension in lifting and closure. Incorporation of the mastoid crevasse technique provides a deeper and more secure point of fixation. Extension of the mastoid crevasse under the conchal bowl also makes a more vertical lift possible. Vectorial concepts are demonstrated and improve the surgeon's ability to analyze the neck and make improvements that come from narrowing the diameter around the hyoid and the curve towards the mastoid around the neck, relative to the dimensions of the mandible. Limitations in lifting

Figure 9. (A-J) Before-and-after photographs of a 59-year-old male before and 12 months after a comprehensive Auralyft. This included fat grafting, corner lip lift, and brow lift. His Auralyft involved bilateral submandibular gland reduction, bilateral digastric reduction, perihyoid fat pad reduction, and interrupted netting sutures. He also underwent an upper blepharoplasty with fat removed from bilateral nasal pads and injected into the right lateral brow. His lower blepharoplasty involved fat repositioning, fat grafting, double canthopexy, skin excision, and carbon dioxide laser treatment.

based on anatomic variants of the mastoid tip are overcome by utilizing this technique which also provides a more appropriate suspension of the submental platysma, digastrics, hyoid bone, and submandibular glands. The necessity for skin delamination is decreased by increasing the surface area of skin travel caused by 3D deepening of cervical contours. Limitations based on parotid gland hypertrophy are also better overcome with this technique. Analyzing a measurable endpoint at the gonial angle with the mastoid crevasse technique will aid practitioners in obtaining better results in the anterior and lateral neck and jawline, while leaving less to chance.

Supplemental Material

This article contains supplemental material located online at www.aestheticsurgeryjournal.com.

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Part VI

Eyelid Surgery

VI

31 Eyelid and Periorbital Anatomy

Amy D. Patel and Guy G. Massry

Abstract

A fundamental understanding of the anatomy of the eyelid and periorbital region is critical to achieve an optimal aesthetic outcome and maintain appropriate function. Sound surgical technique can be achieved only with a thorough understanding of the intricate details of the periorbital structures. With this foundation, appropriate surgical intervention can lead to satisfied patients and avoid significantly adverse events that can threaten vision and impair quality of life. This chapter thoroughly reviews eyelid anatomy and critical principles while emphasizing surgical pearls to help guide an aesthetic surgeon. In addition, it outlines the anatomy of the forehead, temples, and midface in relation to the periorbital region, as well as details how these anatomic areas transition together. The goals of this chapter are to lay a foundation for the aesthetic surgeon and provide a better understanding of the anatomic nuances of the periorbital region and adjacent structures.

Keywords

periorbital anatomy, midface, forehead, temples, eyelid anatomy, upper eyelid, lower eyelid, levator, blepharoplasty, temporal fascia

31.1 Introduction

The fundamental basis of surgery starts and ends with a detailed knowledge of anatomic constructs. This is especially true in reference to the delicate eyelid and periorbital regions. In these areas sound surgical technique and principles can be applied only with a thorough comprehension of the various anatomic structures that make up this aesthetic subunit of the face. This basic premise allows maintenance of form and function, both of which are critical to attaining optimal outcomes, achieving high patient satisfaction, and avoiding adverse events. This chapter is presented as an overview of what the authors have identified as clinically relevant concepts of eyelid and periorbital anatomy. In addition to the eyelids, the adjacent forehead, temples and midface are included, as these adjacent structures are in continuity with the eyelids, making them critically relevant anatomically and surgically to the aesthetic eyelid surgeon. The authors' goal is that upon completion of this chapter, the reader will understand the anatomic nuances of these facial subregions and how their five tissue layers transition with each other. Each chapter section will include highlighted ***"clinical pearls,"*** in italics and bold, emphasizing how knowledge of anatomy directs surgical technique and enhances surgical proficiency.

31.2 Temple and Brow

The upper third of the face can be subdivided into two regions: the forehead, which is centrally based, and the temples laterally. Externally, without animation, the two regions blend together without a discrete boundary. When the frontalis muscle contracts, horizontal rhytids are noted within the forehead to its lateral extent. Where these rhytids end, the temple begins. The subcutaneous transition of these facial structures is more complicated. At the level of bone, this occurs at the superior temporal line (STL), a concave, curvilinear bony groove composed of the zygomatic, frontal, and parietal bones (**Fig. 31.1**). The STL forms

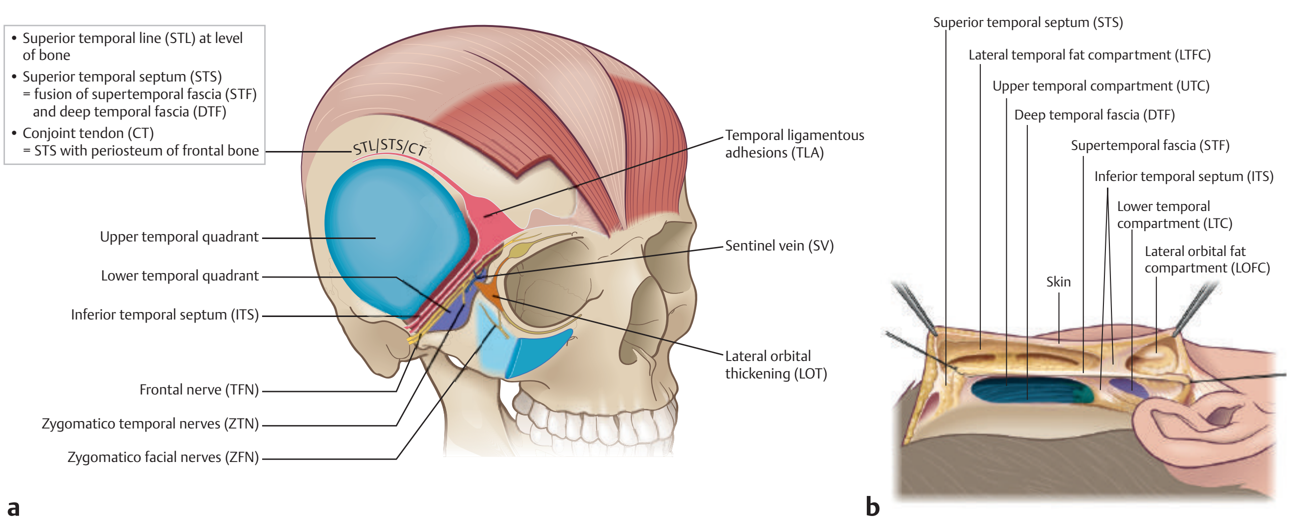


Fig. 31.1 (a) Important anatomic quadrants and landmarks of the temple and forehead region. **(b)** Cross-sectional view of the layers of the temple region.

the superior medial boundary of the temporalis fossa, where the temporalis muscle resides. The deep temporal fascia (DTF), a dense fascial layer overlying the temporalis muscle, inserts on this landmark. The DTF also fuses with the more superficial and flimsier superficial temporal fascia (STF) at this point. This line of fusion forms one of two septa in the temple, this one called the superior temporal septum (STS). The name given to the continuity of the STF/DTF (STS) and the periosteum of the frontal bone is the conjoint tendon (CT) or the area of fusion between the fascial layers of the temple and the soft tissue of the forehead (**Fig. 31.1**). ***The CT is an important landmark in brow lifting surgery, as its division makes the surgical planes of the temple and forehead continuous.***

31.2.1 Temple

The temple is externally bounded by the hairline superolaterally, the STL medially, and the zygomatic arch below. Like all regions of the face, it is composed of 5 layers (**Fig. 31.1b**):

1. Skin
2. Subcutaneous tissue/fat
3. Superficial fascia (STF, also known as the temporoparietal fascia, TPF)
4. Loose areolar tissue (a potential space)
5. The DTF overlying the temporalis muscle

As described, the STS is the medial fusion of the STF and DTF, which overlies the transition of the temple and forehead. Similarly, there is a second and inferior septum of the temple region, the inferior temporal septum (ITS), which is also a fusion of the STF and DTF. The ITS traverses a dense adhesion above the lateral brow, referred to as the temporal ligamentous adhesion (**Fig. 31.1a**), and continues to the helix of the ear. It divides the temple anatomically into two separate superficial and deep compartments. In superficial Layer 2 of the temple, the ITS divides the subcutaneous fat into an upper temporal fat compartment and the lateral orbital fat compartment (**Fig. 31.1b**). In the deeper Layer 4 of the temple, the ITS divides this plane into the upper temporal compartment (UTC) and the lower temporal compartment (LTC). ***This space between the STF and DTF of the temple is the surgical plane for endoscopic brow lifting surgery.*** The UTC is an extension of the sublegal plane of the forehead, is a true potential space, and is defined medially by the STS and inferiorly by the ITS. The UTC is composed of loose areolar tissue, and surgical dissection can proceed bluntly and easily to its boundaries (**Fig. 31.2**). At its boundaries, more meticulous dissection is required to avoid complications. ***At the medial boundary of the UTC, dividing the CT is a necessary step in endoscopic brow lift surgery*** **(Fig. 31.3)**. ***During this step, if an elevator is used to divide the CT, it is critical to divide the tendon from the temporal subaponeurotic space to the central subperiosteal space.*** The deep lateral branch of the supraorbital nerve runs just above the frontal periosteum, parallel and medial to the CT (**Fig. 31.4**). ***Dissection must be subperiosteal over the frontal bone to protect this nerve.*** If this nerve is damaged, prolonged scalp numbness/paresthesia or itching can occur. ***Also, if the inferior release of the CT proceeds medial to lateral, the STF can be inadvertently entered, with subsequent damage to the frontal branch of the facial nerve.*** Of note, while motor nerve injury has greater functional and aesthetic implications than sensory injury during endoscopic brow lift surgery, sensory deficit is far more common.

Fig. 31.2 Upper temporal quadrant dissection. The dissection proceeds easily in a blunt fashion. It demarcates superficial temporal fascia above, deep temporal fascia below.

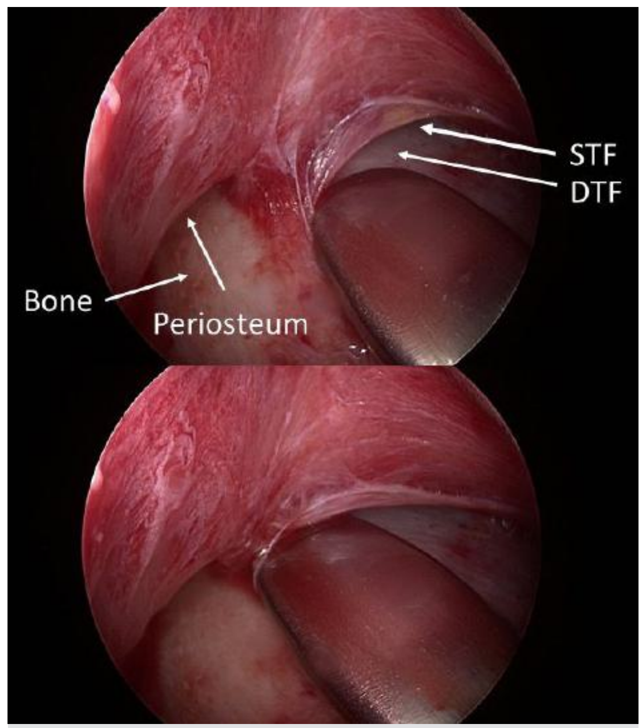


Fig. 31.3 Surgical endoscopic view of the conjoint tendon. Dissection proceeds in a subperiosteal manner.

Inferiorly, below the ITS, the LTC, which is functionally an extension of the midface below, is bounded by denser adhesions. Dissection in this area to access the lateral brow or midface requires caution so as to avoid injury to critical neurovascular structures. These include the frontal branch of the facial nerve and both the sentinel (medial zygomaticotemporal) vein and various branches of the zygomaticotemporal nerves. ***Preserving***

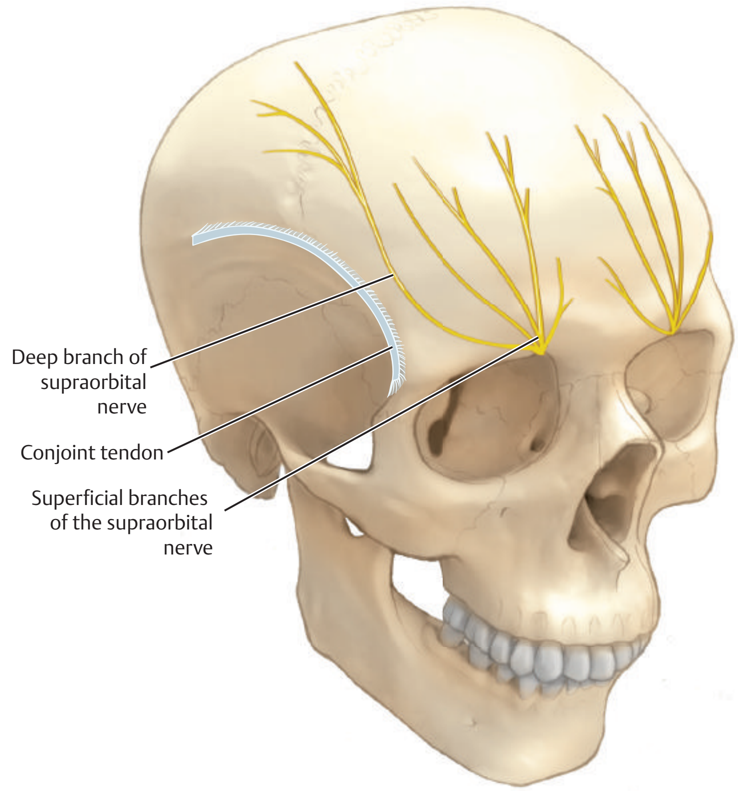


Fig. 31.4 The deep branch of the supraorbital nerve runs just above the frontal bone periosteum, parallel and medial to conjoint tendon. Dissection must be subperiosteal to prevent sensory deficit. (Reproduced from Pu L. *Aesthetic Plastic Surgery in Asians. Principles & Techniques*. New York, NY: Thieme; 2015.)

the sentinel vein during endoscopic brow lift and midface surgery is important to prevent the development of new and visible postoperative periorbital veins and prolonged edema (**Fig. 31.5**). Of all these structures, understanding the course of the frontal branch of the facial nerve is most important. Externally, the nerve courses along the Pitanguy line, from a point 0.5 cm below the tragus to a point 1.5 cm lateral to the supraorbital rim (**Fig. 31.1a**). Internally, it lies in the roof of the LTC in the innermost aspect of the STF.

Of note, just above the ITS the DTF divides into two laminae, with a fatty layer between (the superficial temporal fat). ***Disruption of this fat pad during surgery can lead to postoperative temporal wasting.*** Below this division the superficial layer of the DTF is known as the innominate or intermediate fascia. The two layers of the DTF insert on the zygomatic arch. The superficial layer of the DTF continues beyond the zygomatic arch and blends with the parotideomasseteric fascia of the face. The arterial supply of the temple is from the superficial temporal artery (STA), which courses in the STF in this location. ***Care must be taken with filler and fat injections superficially within the temple, as the STA communicates within the forehead with the supraorbital artery. Inadvertent intra-arterial injection can lead to vision loss via this route.*** Venous drainage is from the superficial temporal vein, while lymphatic drainage is via the preauricular nodes. Motor innervation of the temporalis muscle is from branches of the mandibular division of the trigeminal nerve (cranial nerve V_3). These branches are called the deep temporal nerves. Sensory innervation of the temple is from the zygomaticotemporal nerve, a branch of the maxillary division (V_2) of the trigeminal nerve that exits the lateral orbit to arrive at the temple, and the auriculotemporal nerve, a branch of the mandibular division (V_3) of the trigeminal nerve that runs superiorly with the superficial temporal artery and veins to ascend to the temple.

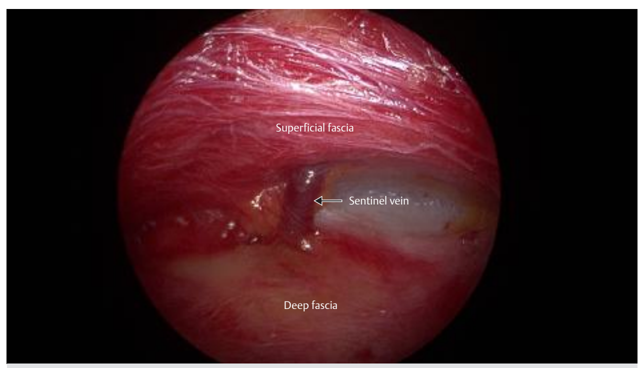


Fig. 31.5 Surgical endoscopic view of the sentinel vein, which should be preserved in surgery to avoid new and visible postoperative periorbital veins and prolonged edema.

31.2.2 Forehead

The forehead is delineated superiorly by the hairline; inferiorly by the glabella, frontonasal groove, and eyebrows; and laterally by its boundary to the temple as already described. It is also composed of five layers, which include the following (**Fig. 31.6**):

1. The skin
2. Subcutaneous tissue/fat
3. Galea aponeurotica
4. Loose areolar tissue
5. Periosteum

The main retractor of the forehead is the paired and vertically oriented frontalis muscles, which tighten the scalp, raise the eyebrows, and create horizontal forehead rhytids. The frontalis is encased by the superficial and deep layers of the galea aponeurotica as part of layer 3 (**Fig. 31.6**). It fuses with the occipitalis muscle posteriorly (some consider it part of the occipitofrontalis muscle), is continuous (as part of the galea) with the STF of the temple, and interdigitates with the procerus, corrugator supercilii, and orbicularis oculi muscles inferiorly, before inserting into the dermis underlying the eyebrows. ***As the frontalis has no bony origin or attachment, it serves only to provide facial expression.*** Finally, the lateral forehead and eyebrows receive their blood supply from the STA, while the medial forehead is supplied by terminal branches of the ophthalmic artery, including the supraorbital and supratrochlear arteries. Venous drainage for the forehead is via the supraorbital, supratrochlear, and superficial temporal veins, while lymphatic drainage is to the preauricular and parotid lymph nodes. The forehead (frontalis muscle) receives motor innervation from the frontal branch of the facial nerve and sensory input from the supraorbital and supratrochlear nerves, both terminal branches of the ophthalmic division (V_1) of the trigeminal nerve. The supraorbital nerve has two branches (see **Fig. 31.4**):

1. A medial superficial branch, which pierces the corrugator supercilii muscle before supplying the central forehead
2. A deep lateral branch that runs just above the periosteum lateral to the conjoint tendon, supplying the lateral forehead and posterior scalp

This deep lateral branch should be protected in endoscopic brow lifting surgery (dissect subperiosteally below it) to prevent protracted postoperative sensory deficit.

At the level of the brow, the deep layer of the galea splits and envelops the brow fat pad, also called the retro–orbicularis oculi fat (ROOF). The ROOF continues into the eyelid proper as the postorbicularis fascia in Caucasians and the preseptal fat in Asians.

The lateral extent of frontalis is bounded by the STL. Beyond this landmark the tail of the brow has no elevator. Therefore, neuromodulation of the lateral brow depressors (lateral orbicularis oculi muscle) is a common intervention for chemical lateral brow lifts. In addition, the ROOF descends and deflates with age. Elevating (with brow lifts or suspension sutures) or chemical filling (i.e., hyaluronic acid gel) of the ROOF can also lift and/or project the tail of the brow. The authors prefer the term* brow recontour *rather than* brow lift, *as in their view it is the shape, arch, and contour of the brow that are more important than height. A detailed knowledge of anatomy is what allows consistent and reproducible results to these interventions.

While there is one elevator of the eyebrows, there are multiple depressors. These include the glabellar muscles medially, consisting of the corrugator supercilii and procerus muscles, and the orbicularis oculi muscle laterally. Unlike the frontalis, these muscles do have bony attachments. The frontal branch of the facial nerve innervates the orbicularis and corrugator muscles, while the buccal and zygomatic branches of the facial nerve innervate the procerus muscle.

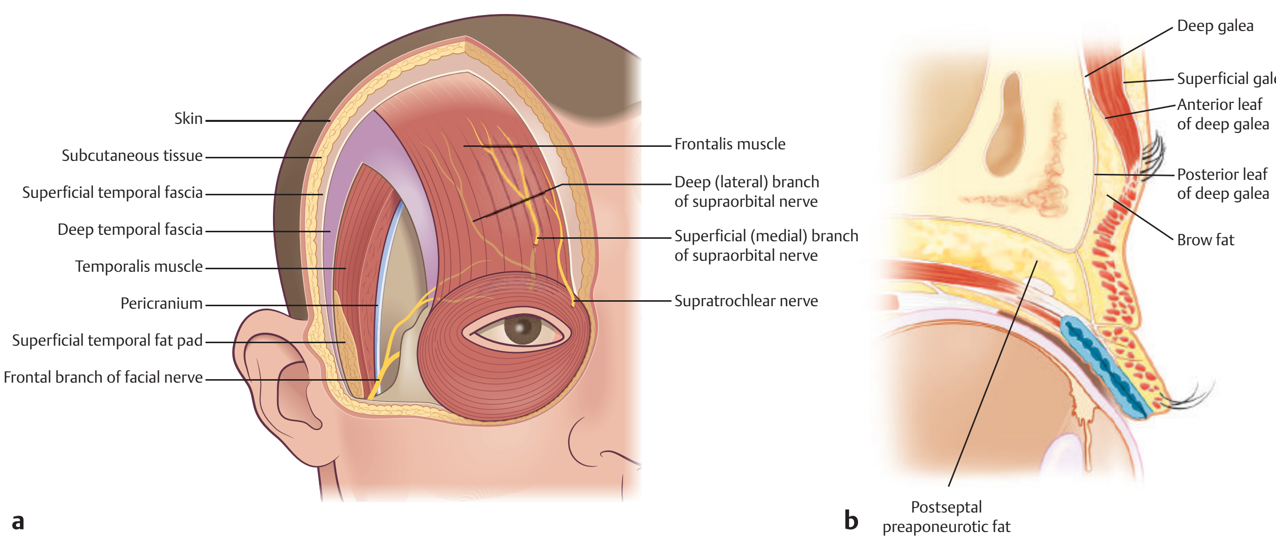


Fig. 31.6 Layers of the forehead. **(a)** Frontal view. (Reproduced from Sokoya M, Inman J, Ducic Y. Scalp and forehead reconstruction. *Semin Plast Surg* 2018;32(02):90–94.) **(b)** Parasagittal section through eyeball. (Reproduced from Codner M, McCord C, eds. *Eyelid & Periorbital Surgery*, 2nd ed. New York, NY: Thieme; 2016.)

31.3 Eyelid Anatomy

31.3.1 General Considerations

The supraorbital ridge marks the transition of the upper to the middle third of the face. The upper and lower eyelids are, thus, in the middle third. They are complicated, multilayered, and dynamic structures that act to protect the ocular surface and preserve vision. ***Failure to maintain the anatomic integrity and biomechanics of the eyelids during surgery can lead to aesthetic and functional disability, including visual compromise.*** They span the lateral to medial canthi, with the upper eyelid bounded by the brows above and the lower eyelids by the midface below. These transitions are not distinct but rather blend together, so that the brows and upper eyelids and the lower eyelids and midface behave, and are considered, as individual functional and aesthetic facial subunits (**Fig. 31.7**). ***The area between the brows and upper lids at their junction is called the superior sulcus. Avoiding hollowing of this area by overresection of skin, muscle, and fat is an important paradigm of upper blepharoplasty for aesthetic enhancement.***

Externally, the eyelids are topographically subdivided into a palpebral (pretarsal and preseptal) and an orbital segment, based on the internal anatomic structure underlying the eyelid skin and muscle in this area (**Fig. 31.7**). Internally, the eyelids are composed of three distinct lamellae: anterior, composed of thin skin and orbicularis muscle; middle, defined by the orbital septum; and posterior, made up of conjunctiva, tarsus, and retractors depending on topographic location on the eyelid (**Fig. 31.8**). Eyelid closure is controlled in both the upper and lower eyelids by the orbicularis oculi muscle, the only protector of the eyelids. Conversely, eyelid opening is driven by separate and differing structures in the upper and the lower eyelids, generally referred to as eyelid retractors, discussed hereafter. Finally, the eyelids are internally separated from the orbit proper by a thin connective tissue structure called the orbital septum. ***The orbital septum is a critical landmark in eyelid surgery, as the eyelid/orbital fat, which is excised or transposed in blepharoplasty, is always posterior to the septum.***

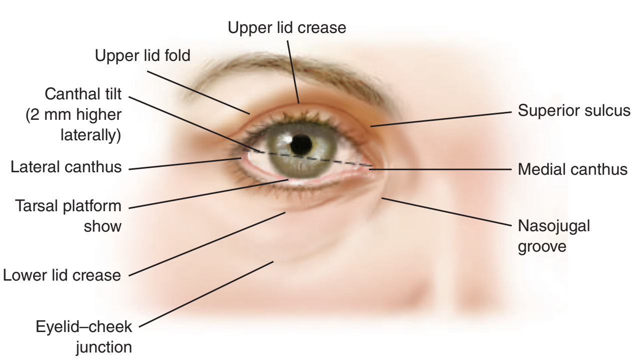


Fig. 31.7 Normal eyelid surface anatomy.

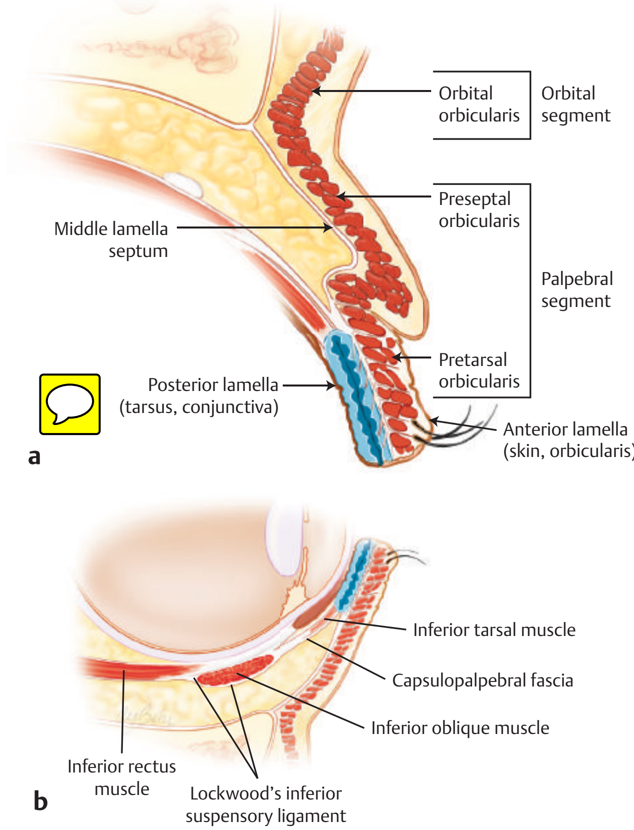


Fig. 31.8 (a) Upper lid cross section. **(b)** Lower lid cross section.

31.3.2 Key Points

The orbicularis oculi is a concentric muscle that, depending on its subdivision, originates and inserts on the orbital rim, lateral raphe, or canthi. As it is a circular sphincter, it requires counterfixation at the canthi to allow appropriate vertical eyelid excursion. ***Poor canthal stability after blepharoplasty surgery can lead to a biomechanical deficit in eyelid closure, medialization of the lateral canthus, with subsequent shortening of the horizontal palpebral fissure, collectively referred to as "fishmouthing."*** The pretarsal orbicularis lies above the tarsal plate and is thought to contribute (with the preseptal orbicularis) to involuntary upper eyelid excursion such as blink. The muscle continues to the eyelid margin, where it can be seen as the "grey line," also referred to as the muscle of Riolan. The muscle has both superficial and deep components that contribute to the medial and lateral canthal tendons. The preseptal orbicularis overlies the orbital septum; is mobile as compared with its pretarsal counterpart, which is fixed to the tarsus; and also has superficial and deep segments, which contribute to the canthal tendons. Both these segments of orbicularis contribute to the lacrimal pump mechanism for tear drainage. As the eyelids close, the orbicularis muscle contracts. The pretarsal component compresses the canaliculi, driving tears to the lacrimal sac. As the preseptal orbicularis (which inserts into the lacrimal sac) contracts, it expands the lacrimal

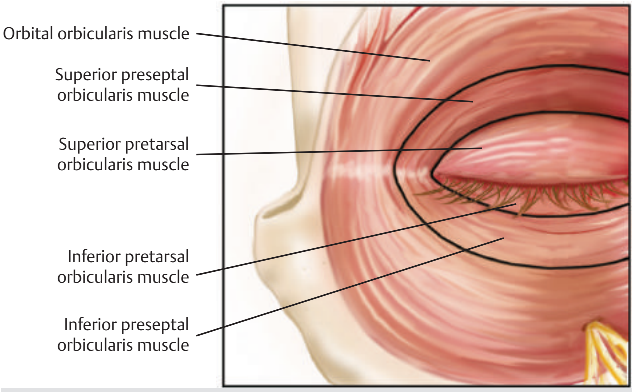


Fig. 31.9 Orbicularis oculi muscle is classically divided into three portions: orbital, preseptal, and pretarsal.

sac, creating a negative pressure that draws the tears into the sac. As the eyelid opens, the orbicularis muscle relaxes, which in turn opens the puncta and collapses the lacrimal sac, and the cycle repeats. ***The bottom line is that normal eyelid function is critical to prevent postsurgical tearing.*** The orbital orbicularis is the largest segment of the orbicularis muscle and controls voluntary upper eyelid closure as well as medial and lateral brow depression. **Fig. 31.8** and **Fig. 31.9** demonstrate the anatomic subdivision of the orbicularis muscle.

The eyelids are anchored medially and laterally by the medial and lateral canthal tendons. The medial canthal tendon is formed by fibrous extensions of the orbicularis muscle and has both anterior and posterior crura, which attach to the anterior and posterior lacrimal crests, respectively. The anterior lacrimal crest is an extension of the frontal process of the maxilla. The posterior lacrimal crest is part of the lacrimal bone. The lacrimal sac lies between the anterior and posterior crura of the medial canthal tendon and within the lacrimal fossa. The lateral canthal tendon is similarly formed by fibrous extensions of the orbicularis muscle that connect the tarsal plate to the lateral orbital rim, and it also has anterior and posterior crura. The anterior crus attaches to the anterior orbital rim, while the posterior crus attaches to Whitnall's tubercle, a bony prominence 3 mm posterior to the lateral orbital rim and 10 mm below the frontozygomatic suture. ***Four anatomic structures attach to Whitnall's tubercle (the 4 Ls): the lateral rectus check ligament, the levator aponeurosis (LA), Lockwood's suspensory ligament, and the lateral canthal tendon.*** In addition, the lateral canthal tendon sits approximately 2 mm higher than the medial canthal tendon. This is known as the normal canthal tilt (**Fig. 31.7**). ***It is critical to re-create this posterior/superior attachment of the LCT in surgery, as it allows appropriate apposition of the lid to the globe and directionality of the horizontal palpebral fissure.*** **Fig. 31.10** shows critical structures and landmarks in canthal anatomy.

The upper and lower tarsal plates are dense connective tissue structures that provides structural integrity and support to the eyelids. The upper tarsus measures approximately 10 mm in height and 25 mm in width. It tapers medially and laterally and tends to decenter temporally with age. The lower tarsal plate measures 4 mm in height and is approximately the same width. Finally, in both the upper and lower eyelids, the orbital septum originates at a periosteal fusion site at the orbital rim called the arcus marginalis and inserts onto the LA on the upper lid and the eyelid retractors of the lower lid (**Fig. 31.11**).

31.3.3 Specific Upper Eyelid Anatomy

The critical layers of the upper lid are the anterior lamellae (skin and orbicularis muscle), the middle lamella (orbital septum), and the posterior lamella (conjunctiva, retractors, and tarsus). The anterior lamella overlies the tarsus and orbital septum, which, as stated, separates superficial eyelid tissue from the deeper orbit proper. The orbital septum, which originates at the arcus marginalis of the superior orbital rim, fuses with the LA approximately 2 to 3 mm above the tarsal plate in Caucasians and below the

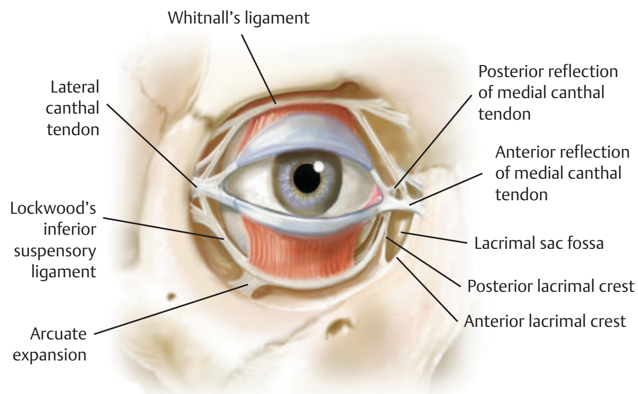


Fig. 31.10 Critical structures and landmarks in canthal anatomy.

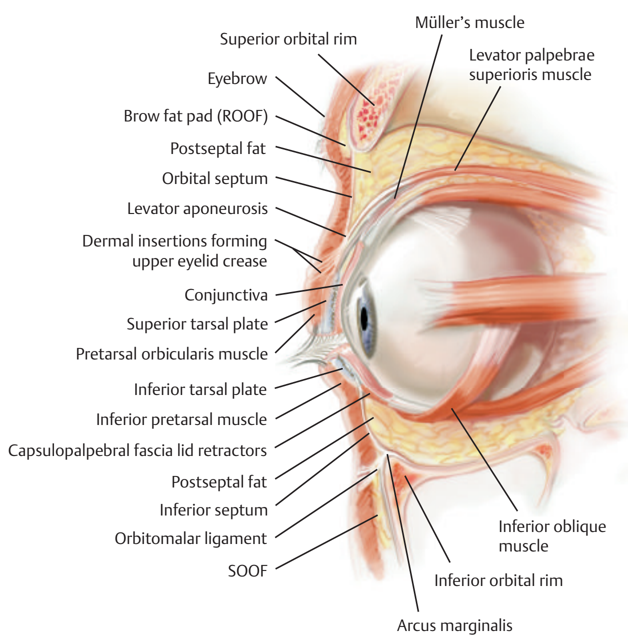


Fig. 31.11 Relevant anatomic structures for upper and lower lid anatomy. ROOF, retro–orbicularis oculi fat; SOOF, sub–orbicularis oculi fat.

superior border of the tarsal plate in Asians (**Fig. 31.12**). ***Dermal attachments of this fusion point create the eyelid crease*** (**Fig. 31.11**). Posterior to the septum, the upper eyelid has two fat pads:

1. Nasal or medial
2. Central or preaponeurotic fat (PAF)

The fat pads are separated by the trochlea, the tendinous sling of the superior oblique muscle (**Fig. 31.13**). In contrast to the lower eyelid, there is no lateral fat pad in the upper lid, but a prolapsed lacrimal gland can clinically appear as a full lateral upper lid. ***It is important to familiarize oneself with the appearance of the lacrimal gland in surgery so as not to resect it in error, assuming that it is eyelid/orbital fat***. The nasal fat pad, which is paler than the more yellow PAF, is an extension and in continuity with deeper orbital fat. Conversely, the PAF lies above the LA, which separates it from the deeper orbital fat. The nasal fat, as compared with PAF, tends to be relatively stem cell rich and becomes more prominent clinically with age. ***As the nasal fat pad is laterally bounded but not divided by the LA, it can be accessed from a transconjunctival approach***. ***Also, as the nasal fat pad is richer in progenitor cells and tends toward prominence with age, it can be transposed centrally within the eyelid to potentially maintain volume and prevent postoperative superior sulcus hollowing during blepharoplasty.*** While there is no distinct lateral fat pad in the upper lid, the PAF can have lateral extensions that mimic this appearance. ***The PAF is a critical landmark in eyelid surgery, as it overlies the LA, which must be preserved in blepharoplasty to avoid postoperative ptosis. Do not continue dissection through the eyelid if fat is not identified.***

The levator palpebrae superioris (LPS) muscle is the main retractor of the upper eyelid (**Fig. 31.11**). It is skeletal muscle, under voluntary control, and originates within the orbital apex just above the optic foramen, from the lesser wing of the sphenoid bone, and inserts on the anterior tarsal plate and the orbicularis muscle and skin (to form the eyelid crease). It is innervated by the superior division of the oculomotor nerve (OMN; cranial nerve III) and is composed of a muscular portion measuring 40 mm in length and a tendinous portion (aponeurosis) measuring 14 to 20 mm in length. Whitnall's ligament (the superior transverse ligament) lies at the junction of the muscular and tendinous portions of the levator complex, is partially formed by the fascia of the levator muscle, and inserts medially at the trochlea of the superior oblique tendon and laterally at the lacrimal gland pseudocapsule and frontal bone of the lacrimal sac fossa, 10 mm above Whitnall's tubercle (**Fig. 31.10**). ***Whitnall's ligament, interestingly, does not attach to Whitnall's tubercle.*** The ligament acts as a fulcrum to change direction of the LPS from anterior to posterior to superior and inferior. This allows the levator muscle to function as an eyelid elevator and helps maintain eyelid/globe apposition. As the levator aponeurosis continues inferiorly, it expands to medial and lateral horns. The lateral horn divides the lacrimal gland into orbital and palpebral and inserts on the lateral orbit at Whitnall's tubercle. Some of its fibers contribute to the lateral canthal tendon. The medial horn inserts into the posterior reflection of the medial canthal tendon and posterior lacrimal crest. These horn insertions are important to maintain optimal lid contour. Projections of the distal LA continue anteriorly to the orbicularis muscle and skin to form the eyelid crease (**Fig. 31.11**). With age, the levator aponeurosis tends to attenuate and/or dehisce from its insertion. This leads to the characteristic clinical presentation of ptosis, a hollow sulcus (recessed PAF), and an elevated eyelid crease (levator recession)

The second upper eyelid retractor is Müller's muscle (**Fig. 31.11**). This smooth muscle is responsible for involuntarily lifting the eyelid approximately 2 mm (i.e., during the fight or flight response), is sympathetic innervated, and loosely adheres to the levator aponeurosis anteriorly and tightly connects to the conjunctiva posteriorly. It originates from the undersurface of the levator muscle and inserts onto the superior tarsal plate. In the presence of ptosis, topical phenylephrine drops can be placed in

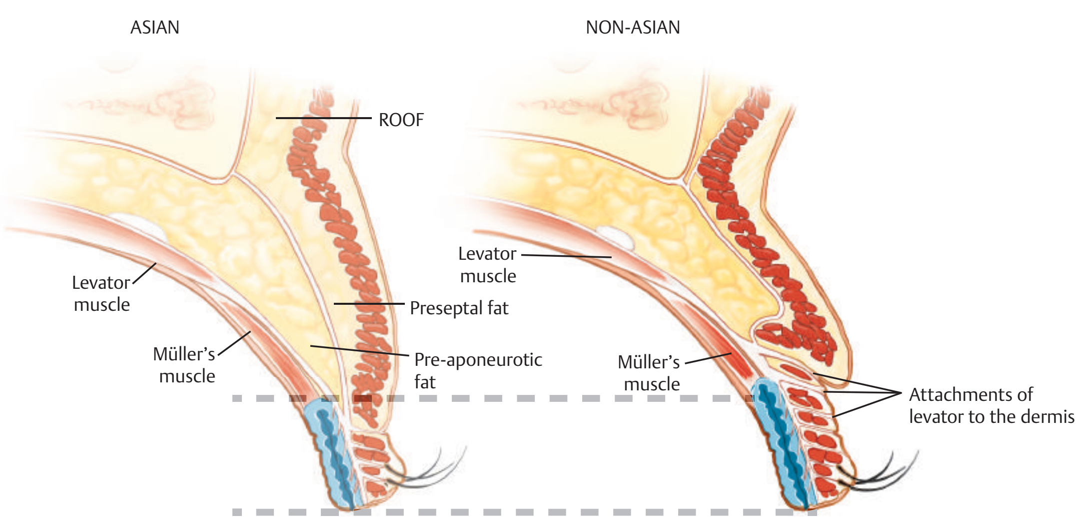


Fig. 31.12 Asian eyelids are fuller than those of non-Asians, as preaponeurotic fat rides lower in the lid and there is a preseptal fat layer, which is continuous with the brow fat pad. Also, note potentially blunted attachments of the levator to the dermis, which can lead to an incomplete or absent crease in many patients.

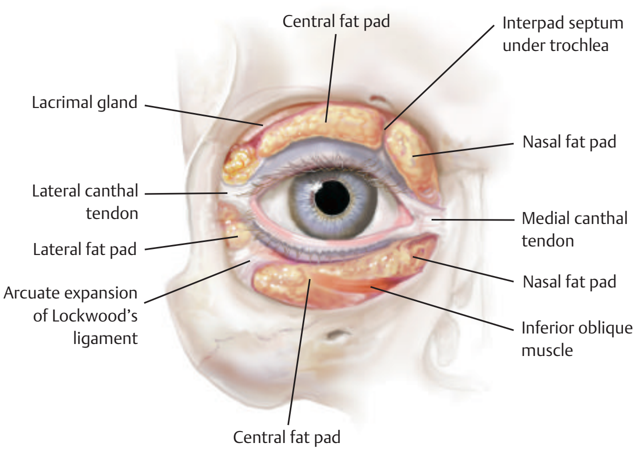


Fig. 31.13 Fat pads of the upper and lower eyelids. The trochlea separates the upper nasal and preaponeurotic fat pad. The inferior oblique separates the nasal and central fat pad of the lower eyelid. The arcuate expansion separates the lateral fat pad of the lower eyelid.

the affected eye to potentially stimulate muscle contraction and accordingly plan posterior approach ptosis repair surgery based on a predetermined algorithm. ***Posterior approach ptosis repair (müllerectomy) requires no patient cooperation and less detailed knowledge of anatomy, is technically easier, and is more consistent and reproducible than levator-dependent ptosis surgery.***

Asian Upper Eyelid Anatomy Variations

It is important to recognize the differences in Asian upper eyelid anatomy (**Fig. 31.12**). Approximately 50% of Asian eyelids have a partial or no eyelid crease. This occurs because the orbital septum can attach lower on the LA. This more inferior attachment of the septum allows PAF to ride lower in the eyelid and potentially blunt the terminal attachments of the LA to the orbicularis muscle and skin. The lower-riding fat is also one of the factors predisposing to fuller eyelid in Asians. The other factor is that in Asians there is a preseptal fat layer in the eyelid, which is a continuation of the brow fat pad (ROOF). In Caucasians the brow fat pad continues into the upper lid as postorbicular fascia. Finally, Asians often have a shorter vertical tarsal height.

31.3.4 Lower Eyelid Anatomy

Lower eyelid anatomy can be more challenging to conceptualize three-dimensionally than the anatomy of its upper lid counterpart. This anatomy often wreaks havoc on novice surgeons, especially when performing surgery transconjunctivally. In addition, lower lid blepharoplasty is fraught with more frequent and potentially disabling functional and aesthetic complications than similar upper lid surgery. Accordingly, familiarization with the complex and delicate nature of lower lid structure is critical to maintain both form and function after surgery (**Fig. 31.11**).

As in the upper eyelid, the anterior lamella of the lower lid consists of skin and orbicularis muscle subdivided into orbital and palpebral (preseptal and pretarsal) segments, and the middle lamella is composed of orbital septum. ***While it can be safe to excise preseptal orbicularis during lower blepharoplasty surgery, care must be taken to preserve the pretarsal orbicularis muscle during this procedure so as to avoid lower eyelid malposition.*** What is different in the lower lid is that the retractors are structured differently and are composed of both the capsulopalpebral fascia (CPF) and the inferior tarsal muscle (ITM). The orbital septum fuses with the retractors approximately 5 mm below the tarsal plate. This fusion point is important when performing transconjunctival blepharoplasty, as it allows both a preseptal and a postseptal surgical dissection plane, depending on where the incision is made (**Fig. 31.14**). ***It has been shown with transconjunctival surgery that both pre- and postseptal surgery lead to a negligible incidence of lower lid malposition. In addition, with the postseptal approach, an incision 6.5 mm below the tarsus has been shown to attain direct fat access in 82% of cases.*** Posterior to the orbital septum are three fat pads: nasal, central, and lateral. The nasal and central

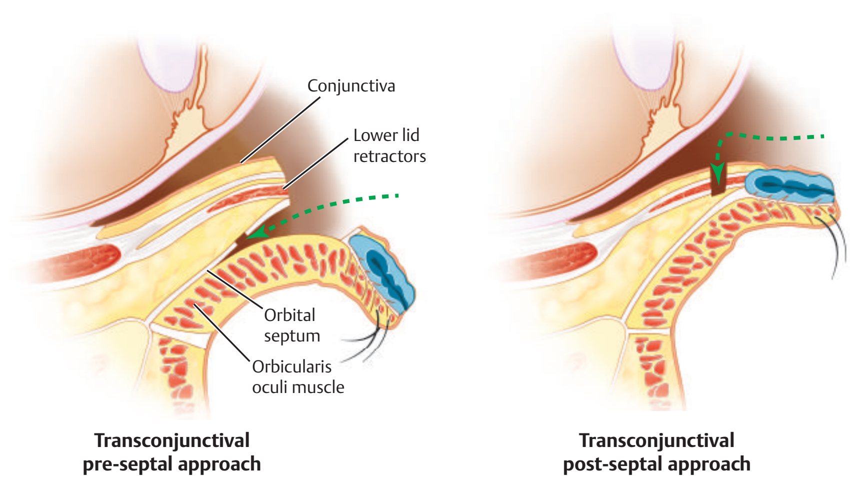


Fig. 31.14 Preseptal versus postseptal transconjunctival blepharoplasty.

fat pads are superficially divided by the inferior oblique muscle (IOM), which originates from the medial orbital floor and courses superolaterally to insert on the posterior aspect of the globe. It is responsible for extorsion, abduction, and elevation of the globe, and iatrogenic trauma to the muscle during blepharoplasty can lead to postoperative diplopia (**Fig. 31.13**).

Like the upper lid, the lower lid also has a suspensory structure, called Lockwood's ligament (**Fig. 31.10**). It functions as a hammock below the globe to support it and prevent its downward displacement. It is attached to the medial and lateral orbit (laterally inserts on Whitnall's tubercle), is a thickening of Tenon's capsule (bulbar sheath) and is intimately associated with both the IR muscle and IOM. The arcuate expansion of Lockwood's ligament is a projection of the ligament that inserts on the inferolateral orbital rim and separates the central and lateral fat compartments of the eyelid (**Fig. 31.13**). Surgically, the nasal and central fat pads typically override the IOM as the muscle arises deep to the orbital rim. Conversely, the central and lateral fat pads do not override the arcuate expansion, which is a more superficial structure. ***Accordingly, during clinical evaluation of a patient for lower blepharoplasty, the nasal and central fat pads appear as one fat pad, while a demarcation is often noted between the central and lateral fat pads. These findings are more pronounced when the patient looks up.*** While the IOM and the arcuate expansion are structural landmarks that separate the lower lid fat pads, these fat pads are continuous, as can be seen when pulling in opposite directions sequentially on the nasal and central fat pad under the IOM. ***This maneuver has been called the "inverse shoeshine sign."***

The posterior lamella of the lower lid is composed of the tarsus and conjunctiva for the first 5 mm below the lashes (where the tarsus ends). Below the level of the tarsus, the posterior lamella consists of the lower eyelid retractors, including the CPF, ITM, and conjunctiva (**Fig. 31.8b**). The lower lid retractors are intimately associated with the conjunctiva. The capsulopalpebral head originates from the fascia of the IR muscle, then envelopes the IOM to become the CPF, which fuses with the orbital septum to insert on the inferior tarsal border. The ITM, similar to Müller's muscle of the upper eyelid, is a sympathetically driven smooth muscle that lies posterior to the CPF. The lower eyelid crease is formed by small fibrous attachments of the CPF to the skin of the lower lid a few millimeters below the tarsus. ***As the lower lid retractors have origins at the IR muscle, strabismus surgery involving the IR muscle can change eyelid position.***

31.3.5 Neurovascular Supply of the Eyelids

Arterial Supply

The arterial supply of the eyelids is derived from both the internal carotid artery (ICA) and the external carotid artery (ECA). The ophthalmic artery (OA), the first branch of the ICA, gives off multiple orbital branches including the lacrimal and supraorbital arteries. These terminal branches primarily contribute to the marginal and peripheral arcades of the eyelids. In the upper eyelid, the marginal arterial arcade lies 2 mm superior to the eyelid margin and anterior to the tarsal plate. The peripheral marginal arcade lies superior to the tarsus between the levator aponeurosis and Müller's muscle. In the lower eyelid, there is only one arterial arcade, which is located at the inferior tarsal border. From the ECA the STA gives off three branches that contribute to eyelid arterial blood supply. These include the frontal branch, which communicates with both the lacrimal and supraorbital arteries; a zygomatico-orbital branch, which in part supplies the upper lid; and a transverse facial branch, which anastomoses with the infraorbital arteries supplying the lower lids. Finally, the infraorbital artery (a branch of the internal maxillary artery, from ECA) provides a rich arterial supply to the peripheral lower lid. ***It is important to understand the varied communication of the ICA and ECA. These connections provide potential access of facial injections of filler, fat, or particulate material into the ICA circulation via retrograde flow with injection pressure. The subsequent antegrade flow to the ophthalmic artery, when injection pressure is released, can lead to blindness via infarction of arterial branches to the anterior and posterior optic nerve or retinal circulation.*** Refer to **Fig. 31.15** for vascular supply of the eyelids.

Venous and Lymphatic Drainage-

The venous drainage of the eyelids is divided into pretarsal and posttarsal components. The pretarsal tissue drains into the angular veins medially and the superficial temporal vein laterally. The posttarsal drainage is into the orbital veins and the deeper branches of the anterior facial vein and pterygoid plexus. Lymphatic vessels that serve the medial eyelid drain into the submandibular lymph nodes, while those serving the lateral portions of the eyelids drain first into the superficial preauricular nodes and then into the deeper cervical nodes.

Eyelid Innervation

Motor eyelid innervation is supplied by branches of the facial nerve (FN; cranial nerve VII), the OMN (cranial nerve III), and sympathetic nerve fibers. The OMN and sympathetic fibers are responsible for eyelid retraction (opening), while the FN is responsible for eyelid protraction (closing). The superior branch of the OMN innervates the main upper eyelid retractor, the levator palpebrae superioris. Sympathetic nerve fibers innervate the ancillary eyelid retractors, including Müller's muscle of the upper eyelid and the ITM of the lower eyelid. First-order neurons of the sympathetic pathway begin centrally at the hypothalamus and descend caudally to the cervical spinal cord. Second-order neurons exit the cervical cord and travel with the brachial plexus as part of the cervical sympathetic chain and synapse in the superior cervical ganglion. Third-order neurons leave the superior cervical ganglion and travel into the cranium, entering in proximity to the internal carotid artery (internal carotid nerve), after which they enter the orbit with the optic nerve and ophthalmic artery through the optic foramen. Disruption of the sympathetic pathway can lead to Horner's syndrome, which presents with a combination of the classic findings of ptosis, miosis, and anhidrosis.

Eyelid protraction is controlled by various branches of the FN, including the frontal, zygomatic, and buccal branches. The frontal branch innervates the upper eyelid orbicularis, while the lower lid orbicularis is innervated by both the zygomatic and buccal branches. ***Recent cadaveric dissections have demonstrated that***

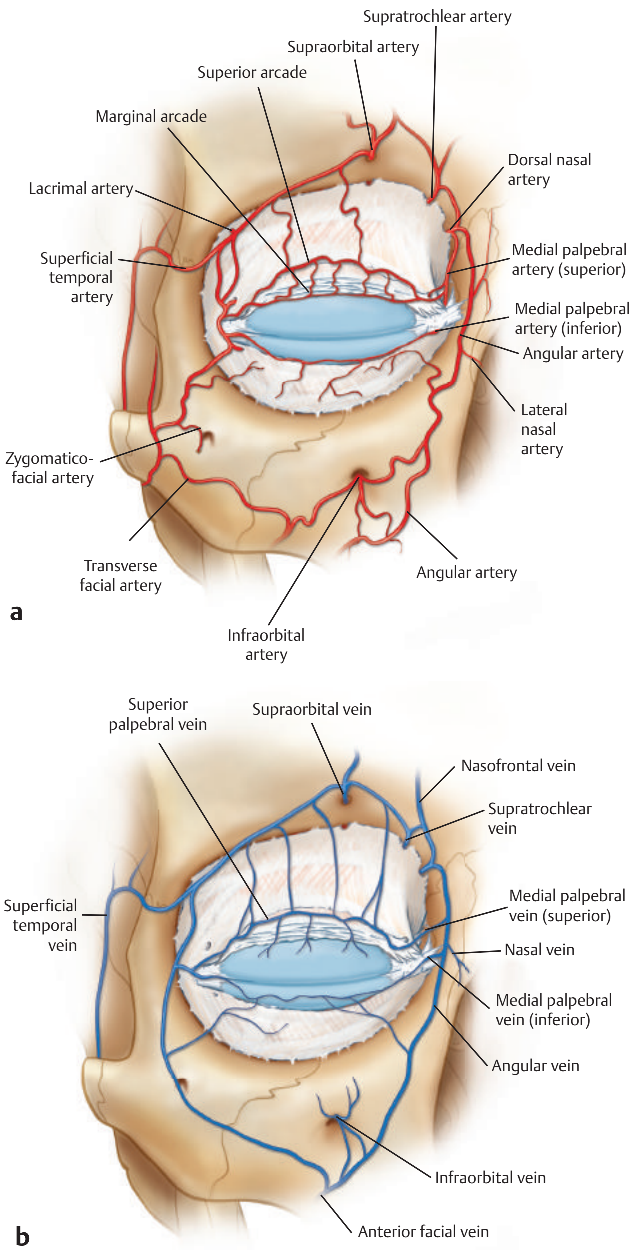


Fig. 31.15 **(a)** Arterial and **(b)** venous supply of the eyelid.

the lower orbicularis is not innervated by multiple vertically oriented motor nerve fibers as had been thought. In fact, it was shown that these vertical fibers emerge from the infraorbital foramen, indicating that they are sensory nerves. Furthermore, it has been shown that the zygomatic branch of the facial nerve, with buccal branch contribution, travels obliquely through the anterior cheek and supplies the orbicularis oculi of the lower eyelid and the medial portion of the upper eyelid.

Sensory innervation to the eyelids is supplied by the ophthalmic (V_1) and maxillary (V_2) divisions of the trigeminal nerve. Terminal branches of V_1 that innervate the upper eyelid include the lacrimal, supraorbital, and supratrochlear nerves from lateral to medial. Similarly, in the lower lid, sensory branches emerge from V_2 and include the zygomaticofacial and infraorbital nerves, lateral to medial (**Fig. 31.16**).

31.4 Midface Anatomy

The midface, which transitions from the lower eyelid at the infraorbital rim, completes the middle third of the face. It has been traditionally bounded superiorly by the lid–cheek junction and inferiorly by a line from the inferior tragus to the oral commissure. It is also divided into a lateral and more central anterior compartment by a line from the lateral canthus to the oral commissure. This lateral/central division has anatomic and clinical relevance, as laterally the five tissue layers of the face are thin and functionally fused over the muscles of mastication; thus, there is little facial expression in this location. In the central (anterior) midface, by contrast, the five tissue layers are robust and act in consort to convey facial expression.

The layers of the midface are the same as in other regions of the face and include the following (**Fig. 31.17**):

1. Skin
2. Subcutaneous tissue
3. A fibrous layer investing the muscle of facial expression: the superficial musculoaponeurotic system (SMAS)
4. A loose areolar tissue plane
5. Periosteum or deep fascia

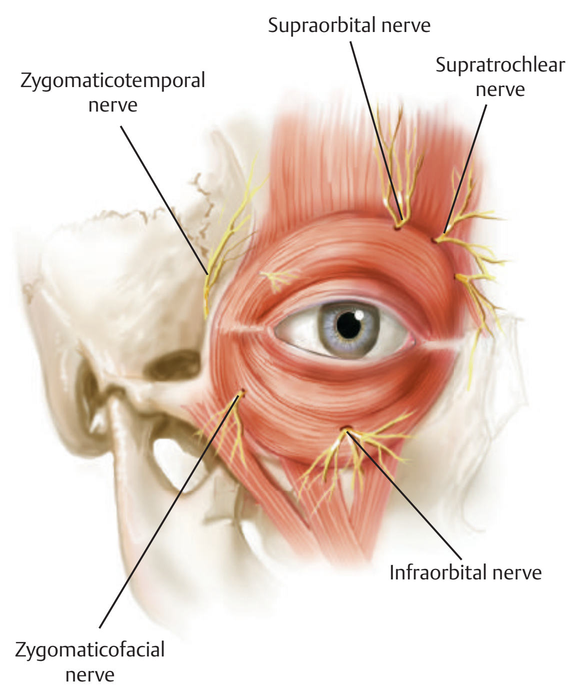


Fig. 31.16 Sensory innervation to the eyelids.

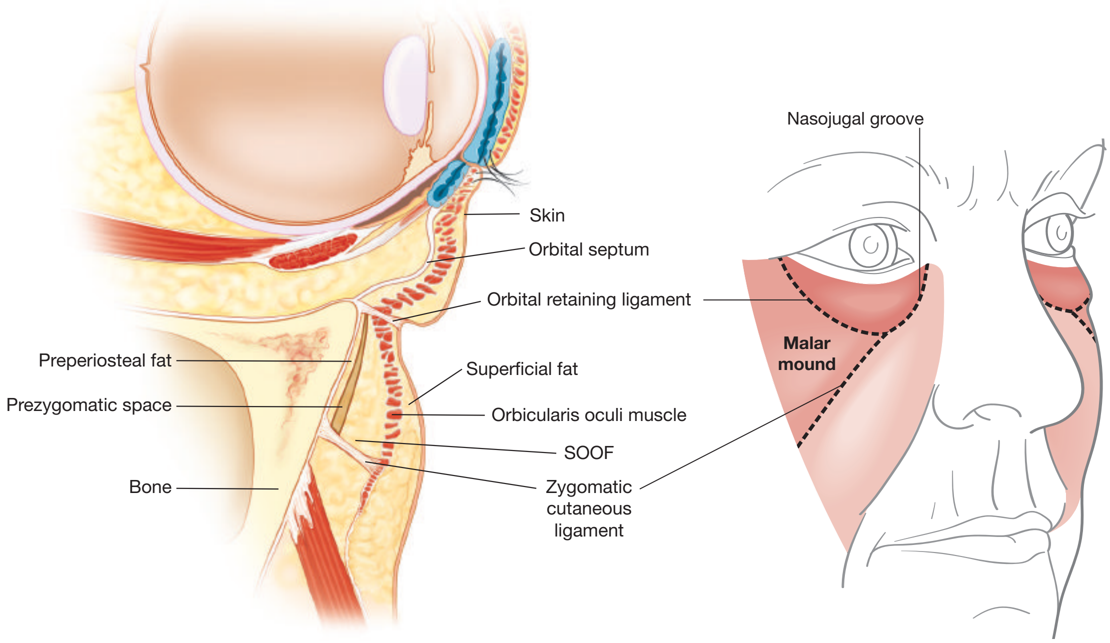


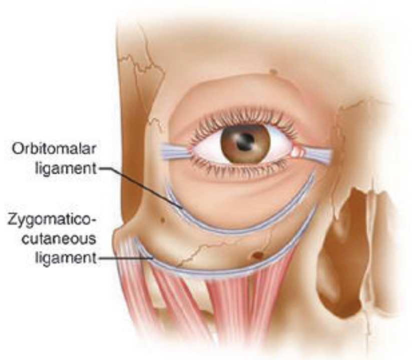
Fig. 31.17 Layers of the midface from skin to periosteum with associated grooves and mounds which develop with age.

As stated, in the lateral midface, all tissue layers are essentially fused. Accordingly, they cumulatively act as one structural retaining ligament. In the anterior midface, there are three prominent ligamentous attachments, which traverse all five facial tissue layers (deep fascia to dermis) to support the dynamic midfacial soft tissue in this location. These include the orbicularis retaining ligament (ORL), the zygomaticocutaneous ligament (ZCL), and the masseteric ligament (**Fig. 31.17**, **Fig. 31.18**). Critical to eyelid and midfacial aging changes are the ORL and ZCL. At the medial lower lid/cheek junction, there is a dense attachment of orbicularis fibers to the upper maxilla. This is a true ligament, which has been called the tear trough ligament. With age, a multitude of factors, including volume loss, orbital septal attenuation, and midface ptosis, create a topographic depression over this area, which has been called the tear trough or nasojugal groove (**Fig. 31.17**, **Fig. 31.18**). At the midpupil the ligamentous attachment of the inferior orbital rim to the dermis becomes less dense and longer as it traverses thicker tissue planes including fat. At this point the ligament is called the ORL, and its associated age-related depression above the orbito- or palpebromalar groove. In combination, the nasal-to-lateral age-related lid–cheek depression is often referred to as a prominent “lid–cheek junction” (**Fig. 31.19**). ***Effacement of periorbital hollows, including the tear trough, has been attempted by filling with synthetic materials, autologous fat or allografts, native fat transposition, and a variety of tissue lifting techniques. Familiarization with lower eyelid and midface anatomy is critical to attaining successful results and avoiding sometimes permanent complications with these innervations.***

The ZCL, like the ORL, is an osteocutaneous ligament that originates from the periosteum of the zygoma and/or the anterior and lateral border of the zygomatic arch (posterior to the origin of the zygomaticus minor muscle) and insets into the dermis of the cheek. As with the lid–cheek junction, age-related volume loss and tissue descent lead to a characteristic groove (malar groove) overlying the ligament, with tissue bulges or bags around the groove (malar mound, **Fig. 31.17**, **Fig. 31.19**). As a general rule, potential spaces are present in the loose areolar plane of the anterior midface, and these spaces are bounded by the ligaments described. These spaces are glide planes between the muscles of facial expression above (within the SMAS) and the periosteum or deep fascia below. These glide planes allow the facial soft tissue to move freely over fixed tissue. ***With age, differential laxity occurs between these spaces and their accompanying ligament-supported boundaries. These differences account for much of what we see in facial aging (bags and depressions).***

Volume is an essential part of midface structure. Much of this volume is attained from the midface fat pads. These fat pads are critical to facial shape and appearance, involute with age in a nonuniform way, and are target sites for facial volumization with synthetic fillers or autologous fat. These fat pads can be divided into two groups. The first is subcutaneous or superficial in depth and above the SMAS, while the second is deep and sub-SMAS in location. The superficial fat has nasolabial, medial, middle, and lateral temporal compartments. The deep fat is divided into the sub–orbicularis oculi fat (SOOF), which has both a medial and lateral segment; a deep medial cheek fat, also with a medial and lateral segment; and a deeper medial fat in a location called Ristow’s space (lateral to piriform aperture, medial to deep medial fat).

The midface musculature functions to elevate the lip and the corner of the mouth. These include the levator labii superioris



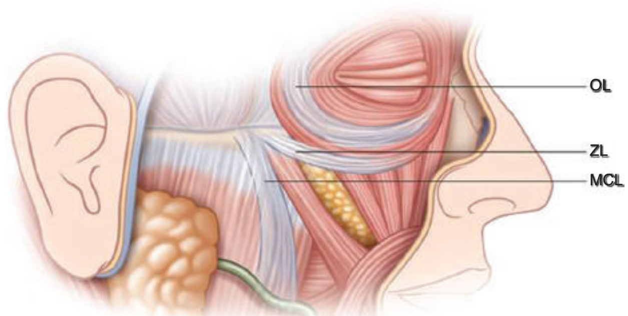


Fig. 31.18 Osseocutaneous ligaments of the midface. OL, orbicularis retaining ligament (ORL in text); ZL, zygomaticocutaneous ligament (ZCL in text); MCL, masseteric ligament.

(LLS), levator labii superioris alaeque nasi (LLSAN), and the levator anguli oris (LAO) medially, and the zygomaticus major (ZM) and minor (Zm) laterally. The LLS originates on the medial inferior orbital rim, courses over the infraorbital foramen to insert on the orbicularis oris, and functions to elevate the lip vertically. The LLSAN originates on the frontal process of the maxilla course inferiorly and splits into a medial and lateral head, inserting onto the skin of the lateral nostril and upper lip. It functions to flare the nostril and raise the lip. The LAO originates 1 cm below the infraorbital foramen and inserts on the modiolus and outer edge of the lip. It functions to elevate the angle of the mouth. The ZM originates at the zygomatic arch, inserts on the modiolus of the mouth, and serves to move the lip laterally and vertically. Finally, the Zm originates on the maxillary process of the zygoma, inserts on the lip just lateral to the LLS, and also functions as a lip elevator.

31.4.1 Innervation

All midface muscles described above are primarily innervated by the buccal branch of the facial nerve, with some overlap with the zygomatic branch (**Fig. 31.20**). Damage to the facial nerve with subsequent aesthetic and functional impairment has been a major concern to surgeons operating in the midface. For this reason, subperiosteal midface lifts gained popularity as to avoid neuroinjury. However, in the midface, the facial nerve branches run outside the walls of the glide planes described near the retaining ligaments. Accordingly, surgical dissection is safe with appropriate knowledge of anatomy. The sensory innervation

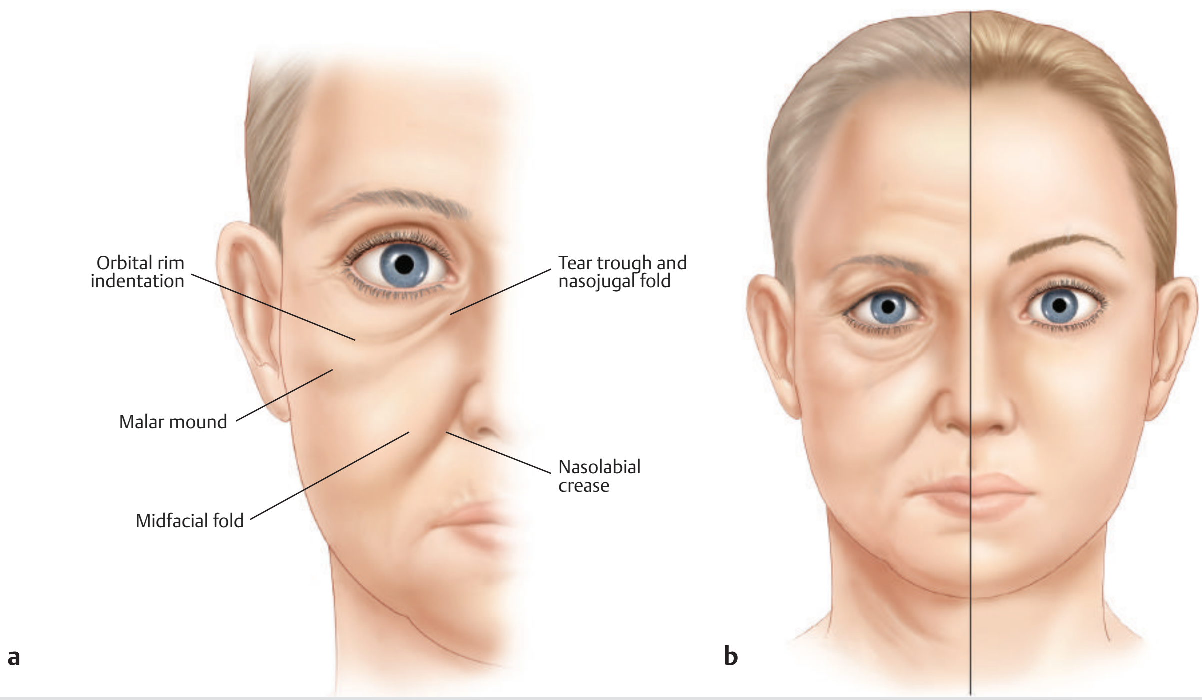


Fig. 31.19 Common aging changes in the periorbital and midface region. **(a)** The aged face with associated changes. **(b)** The youthful face.

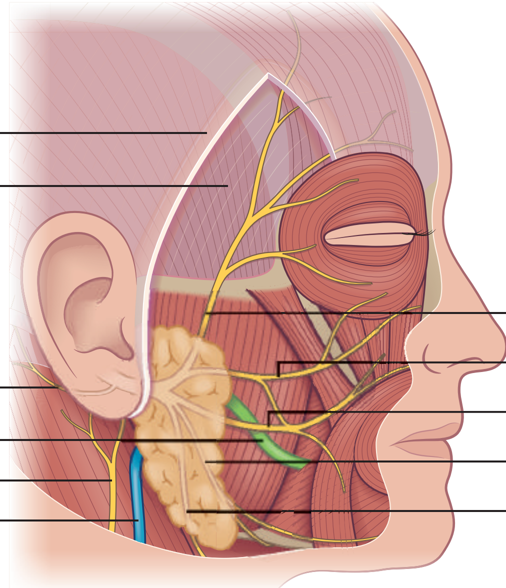


Fig. 31.20 Illustration of the facial anatomy, including motor innervation of the midface via the zygomatic and buccal branches of the facial nerve.

of the midface is from the maxillary division of the trigeminal nerve (V_2) via its infraorbital and zygomaticofacial branches.

31.4.2 Vasculature

The arterial supply of the midface is primarily from the ECA via its terminal branches, including the infraorbital artery (from the maxillary branch) and transverse facial artery (from the STA). There is also a small contribution from the ICA through its zygomaticofacial branch.

31.4.3 Venous and Lymphatic Drainage

The venous drainage of the midface is via the inferior ophthalmic vein into the pterygoid plexus and from various facial veins that drain into the external jugular vein. The lymphatic drainage can be variable, with medial drainage to the submental and submandibular nodes and lateral midface drainage to the preauricular nodes.

31.5 Concluding Thoughts

As can be gleaned from reading this chapter, the anatomy of the forehead, temples, eyelids, and midface are intimately associated and transition in a characteristic way from one structure to the next. Understanding these interrelationships provides the critical foundation necessary to proceed to sound surgical interventions. It can be difficult for the novice surgeon to appreciate the anatomy described three-dimensionally. It is highly recommended that this text, and others like it, solely serve as guides to a more thorough comprehension that can be attained in dissections courses and anatomy labs.

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Management of Postblepharoplasty Lower Eyelid Retraction

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KEYWORDS

• Blepharoplasty • Lower eyelid retraction • Lower eyelid malposition • Lower eyelid ectropion • Eyelid scar • Eyelid laxity • Eyelid volume

KEY POINTS

- Postblepharoplasty lower eyelid retraction (PBLER) is a challenging and multifactorial problem that primarily occurs after transcutaneous lower eyelid blepharoplasty.
- Identifying eyelid and periorbital deficits that underlie this eyelid malposition is critical to successful treatment.
- A more contemporary understanding of how volume loss, eyelid/cheek topography, and orbicularis deficit contribute to PBLER offers additional insights into the problem and other potential modalities of intervention.
- Surgical success depends on patient education, modulating expectations, sound surgical technique, and detailed attention to postoperative care.
- The psychological impacts of this complication are enormous, and patients require significant time and attention by physician and staff.

INTRODUCTION

Postblepharoplasty lower eyelid retraction (PBLER) is a multifactorial eyelid malposition that often leads to functional impairment, significant aesthetic deficit, and psychological trauma.[1,2] Its surgical correction is technically difficult, and lasting surgical outcomes require specialized training, a unique skill set, and the ability to manage postoperative tissue biology, including tissue contraction and wound healing. Clearly, this is a daunting task that should only be undertaken by those who will commit the time and energy necessary to allow the best and most consistent and reliable results from this procedure. In the view of the senior author (GGM), who manages these patients routinely, assuming the responsibility of these patients can be physically, mentally, and psychologically stressful for both patient and surgeon. It is critical to keep this in mind when deciding to intervene in these cases because a good outcome only occurs when the patient is happy, and attaining this end is often difficult.

Traditional thought regarding the etiologic factors of PBLER is that it is related to transcutaneous (open-approach) surgery (reported in as high as 6%–20% of these cases)[3] and that it is associated

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with 3 principal deficits: (1) unaddressed eyelid laxity, (2) anterior lamellar (skin or muscle) shortage, and (3) middle lamellar (orbital septal) scar.[4–7] Webster and colleagues[6] were the first to recommend canthal suspension (CS) as a preventative measure for PBLER after transcutaneous surgery. Since then, CS (whether a canthoplasty or a canthopexy) has become a mainstay in open-approach lower blepharoplasty and most assuredly has, to a degree, reduced the incidence of PBLER.[8–12] Until the 1980s, surgical correction of PBLER typically involved skin grafting, scar lysis as needed, and CS. Unacceptable scarring from skin grafts led to the development of an alternative means of adding skin to the lower eyelids, that being the recruitment of skin from below via transeyelid midface lifting.[1,4,7,13,14] In addition to skin recruitment, posterior lamellar spacer grafts were added to address the middle lamellar scar[14–17] and an open CS to support and secure the lower eyelid.[12,18–20] For the purposes of this article, this combination of midface lifting, spacer grafts, and CS (MSC) will be referred to as standard surgery. After MSC, the lower eyelid is typically put on stretch with some variant of tarsorrhaphy for the first 1 to 2 weeks postoperatively to help prevent wound contracture and maintain lower eyelid position.[1,13,17] Although many modifications of this approach have been reported, the initial descriptions by Shorr and colleagues of the modification known as the Madame Butterfly procedure are really the fuel that fed the engine of transeyelid midface lifting for correction of PBLER as it is known today.[1,13,17,21] The problem with this surgery is that, although it has consistently led to variable degrees of improvement in form and function, patient satisfaction has never formally been studied in an evidence-based manner.

In data gathered by the senior author (GGM; unpublished), patient satisfaction (40% by direct questioning) is significantly lower than surgeon satisfaction (80% by blinded assessment of patient photographs of outcome).[22] The authors believe surgeon satisfaction is high because lower eyelid position typically improves (surgeon's goal). However, patients must be heard and it is common for patients who have had MSC to complain of (1) an abnormal canthal appearance, (2) a shortened horizontal eyelid aperture, (3) hollowed lower lids, and (4) an ill-defined canthal and eyelid discomfort.[1] Number 4 is a real problem because corrective surgery may change form and structure; however, it is very hard to correct a feeling or sensation, especially when it is so difficult to describe. This led the senior author to study MSC outcomes in depth.[21] The findings will be described, and suggestions of alternative paradigms that may simplify surgical intervention and recovery, and improve patient satisfaction, are suggested. However, the focus of this article is detailing the typical presentation of patients with PBLER and reviewing the steps and pearls of MSC.

PREOPERATIVE EVALUATION

Patients presenting with PBLER have a wide spectrum of findings, which will dictate the appropriate intervention. As stated, traditional thought with this deficit is that it is related to anterior lamellar shortage, a middle lamellar scar, and unaddressed eyelid laxity.[4–7] In line with this, the standard surgical intervention since the 1980s has been MSC. One of the authors (GGM) has studied patients with PBLER in detail and has identified that orbicularis weakness, a negative vector globe/midface morphology (prominent eye or negative vector eyelid), and a volume-depleted inferior orbit/lower eyelid are common findings in patients with PBLER that are unaddressed by standard surgery.[21] Also, as stated in a presentation at the annual American Society of Ophthalmic Plastic and Reconstructive Surgery scientific symposia in 2013,[22] the same author (GGM) demonstrated that patient satisfaction with MSC was significantly less that surgeon satisfaction (40% vs 80%). Why this discrepancy? It is possible that performing standard surgery on all patients, which has been the accepted standard, is a flawed approach?[1] Can alternative treatments, based on other findings not addressed by standard surgery, narrow the gap between patient and surgeon satisfaction?[1] These are excellent questions, which the authors continue to evaluate.

Although standard surgery is appropriate in many patients, when the findings suggest a primary deficit in volume, or topographic disparity of the globe and midface, filler injections are often enough and have yielded high patient satisfaction (**Fig. 1**).[1] Also, when orbicularis weakness predominates, performing orbicularis sparing or preserving surgery has shown to be beneficial and again has yielded high patient satisfaction (**Fig. 2**).[23] In some patients who have failed previous attempts at midface lifting, or when topography or skin shortage is pervasive, skin grafting still has role in surgical correction (**Fig. 3**). Scarring after such surgery may be mitigated by injections of the antimetabolite 5-fluorouracil (5FU).[24] Harvesting of skin from the supraclavicular area with appropriate thinning of subcutaneous tissue has shown to be effective in enhancing donor match and transition to lower lid skin.[1,24] Finally, in patients with true or relative globe prominence

Fig. 1. A 36-year-old woman who presented with bilateral lower eyelid retraction 7 months following transcutaneous lower eyelid blepharoplasty (*left*). Note her improved lower eyelid position 3 months after lower eyelid volume augmentation (*right*). She was very satisfied with the outcome. (*From* Griffin G, Azizzadeh BA, Massry GG. New Insights into Physical Findings Associated with Post Blepharoplasty Lower Eyelid Retraction. *Aesth Surg J* 2014;34:995-1004; with permission.)

and in those with orbicularis deficit, orbital decompression by itself, or as an adjunct to MSC, has shown promise in helping to correct lower lid retraction in Graves' disease patients and also in patients with PBLER (**Fig. 4**).[25,26] The authors refer to this as orbital surgical vector correction. By setting the globe back, the vector discrepancy is reduced and a compromised orbicularis works less to maintain eyelid position. This is very specialized surgery that should only be addressed with a surgeon well-versed in decompression surgery. Because discussion of these alternate interventions can be a separate article within itself, please refer to references for detailed descriptions of each.[1,23–27]

PBLER presents with the characteristic findings of retracted (pulled down) lower lids, scleral show (sclera noted between inferior iris and lower lid margin), and rounded lateral canthi.[1,21] Typical ancillary findings include a shortened horizontal palpebral fissure without animation[1] and fishmouthing (medial displacement of the lateral canthus) with attempted eyelid closure.[1,21]

Fig. 2. A woman in her 70s developed bilateral lower eyelid retraction following transcutaneous lower blepharoplasty (*left*). Postoperative photograph 1 year after a minimally invasive orbicularis-sparing (MIOS) lower eyelid recession procedure demonstrating improved lower eyelid position (*right*). (*From* Yoo DB, Griffin GR, Azizzadeh BA, Massry GG. The Minimally Invasive Orbicularis Sparing "MIOS" Lower Eyelid Recession Procedure for Mild to Moderate Lower Lid Retraction with Reduced Orbicularis Strength. *JAMA Facial Plast Surg.2014*;16(2):140-146.)

Fishmouthing is related to poor lateral canthal fixation and leads to a biomechanical limitation of eyelid closure.[1,28,29] To best assess PBLER, a basis of understanding of normal native lower eyelid position is essential. The lower eyelids are anchored by the canthal tendons medially and laterally, and supported from below by eyelid or orbital fat and the bony and soft tissue projection of the midface. Anteriorly, the lower lid is supported by the dynamic sphincteric function of the orbicularis muscle, and by having an adequate amount of vertical eyelid skin to span the cheek to the lower eyelid margin.[12,19–21] When any of these parameters is negatively affected, eyelid retraction can occur. The authors use a standard examination protocol for patients with PBLER. This includes identifying the presence and degree of 6 potential distinct deficits.[21] The following sections list these problems and how their presence is evaluated. Also, the percentage of occurrence of these findings on examination has been studied by the authors,[21] and their experience is elaborated for each.

Orbicularis Strength

To test orbicularis strength, the patient is asked to close their eye forcefully. In the normal setting, the examiner should not be able to pry the lid open. If the examiner can, then orbicularis weakness is present. This can be subjectively graded on a 1+ (minimal) to 4+ (maximal) scale. Orbicularis deficit occurs in 86% of eyelids (**Fig. 5**A, B).[21]

Internal Eyelid Scar

Internal eyelid scar is assessed with the forced traction test (FTT). With the patient looking up, the lower eyelid is pushed superiorly. It should move freely to the upper lid. If there is more than mild restriction of superior lid excursion, the test is positive and can signify an internal eyelid scar (**Fig. 5**C, D). Anterior lamellar shortage can also limit excursion, so the deficit must be out of proportion to skin shortage. This can be differentiated by elevating the cheek and then performing the FTT. The cheek elevation will eliminate the anterior lamellae deficit by recruitment of skin from below. The authors refer to this maneuver as the FFT2 (**Fig. 6**). An internal eyelid scar of clinical significance occurs in 17% of eyelids.[21] Of note, the authors use the term internal eyelid scar as opposed to the traditional middle lamellar scar because the middle lamella refers to the orbital septum. It has been recently shown that orbital septal violation, in and of itself, does not lead to eyelid scars of clinical significance.[30] Instead, a mixed skin, muscle, and septal scars are most likely the culprits.

Fig. 3. Two women in their 60s underwent skin grafting procedures to their left lower eyelids for lower eyelid retraction after transcutaneous blepharoplasty; preoperative (*left top* and *bottom*). The first patient's (*top row*) donor site was the same-side upper eyelid. The second patient's (*bottom row*) donor site was the supraclavicular area. Just before removing skin graft sutures at 1 week (*top middle*). Two weeks postoperative, with sutures removed (*bottom middle*). The final postoperative outcome at 9 months (*right top* and *bottom*). (*From* Yoo DB, Azizzadeh BA, Massry GG. Injectable 5FU With or Without Added Steroid in Periorbital Skin Grafting: Initial Observations. *Opthal Plast Reconst Surg.* 2015;31:122-26; with permission.)

Anterior Lamellar (Skin or Muscle) Shortage

Anterior lamellar shortage is tested by having the patient look up and open their mouth. If increased retraction or frank ectropion develops, tissue shortage exists. This can also be graded on a similar 1 + to 4 + subjective scale by the examiner. Anterior lamella shortage was found in 79% of eyelids (**Fig. 7**A, B).[21]

Volume Loss to Inferior Orbit or Eyelid

Volume loss to the inferior orbit or the eyelid is evaluated subjectively by observing significant hollowing (concavity) of the inferior eyelid. This occurs in 70% of eyelids (**Fig. 7**C, D).[21]

Fig. 4. A 57-year-old woman developed severe post-blepharoplasty lower eyelid retraction after transcutaneous blepharoplasty. She underwent several lower eyelid and canthal revisional procedures without improvement (*left*). After bilateral orbital decompression combined with standard MSC surgery, she attained an excellent result 10 months postoperative (*right*).

Negative Vector Topography of Globe to Cheek (Negative Vector Eyelid)

The patient is evaluated in sagittal view. If the tip of the cornea project more anteriorly than the midface, a negative vector eyelid is present. This occurs in 65% of eyelids (**Fig. 7**E, F).[21]

Eyelid Laxity

Eyelid laxity is evaluated by eyelid snap and distraction testing. In the snap test, the lower lid is pulled inferiorly by the examiner and then released (**Fig. 8**A). The eyelid should return to its native position quickly and without blink. If this does not occur the test is abnormal (positive snap). In the distraction test, the lower lid is pulled away from the globe (**Fig. 8**B). If the eyelid can be pulled 8 mm or more from the cornea, then the test is abnormal (positive). Both tests evaluate eyelid laxity, with the snap test more a measure of orbicularis tone and the distraction test more a measure of canthal tendon integrity. Eyelid laxity occurs in 62% of eyelids.[21]

It is important to know that PBLER is rarely caused by 1 deficit in isolation. In the authors' study, most patients had 4 to 5 obvious deficits, and there was a direct correlation of number of deficits and amount of eyelid retraction.[21] Therefore, even with its limitation noted (patient satisfaction), most of the authors' patients still undergo standard MSC surgery (because it addresses 3

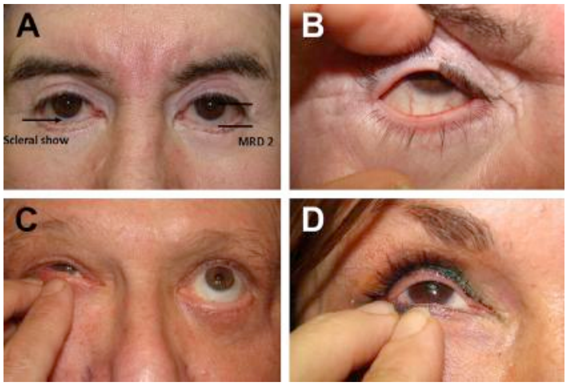

Fig. 5. (*A*) This 52-year-old man presented with bilateral lower eyelid retraction following lower eyelid transcutaneous blepharoplasty. Note the bilateral inferior scleral show. The marginal reflex distance (MRD)2 is the measured distance (mm) between the cornea light reflex and the central lower eyelid margin. (*B*) The eyelid is opened by the examiner on attempted forceful closure of the eyelid by the patient, demonstrating significant orbicularis weakness. (*C*) A 64-year-old man presented with lower eyelid retraction after transcutaneous lower blepharoplasty with minimally limited forced eyelid elevation. Internal eyelid scarring (which will limit forced eyelid elevation) is assessed by the forced eyelid traction test (FTT) in which the lower eyelid is displaced superiorly by the examiner. (*D*) A 68-year-old woman presented with lower eyelid retraction 9 months following transcutaneous lower blepharoplasty. Note moderate amount of reduced forced eyelid elevation. (*From* Griffin G, Azizzadeh BA, Massry GG. New Insights into Physical Findings Associated with Post Blepharoplasty Lower Eyelid Retraction. *Aesth Surg J* 2014;34:995-1004; with permission.)

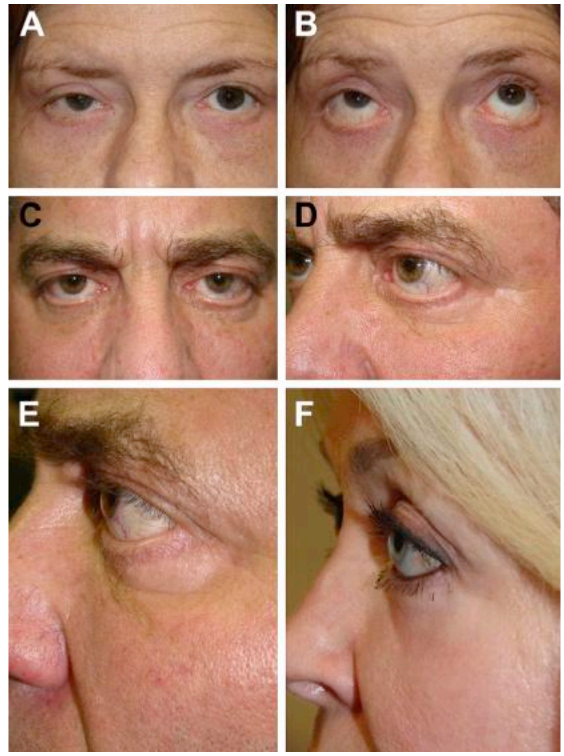

Fig. 7. (*A, B*) This 57-year-old woman presented after transcutaneous lower blepharoplasty. A skin deficit was evident in **Fig. 7**B when she looked upward with her mouth ajar (note lower eyelids pull down further). (*C, D*) This 56-year-old man with lower eyelid retraction after transcutaneous lower blepharoplasty demonstrates inferior eyelid/orbit volume deficit. (*E*) The same patient in 7D showing negative vector eyelid configuration. (*F*) A 62-year-old woman with a similar history as patient 7 C, D, E also has a negative-vector eyelid configuration. (*From* Griffin G, Azizzadeh BA, Massry GG. New Insights into Physical Findings Associated with Post Blepharoplasty Lower Eyelid Retraction. *Aesth Surg J* 2014;34:995-1004; with permission.)

critical issues). Before surgery, however, all patients are counseled about the expected outcome and how this outcome is perceived by patients in terms of satisfaction. Mitigating expectations realistically has increased postoperative success greatly.[1] When the primary dominant examination findings are volume loss, vector discrepancy, and/or orbicularis deficit, the alternate interventions previously noted are suggested as first-line treatment. Also, although posterior spacer grafts have been a mainstay of standard MSC surgery, the authors have used them less frequently over the last 5 years. Only 17% of patients in the authors' previous evaluation of PBLER patients had an internal eyelid scar of clinical significance,[21] which was much less than anticipated. In the past, this has been a primary indication for using eyelid spacers. However, the authors think spacer grafts likely also improve eyelid contour, potentially add eyelid volume, and are useful in posterior lamellar lengthening in cases of prominent eyes.[31,32] For these reasons, the authors still use

Fig. 6. A woman in her 70s has a FTT (*left*), which is limited (positive). Besides an internal eyelid scar, this can be related to anterior lamellar deficit. This can be identified when the cheek is lifted to recruit skin from below and then forcibly lifting the eyelid (*right*). The authors refer to this as the FFT2. If the FTT is positive (limited eyelid elevation) and the FTT2 is negative (lower eyelid displaces superiorly) then the deficit is primarily anterior lamellar. In many cases there is a mixed picture.

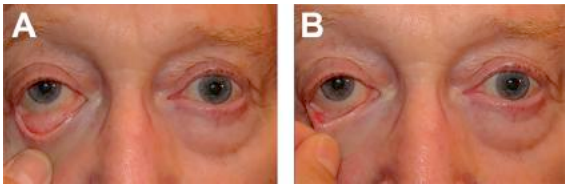

Fig. 8. (*A*) The snap-back test: the lower eyelid is pulled inferiorly and away from the globe. If the eyelid does not snap back to its normal position without blink, the test is positive and eyelid laxity is present. (*B*) The eyelid distraction test: the lower eyelid is pulled away from the globe. If the distance created between the eyelid and globe is 8 mm or more, this signifies eyelid laxity. (*From* Kossler A, Massry G. The Spectrum of Canthal Suspension Techniques in Lower Blepharoplasty. In: Azizadeh B, Murphy M, Johnson C, Massry G, Fitzgerald. *Master Techniques in Facial Rejuvenation.* Elsevier, New York, NY, 2018:152-165.)

spacer grafts frequently. Finally, in the setting of PBLER, before any intervention ocular health is considered, special attention given to vision, the integrity of the cornea, and control of exposure symptoms. It is best to refer to an ophthalmologist to manage symptoms, optimize eye health, and clear the eyes for surgery.

SURGERY (STANDARD MIDFACE LIFTING, SPACER GRAFTS, AND CANTHAL SUSPENSION)

Most surgeries are performed under general anesthesia, especially if a palate graft is harvested. The procedure described is for 1 eyelid; however, surgery is performed bilaterally as dictated by the physical findings on examination. Often, in bilateral cases, we add a temporal brow lift (our preference is an endoscopic approach). In our experience, this alleviates the canthal bunching that can occur in the first 2 to 3 months postoperatively. It also aesthetically smooths the transition between the cheek, lateral eyelid, and temple. In this setting, the temporal brow is addressed (as has been discussed preciously).[33,34] The CS is typically performed in an open fashion, which is described. Less frequently, a closed CS is performed. Please refer to references of this procedure for description.[35–37]

The canthus, lower eyelid, and midface are anesthetized with 3 mL of 1% xylocaine with 1:100:000 epinephrine. Next, a canthotomy and cantholysis are performed. A subtarsal incision is made the full width of the lower eyelid through both the conjunctiva and lower eyelid retractors. These tissues are engaged with a 4-0 silk traction suture, which is secured to the head drape. A Desmarres retractor is placed to displace the lower lid inferiorly. Blunt cotton-tip dissection ensues in the postorbicularis fascial plane to the orbital rim. In these reoperations, this is often a scarred plane. The Desmarres retractor can be used to sweep the surgical plane inferiorly to aid in dissection. If blunt dissection is not possible (eg, in the setting of severe scar), the Desmarres retractor is elevated, which pulls the lower eyelid up, placing the surgical plane on stretch, and an electrocautery unit or a Stevens scissors is used to dissect between the orbicularis muscle and a true or pseudo orbital septum to the orbital rim. The orbital rim should be isolated from the medial to the lateral canthus. The arcus marginalis is identified and midface dissection ensues. There are 2 surgical planes for midface surgery: subperiosteal or preperiosteal. Our preference is preperiosteal for a few reasons. First, this creates a plane where there are raw surfaces above and below, which can lead to a better adhesion and permanency of the lift. Also, if the cheek soft tissue is mobile over underlying bone (ie, positive glide), when the periosteum is elevated and refixated superiorly, the soft tissue of the cheek may still glide inferiorly, as was the case preoperatively. The midface dissection begins laterally as the orbitomalar ligament is released just above the periosteum in the deep suborbicularis oculi fat (SOOF) plane. It is important to stay in a deep plane to leave as much soft tissue above as possible. This reduces the incidence of skin pucker when engaging the midface for lifting. Dissection ensues laterally to the canthus and medially typically to the junction of the SOOF and medial lip elevators (levator labii superioris and alaeque nasi). We have rarely needed to release these muscles for added lift. Once the orbitomalar ligament is cut, blunt dissection with a cotton-tip proceeds to the zygomatic ligament. Depending on the degree of cheek mobilization and lift needed, this ligament can also be incised. Finger dissection in a sweeping fashion bluntly releases any soft tissue bands that may limit the cheek lift. A 4-0 prolene suture is used to engage the SOOF of the midface. This is a critical step in surgery and some nuances apply. A sweet spot for tissue engagement is critical. The authors prefer the inferior nasal SOOF because we think this best redirects the vector of the midface superolaterally, which is the most anatomic lift. Three close-proximity suture bites of the SOOF are usually taken for security of midface engagement. Finally, the prolene suture is secured to either the lateral orbital rim periosteum or the deep temporalis fascia (DTF) above (dictated by surgeon preference and tissue integrity), to secure the midface. The terminal preseptal orbicularis is

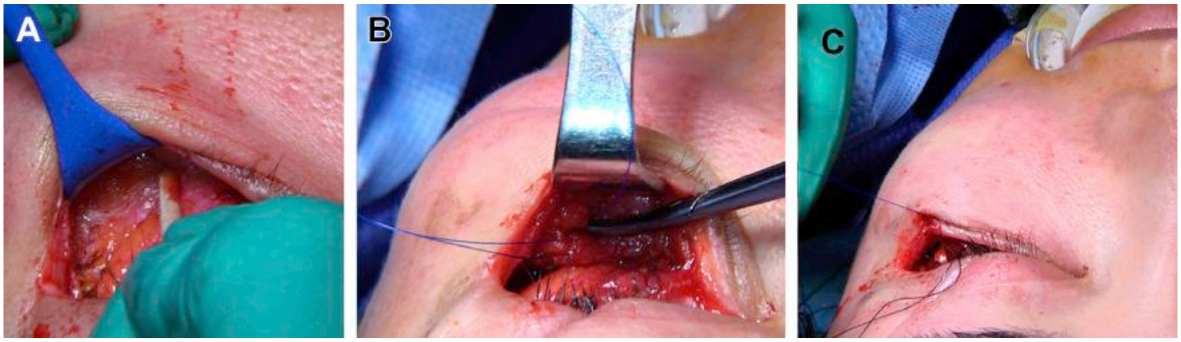

Fig. 9. (*A*) Transconjunctival approach to midface lifting. The cotton-tip is pointing to the preperiosteal midface dissection plane. Note orbital fat above, just below surgical glove. (*B*) The SOOF of the midface is engaged with 4-0 prolene suture. (*C*) Suture elevating the midface in a superolateral vector to recruit skin for the lower eyelid.

then engaged with a 4-0 Vicryl suture on a half-circled P-2 needle and secured to the periosteum or the DTF to create a biplanar (deep SOOF and more superficial orbicularis) suspension of the midface. The Vicryl (polyglactin 910) suture (Ethicon US LLC, Cincinnati, OH) is used because it dissolves and had less tendency to be felt or seen through then skin just lateral to the canthus.

Attention is now brought to the hard palate. An adult-sized Jennings mouth retractor is placed to open the mouth. The hard palate is injected with 1 to 2 cubic centimeters (ccs) of the same local anesthetic. The key with injection is to note whitening (blanching) of the normally red mucosa. The graft size is demarcated based on the degree of retraction and the lower eyelid contour deficit identified preoperatively. When marking the hard palate for harvest, the authors prefer to stay a few millimeters lateral to the medial raphe and medial to the root of the teeth. Further, the dissection should start as close to the central incisors as possible. This allows a longer graft (as much as 30 mm) when needed. The graft can be harvested with a scalpel blade or other cutting device per surgeon preference. Dissection is in the fibrofatty submucosal plane. Hemostasis is attained with cautery, application of Monsel solution, and Surgicel Original Hemostat (Ethicon, Arlington, TX, USA). A prefabricated dental retainer is placed at the conclusion of the graft harvest. The graft is then cut to size and thinned appropriately. The graft is sewn to the tarsus above and the conjunctiva and retractors below with interrupted and buried 6-0 plain gut suture. Before placing the graft, the retractors can be recessed off the conjunctiva (true retractor recession).[23] We add this step in more severe cases of retraction, especially when the cicatricial component is greater or the globe midface vector discrepancy is more significant. For surgeons first performing this surgery, the palate graft can be placed before midface suspension because surgical exposure may be better. The terminal canthus is then secured to the inner orbital rim periosteum with a 4-0 Vicryl suture on a P-3 needle. Many of these cases have premorbid shortened horizontal palpebral fissures, so lid shortening is rarely needed and mostly avoided. A Frost suture or variant is placed to put the lower eyelid on stretch during the first 1 to 2 weeks of recovery. The authors use a 4-0 silk suture looped over a cotton bolster. The suture passes through the gray line of the lower eyelid and is secured

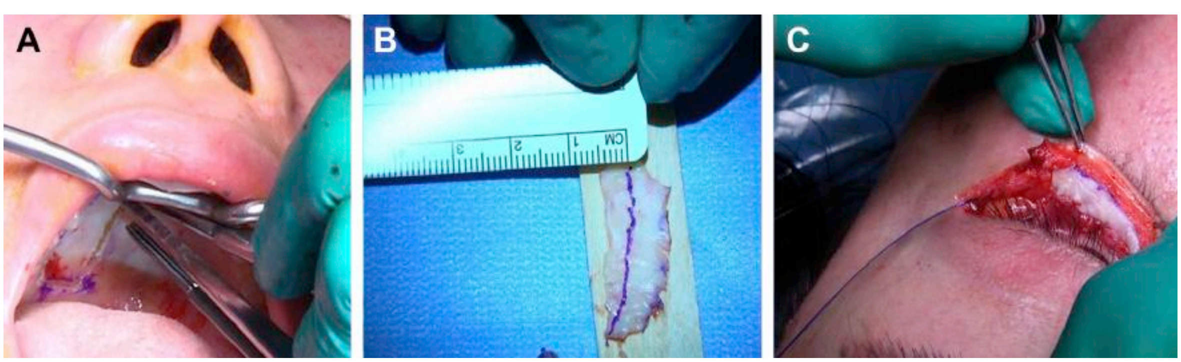

Fig. 10. (*A*) Intraoperative exposure and demarcation of hard palate graft for harvest. (*B*) Customized measured division of palate graft in preparation for implantation. (*C*) Plate graft placed as posterior eyelid space.

through the eyebrows or, alternatively, when a brow lift is added, taped to the forehead with steri-strips over Mastisol Liquie Adhesive (Ferndale IP, Inc, Ferndale, MI, USA). **Figs. 9–11** demonstrate salient features of PBLER surgery, and **Figs. 12–14** show representative examples of results of standard MSC surgery.

POSTOPERATIVE CARE

Patients are instructed to apply ice to the eyelids 10 minutes per hour while awake for 2 days. An antibiotic ointment is applied to sutures and an antibiotic or steroid drop is applied to the eyes 3 times a day for 1 week. The dental retainer is used for comfort as needed and a low sodium soft diet is advanced as tolerated. A topical liquid viscous lidocaine solution is used to gargle with as needed daily for comfort. This can be alternated with an over-the-counter antiseptic solution. Oral antibiotics are used for 1 week, and patients are asked to sleep with the head of the bed at 30° or elevated on 2 pillows for 1 week. The Frost and remaining sutures are removed at 1 to 2 weeks after surgery.

COMPLICATIONS

Prolonged bruising and swelling are not uncommon and require reassurance and, less commonly, oral steroids. Reduced field of vision, inability to read, suture skin erosions, corneal abrasions, and claustrophobia can all occur related to the Frost suture. Early suture removal is indicated if symptoms are more than mild. Eyelid infection is rare but can occur, especially in more compromised eyelids (more previous surgeries with subsequent scaring and poor vascularity). They are treated as clinically indicated with oral antibiotics.

Fig. 11. The prolene suture is tied off to lift and secure the midface.

Fig. 12. A 35-year-old woman developed lower eyelid retraction after transcutaneous lower eyelid blepharoplasty (*left*). Note her improvement 2 years after bilateral transeyelid midface lift, implantation of a hard palate graft, and open CS (*right*). In addition, a conservative posterior approach ptosis repair was added.

A cat-eyed appearance is normal and typically resolves within 3 months. Rarely, in relatively enophthalmic patients, the cat-eyed appearance can persist indefinitely. This can be hard to reverse. Fortunately, patients with enophthalmic globe configuration are less prone to retraction. Chemosis is not uncommon because lymphatic drainage is through the canthus (often already disorganized and violated from previous surgeries). In addition, inferior fornix manipulation can further predispose to chemosis (stay high, just below the tarsus, when placing palate graft). Treatment can include lubrication, patching, additional tarsorrhaphy, topical and/or oral steroids, and conjunctival cutdown or cautery. Most cases resolve with conservative measures. Discrepancies in canthal or lower lid height are not uncommon early, and most cases resolve over time. Reoperation to adjust the canthus or trim the palate graft should wait a minimum of 6 months.

On rare occasions, postoperative bleed at the palate donor site can occur. Office cautery with Surgicel (Ethicon US LLC, Cincinnati, OH) packing and pressure application with the retainer usually resolves the issue. If not, cautery in the operating room is required. Donor site infection is rare on antibiotics. If present and persistent, referral or consultation with a dentist is

Fig. 13. A 59-year-old man had previous transcutaneous lower blepharoplasty with subsequent lower eyelid retraction, and then numerous revisional lower eyelid can canthal procedures that did not meet his expectations (*left*). One-year status after standard MSC surgery (*right*). Note improved lower eyelid position, canthal angle appearance.

Fig. 14. A 34-year-old woman developed lower lid retraction after transcutaneous lower blepharoplasty. She presented with the classic findings of lower eyelid retraction, inferior scleral show, and rounded canthi (*left*). One year after standard MSC surgery (closed CS), all deficits improved significantly (*right*).

warranted. Similar referral is needed when rare granulation tissue irregularities occur on the hard palate donor site. On occasion, neuropathic pain on the roof of the mouth can occur. This is cumbersome and can resolve with tricyclic antidepressants (Elavil), gabapentinoids (Lyrica, Neurontin), or time.

Late regression of effect is unfortunate and most likely related to undercorrection (incidence goes down with experience) or tissue biology (wound contraction). Injections of wound modulators such as 5FU or steroid preparations and tissue expansion with hyaluronic acid gels are useful if timely.[38] Finally, canthal irregularities (eg, webs, commissure separation, scars) can occur with any surgeon but occur especially in less experienced hands. These are very difficult to correct.[39,40] The authors have found that strict attention to surgical technique, reduction of tissue trauma, recreation of anatomy, and experience are the best methods of prevention.

SUMMARY

PBLER is a devastating complication primarily seen after transcutaneous lower eyelid surgery. Because the surgical dictum is do no harm, and this complication occurs after an elective cosmetic procedure that alters both form and function, patients often feel harmed. This emotional overlay adds a psychological component to an already difficult problem to address. Add this to the unpredictability of this complex revision surgery and it becomes clear that meeting patient expectations is difficult at best. For these reasons, these cases should not be taken lightly and referral to a surgeon who has experience with them is important. Even in this scenario, patients should be educated well regarding expectations. Fortunately, advances in more contemporary surgical and nonsurgical modalities continue to emerge that may lead to higher patient satisfaction. Keeping abreast of these changes and the ongoing developing literature regarding PBLER is essential for surgeons who choose to take on these cases.

On a final note, as surgeons, we have focused on an improvement in eyelid position as the primary endpoint of PBLER surgery. What the authors have found is that elevating the lower eyelid, although of primary importance, is just 1 component of PBLER repair that patients focus on. The authors think it is also very important to pay attention to the appearance of the canthal angle and the length of the horizontal palpebral aperture when planning surgery on these patients. Addressing these additional deficits, or at least providing preoperative counseling regarding limitations in outcome related to them, has significantly improved the authors' success rate with surgery.

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Quantified Incision Placement for Postseptal Approach Transconjunctival Blepharoplasty

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Purpose: This study quantifies the incision location in transconjunctival lower eyelid blepharoplasty to optimize postspetal (direct) access to the eyelid/orbital fat.

Methods: A retrospective chart review of patients undergoing transconjunctival blepharoplasty by one surgeon (GGM) from January 2013 to January 2014 was performed. Simultaneous globe retropulsion and lower eyelid inferior displacement was used to balloon the conjunctiva forward to maximally visualize the transconjunctival surface anatomical landmarks of importance. A caliper was used to measure the distance in millimeters from the inferior tarsus to the most superior projection of visible fat. The conjunctival incision was made 0.5mm posterior to this measured distance. For each procedure it was noted whether the preseptal or postseptal plane was entered.

Results: Sixty-six patients were assessed. Fifty patients were women, and the mean patient age was 54 years (range 36–71 years). The mean distance from the inferior tarsus to the visualized superior tip of fat was 6.03mm (range 5–7mm) and the mean incision placement was 6.53mm (range 5.5–7.5mm). The postseptal space (direct access to fat) was entered in 54 cases (82%). The inferior vascular arcade was identified in 23 cases (35%) cases. In this instance, the incision was placed below this landmark in 16 cases (70%). There were 5 cases (7.6%) of postoperative chemosis which all resolved within 2 months with conservative measures. There were no other complications related to the conjunctival incision.

Conclusion: Placing the conjunctival incision for postseptal approach transconjunctival blepharoplasty 0.5mm posterior to the most superior projection of clinically visible fat (with adjunctive globe retropulsion and lower eyelid infraplacement) accesses the postspetal space directly in 82% of cases. Previously suggested incision placements: between 2 and 5mm below the tarsus, at the fornix, or at the inferior vascular arcade are subjective/anecdotal at best and without similar quantitative validation.

(*Ophthal Plast Reconstr Surg* 2016;32:191–194)

The transconjunctival approach for lower blepharoplasty (TCB) was first described by Bourguet[1] in 1924 in the French literature, but generally fell into disfavor for 50 years until it was reintroduced by Tessier[2] in 1973 in selected patients. Soon after, in an effort to reduce the incidence of postoperative eyelid malposition associated with traditional transcutaneous surgery, the technique was further elaborated on by various authors.[3–5] First, Tomlinson and Hovey[3] described a preseptal approach to access orbital fat, and later Baylis et al.,[4] a postseptal technique. Since then transconjunctival surgery has been refined and is now a standard part of the aesthetic eyelid surgeon's armamentarium.[6–21]

As the orbital septum fuses with the lower eyelid retractors approximately 5mm below the inferior tarsus,[22–24] it is known that a conjunctival incision above this fusion point will provide preseptal access (between orbicularis muscle and orbital septum) to the fat pads. However, what is not so clear cut, or been analyzed in an evidence-based manner, is where to optimally place the conjunctival incision for the postseptal approach to fat.

In this report, the authors evaluate a series of patients undergoing a postseptal approach TCB. With adjunctive globe retro-placement and inferior eyelid distraction,[17] the orbital fat and conjunctiva are ballooned forward to maximally delineate and expose the posterior eyelid anatomy. The authors measured the distance from the inferior tarsus to the most superior visible yellow fat seen through the conjunctiva (postseptal space). This point was recorded, and in each case, a conjunctival incision was made just posterior (0.5mm) to this location. The data show the mean incisional location to be 6.5mm, and that fat was directly accessed in 82% of cases. To the best of authors' knowledge, this is the first quantitative study assessing the conjunctival entry point for postseptal fat access during blepharoplasty.

METHODS

A retrospective chart review of patients undergoing lower TCB from January 2013 to January 2014 was performed. All surgeries were performed by the senior author (GGM) in a private practice outpatient setting. None of the patients, or their medical records, was associated with the institution for which GGM has privileges, therefore institutional review board approval was not required. Informed consent was obtained for each procedure, and the review adhered to the standards of the Declaration of Helsinki and was compliant with the Health Insurance Portability and Accountability Act. All patients had a detailed ocular examination prior to surgical intervention and risks/benefits were reviewed. Patients included for study underwent TCB with or without fat transposition for relative lower eyelid fat herniation. Patients were excluded if they had prior lower eyelid surgery, thyroid-associated orbitopathy, previous eyelid or orbital trauma, or eyelid malposition. The intraoperative distance in millimeters from the inferior tarsal edge to the superior tip of visualized fat was documented, as was the corresponding incision placement 0.5mm posterior to this location. The percentage of

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patients for whom this incision allowed direct entry to the postseptal fat compartment was also documented.

SURGICAL TECHNIQUE

All procedures were performed under conscious sedation or general anesthesia. A transconjunctival injection of 2 ml of 1% lidocaine with 1:100,000 of epinephrine was given. Simultaneous globe retropuslion and lower eyelid inferior displacement, as previously described,[17] was used to balloon the conjunctiva forward for better exposure of posterior eyelid anatomy (Fig. 1). This maneuver allowed a clear view of the relevant subconjunctival posterior eyelid landmarks of importance: the tarsus, lower eyelid retractors/orbital septal fusion, and the eyelid/orbital fat. A caliper was used to measure the distance in millimeters from the inferior tarsus to the most superior visible (yellow) projection of fat (Fig. 1, top). A Colorado tip electrocautery was used to make an incision through the conjunctiva and lower eyelid retractors just posterior (approximately 0.5 mm) to this location. A 4-0 silk traction suture engaged the conjunctiva and lower eyelid retractors and was secured to the head drape, while a Desmarres retractor inferiorly displaced the lower eyelid. One of the 3 scenarios was then recorded: 1) Free fat prolapse through the wound (Fig. 1, below); 2) Fat prolapse covered by a thin capsule not connected to the inferior orbital rim (determined by traction on this tissue plane); and 3) A whitish firm tissue overlying fat, which, by traction testing, was fixed to the inferior orbital rim. The authors considered scenario 1 and 2 as postseptal fat access and scenario 3 as access to the preseptal space. In scenario 3, lysis of the white tissue overlying fat was required to enter the fat compartment confirming it to be the orbital septum. Surgery then proceeded in the standard way.

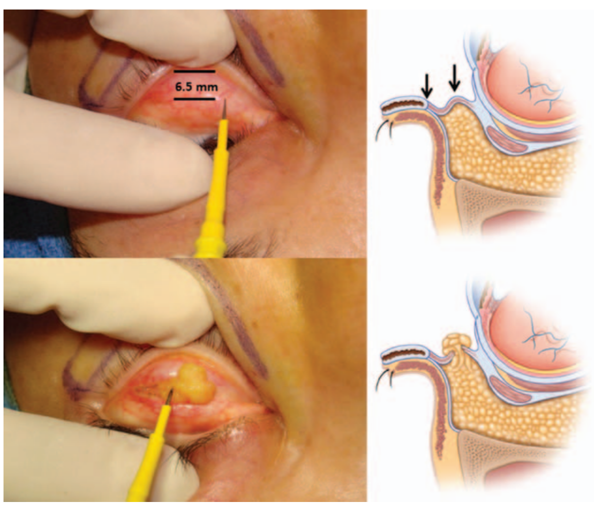

FIG. 1. Simultaneous globe retropulsion and eyelid depression (GRED maneuver) to balloon conjunctiva forward and expose posterior eyelid anatomy. *Top left* Surgeon's view of mean 6.5 millimeter (mm) incision distance from inferior tarsus to superior tip of visible fat (both delineated with *dark black line*). *Top right* Artists drawing (sagittal view) showing *black arrows* depicting same landmarks and distance. *Below left* Surgeons view after conjunctival incision demonstrating free fat prolapse to postseptal space. *Below right* Artists drawing (sagittal view) of same. Modified with permission from Lippincott-Raven Publishers, Peng GL, Jacono A, Massry, GG. Re: *"Globe Retropulsion and Eyelid Depression (GRED)"* - A surgeon controlled, unimanual maneuver to access post-septal fat in transconjunctival lower blepharoplasty. *Opthal Plast Reconst Surg* 2014;30:273–4.

RESULTS

A total of 66 patients met inclusion criteria for review. Fifty patients (76%) were female and the mean patient age was 54 years (range 36–71 years). The measured distance from inferior tarsus to the superior most tip of fat viewed intraoperatively, and the location of the incision placement (0.5 mm posterior to this) are detailed in Table. These mean distances are 6.03 mm and 6.53 mm, respectively. With this conjunctival incision, the postseptal space was entered in 82% of cases (Fig. 2). This included scenarios 1 and 2 described in surgical technique section (free fat or fat covered with thin capsule). In 23 cases (35%), the inferior vascular arcade was visualized surgically. In 16 of these cases (70%), the inferior vascular arcade was above the incision placement. There were 5 cases of chemosis (described as more than minor). All cases resolved within 2 months with conservative management with topical lubricants and antinflammatory agents. No other complications occurred.

DISCUSSION

Transconjunctival blepharoplasty has evolved since its early descriptions,[1–5] with refinements in technique,[6,7,11,12,14–16] the addition of fat preservation adjuncts,[8,9,12–16] and detailed analysis[18,19] adding greatly to the authors understanding and usefulness of the procedure. One area which has not been studied is identification of the most appropriate location for the conjunctival incision. There are 2 general approaches to accessing orbital fat in TCB: pre- and postseptal. The primary benefit of the postseptal approach is preservation of the orbital septum.[8,12,18] It has long been thought that maintaining septal integrity is important to prevent postoperative lower eyelid lower eyelid retraction.[18,22,23,25] While this may be true with transcutaneous surgery, a recent report has shown that septal violation in TCB does not lead to an increased incidence of lower eyelid malposition.[18] That notwithstanding, many still prefer the postseptal approach to access fat during TCB.[4,12,16]

The preseptal approach proceeds with dissection between the orbicularis muscle and the orbital septum. This requires an incision between the inferior tarsal edge and the fusion point of the orbital septum and lower eyelid retractors. The literature has defined this distance as approximately 5 mm.[22–24] Thus, an incision 1–4 mm below the inferior tarsal edge should enter the preseptal plane. While anatomically it makes sense that an incision greater than 5 mm below the inferior tarsus is needed for

Column 1: Distance from inferior tarsal edge measured in millimeters with surgical caliper; column 2: number of and percent of total patients (in parenthesis) where superior tip of fat was noted at specific distances from inferior tarsal edge; column 3: number of and percent of total patients (in parenthesis) where incision was placed from inferior tarsal edge; bottom row shows overall results in columns 2 and 3

Distance measured in millimeters from inferior tarsus	Superior tip of visible fat from inferior tarsus: number of patients (%)	Distance to incision from inferior tarsus: number of patients (%)
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Results	Mean 6.03 mm Range (5.0–7 .0 mm)	Mean 6.53 mm Range (5.5–7 .5 mm)

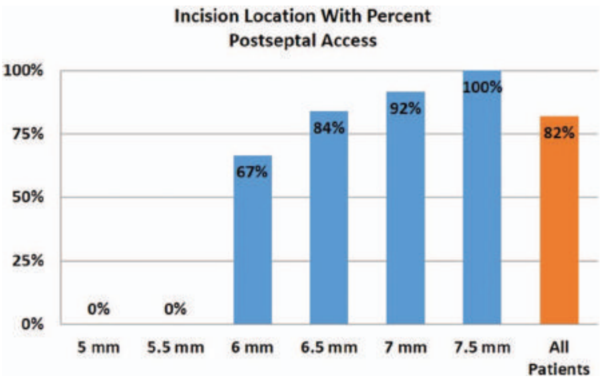

FIG. 2. A histogram chart: In *blue* is percentage of cases which entered postseptal fat compartment (*Y* axis) based on incision location in millimeters (mm) from inferior edge of tarsus (*X* axis). In *orange* (*far right*) is overall percentage of cases which entered postseptal space for all incisional locations

direct postseptal entry to fat, the senior author's (GGM) anecdotal experience is that an incision placed at this location can still require septal division to identify orbital fat. The literature has also been unclear on where to place this incision in this instance, suggesting 2–5 mm below the tarsus,[5,26,27] below this level or in the "fornix,"[4,8,12] or at the inferior vascular arcade.[26,28] A cadaveric study[24] demonstrated that from the conjunctival surface of the lower eyelid fat lies 9.5 mm below the lower eyelid margin, when the lower eyelid is stretched inferiorly as occurs in TCB surgery. The mean inferior tarsal height in this study was 4.4 mm. Thus, a distance of 5.1 mm below the inferior tarsus should be measured to the superior projection of fat. The authors elaborate that this distance can be up to 6 mm. While direct extrapolation from cadaver to live tissue cannot be assumed, this at least provides guidance.

In this report, the authors utilized the most obvious transconjunctival anatomical landmark to optimize incision placement for postseptal fat access. With maximal exposure of the posterior eyelid anatomical landmarks,[17] the most superior tip of orbital fat could clearly be visualized. An incision was made just posterior (0.5 mm) to this location. In this scenario, direct entry to the orbital fat compartment (postseptal plane) was noted in 82% of cases. This meant direct visualization of free fat, or fat covered by a thin connective tissue layer not attached to the inferior orbital rim (confirmed by traction testing). The assumption was that this thin tissue substrate was a "fatty capsule" surrounding the fat. If tissue overlying fat was present and fixed to the orbital rim (orbital septum) a preseptal plane was recorded. The authors, unfortunately, did not subdivide the postseptal group into those who did, or did not, have a "capsule" anterior to fat. However, the authors do not think this biases the study findings as the "*fat capsule*" was free of orbital rim attachments, and thus a postseptal structure.

The significance of the study findings is that it provides guidance as to what has been ambiguously described in the literature in regards to postseptal approach TCB. The data suggest that making an incision 2 to 5 mm inferior to the tarsus should not enter the postseptal plane. While this makes intuitive sense, older reports with clearly delineated anatomy still suggested this incision location.[5,26,27] In this series, fat was visualized 5 mm from the inferior edge of tarsus in only 2 cases (3%) with a subsequent conjunctival incision made at 5.5 mm below the tarsus. The postseptal compartment was not accessed in either case (Table). The authors feel certain that making a conjunctival incision above this level will not enter the postseptal plane, unless an anatomical variant exists. This is further suggested by the findings in the anatomical study described.[24] With regards to a more inferiorly placed or "fornix" incision, the authors agree, with typical anatomy, an incision in this general area is appropriate. However, this encompasses a broad area without clear definition, and provides no concrete guidance as to location of incision placement. Finally, the study is limited in determining the value of placing an incision at the inferior vascular arcade. Prior to initiating the study, the authors, in error, did not define recording the location of the inferior arcade as a study parameter. This was not documented until after the study began when the authors identified its value. Also, the authors routinely injected anesthetic agent with epinephrine prior to initiating surgery. In many cases, this blanched the presence of the vasculature, masking the location of the arcade. As such in only 35% of cases was the arcade noted, and in 70% of these cases the incision placement was below this level. The authors think it is important to note that in the upper eyelid a marginal and peripheral arcade are generally consistently present, but in the lower eyelid the peripheral arcade is often less well defined, discontinuous, or absent.[29] As such, the true value of this landmark is unknown. In addition, this vessel, when present, has been shown on average to be between 4 and 5 mm below the lower eyelid margin,[29] above where anatomy would dictate incision placement for postseptal fat access in TCB. However, the authors concede that a definitive association of the peripheral arcade and postseptal incision placement cannot be made without its definitive and consistent identification and measurement prior to administering injected epinephrine. As such any conclusions drawn from this report with regards to the lower peripheral arcade are inconclusive.

Transconjunctival blepharoplasty is now a mainstream part of aesthetic eyelid surgery. Over the years much has been learned regarding the surgical plane of dissection,[3,4,18] the addition of fat transposition,[8,9,12,16] the significance of septal violation,[18] and patient satisfaction, and outcomes to surgery.[19] What has remained unclear is the optimal location of conjunctival incision placement. This is especially important for the postseptal approach to surgery for those desiring to spare the orbital septum. In this report, the authors provide quantitative data demonstrating that when the incision is placed just posterior (0.5 mm) to the most superiorly visualized fat, when posterior anatomy is maximally exposed, that the postseptal space is entered in 82% of cases. An incision in this location, with the exposure technique described, has not led to an increased incidence of eyelid/globe complications. In this series, the mean incision placement was 6.5 mm inferior to the inferior tarsal edge, close to what has been seen in cadaveric study.[24] However, the authors stress that surgeons base the location of incision on posteriorly visualized fat, and not on a defined distance, as anatomical variations will guide this location.

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Quantified Incision Placement for Postseptal Approach Transconjunctival Blepharoplasty

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Purpose: This study quantifies the incision location in transconjunctival lower eyelid blepharoplasty to optimize postspetal (direct) access to the eyelid/orbital fat.

Methods: A retrospective chart review of patients undergoing transconjunctival blepharoplasty by one surgeon (GGM) from January 2013 to January 2014 was performed. Simultaneous globe retropulsion and lower eyelid inferior displacement was used to balloon the conjunctiva forward to maximally visualize the transconjunctival surface anatomical landmarks of importance. A caliper was used to measure the distance in millimeters from the inferior tarsus to the most superior projection of visible fat. The conjunctival incision was made 0.5 mm posterior to this measured distance. For each procedure it was noted whether the preseptal or postseptal plane was entered.

Results: Sixty-six patients were assessed. Fifty patients were women, and the mean patient age was 54 years (range 36–71 years). The mean distance from the inferior tarsus to the visualized superior tip of fat was 6.03 mm (range 5–7 mm) and the mean incision placement was 6.53 mm (range 5.5–7.5 mm). The postseptal space (direct access to fat) was entered in 54 cases (82%). The inferior vascular arcade was identified in 23 cases (35%) cases. In this instance, the incision was placed below this landmark in 16 cases (70%). There were 5 cases (7.6%) of postoperative chemosis which all resolved within 2 months with conservative measures. There were no other complications related to the conjunctival incision.

Conclusion: Placing the conjunctival incision for postseptal approach transconjunctival blepharoplasty 0.5 mm posterior to the most superior projection of clinically visible fat (with adjunctive globe retropulsion and lower eyelid infraplacement) accesses the postspetal space directly in 82% of cases. Previously suggested incision placements: between 2 and 5 mm below the tarsus, at the fornix, or at the inferior vascular arcade are subjective/anecdotal at best and without similar quantitative validation.

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The transconjunctival approach for lower blepharoplasty (TCB) was first described by Bourguet[1] in 1924 in the French literature, but generally fell into disfavor for 50 years until it was reintroduced by Tessier[2] in 1973 in selected patients. Soon after, in an effort to reduce the incidence of postoperative eyelid malposition associated with traditional transcutaneous surgery, the technique was further elaborated on by various authors.[3–5] First, Tomlinson and Hovey[3] described a preseptal approach to access orbital fat, and later Baylis et al.,[4] a postseptal technique. Since then transconjunctival surgery has been refined and is now a standard part of the aesthetic eyelid surgeon's armamentarium.[6–21]

As the orbital septum fuses with the lower eyelid retractors approximately 5 mm below the inferior tarsus,[22–24] it is known that a conjunctival incision above this fusion point will provide preseptal access (between orbicularis muscle and orbital septum) to the fat pads. However, what is not so clear cut, or been analyzed in an evidence-based manner, is where to optimally place the conjunctival incision for the postseptal approach to fat.

In this report, the authors evaluate a series of patients undergoing a postseptal approach TCB. With adjunctive globe retro-placement and inferior eyelid distraction,[17] the orbital fat and conjunctiva are ballooned forward to maximally delineate and expose the posterior eyelid anatomy. The authors measured the distance from the inferior tarsus to the most superior visible yellow fat seen through the conjunctiva (postseptal space). This point was recorded, and in each case, a conjunctival incision was made just posterior (0.5 mm) to this location. The data show the mean incisional location to be 6.5 mm, and that fat was directly accessed in 82% of cases. To the best of authors' knowledge, this is the first quantitative study assessing the conjunctival entry point for postseptal fat access during blepharoplasty.

METHODS

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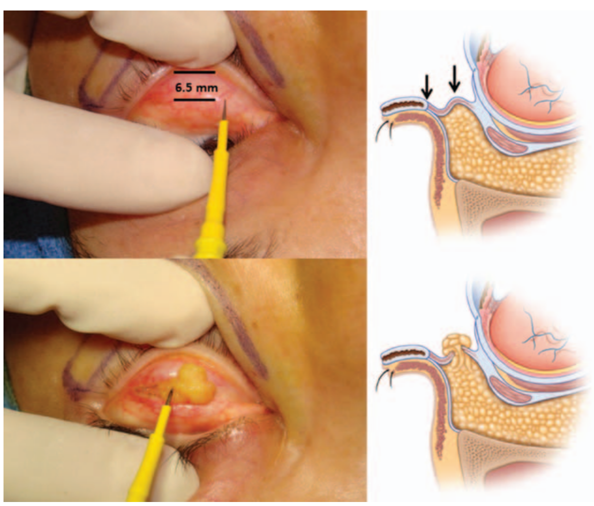

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7.5 mm	0 (0%)	1 (2%)
Results	Mean 6.03 mm Range (5.0–7 .0 mm)	Mean 6.53 mm Range (5.5–7 .5 mm)

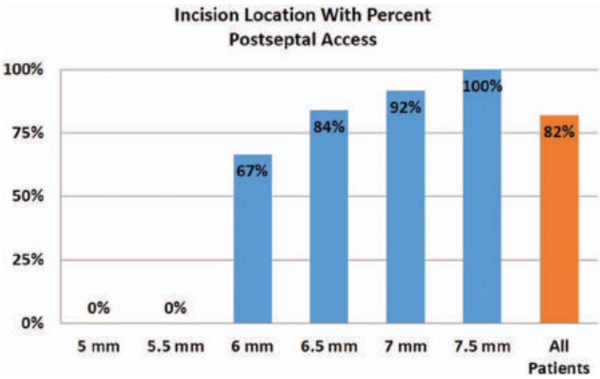

FIG. 2. A histogram chart: In *blue* is percentage of cases which entered postseptal fat compartment (*Y* axis) based on incision location in millimeters (mm) from inferior edge of tarsus (*X* axis). In *orange* (*far right*) is overall percentage of cases which entered postseptal space for all incisional locations

direct postseptal entry to fat, the senior author's (GGM) anecdotal experience is that an incision placed at this location can still require septal division to identify orbital fat. The literature has also been unclear on where to place this incision in this instance, suggesting 2–5 mm below the tarsus,[5,26,27] below this level or in the "fornix,"[4,8,12] or at the inferior vascular arcade.[26,28] A cadaveric study[24] demonstrated that from the conjunctival surface of the lower eyelid fat lies 9.5 mm below the lower eyelid margin, when the lower eyelid is stretched inferiorly as occurs in TCB surgery. The mean inferior tarsal height in this study was 4.4 mm. Thus, a distance of 5.1 mm below the inferior tarsus should be measured to the superior projection of fat. The authors elaborate that this distance can be up to 6 mm. While direct extrapolation from cadaver to live tissue cannot be assumed, this at least provides guidance.

In this report, the authors utilized the most obvious transconjunctival anatomical landmark to optimize incision placement for postseptal fat access. With maximal exposure of the posterior eyelid anatomical landmarks,[17] the most superior tip of orbital fat could clearly be visualized. An incision was made just posterior (0.5 mm) to this location. In this scenario, direct entry to the orbital fat compartment (postseptal plane) was noted in 82% of cases. This meant direct visualization of free fat, or fat covered by a thin connective tissue layer not attached to the inferior orbital rim (confirmed by traction testing). The assumption was that this thin tissue substrate was a "fatty capsule" surrounding the fat. If tissue overlying fat was present and fixed to the orbital rim (orbital septum) a preseptal plane was recorded. The authors, unfortunately, did not subdivide the postseptal group into those who did, or did not, have a "capsule" anterior to fat. However, the authors do not think this biases the study findings as the "*fat capsule*" was free of orbital rim attachments, and thus a postseptal structure.

The significance of the study findings is that it provides guidance as to what has been ambiguously described in the literature in regards to postseptal approach TCB. The data suggest that making an incision 2 to 5 mm inferior to the tarsus should not enter the postseptal plane. While this makes intuitive sense, older reports with clearly delineated anatomy still suggested this incision location.[5,26,27] In this series, fat was visualized 5 mm from the inferior edge of tarsus in only 2 cases (3%) with a subsequent conjunctival incision made at 5.5 mm below the tarsus. The postseptal compartment was not accessed in either case (Table). The authors feel certain that making a conjunctival incision above this level will not enter the postseptal plane, unless an anatomical variant exists. This is further suggested by the findings in the anatomical study described.[24] With regards to a more inferiorly placed or "fornix" incision, the authors agree, with typical anatomy, an incision in this general area is appropriate. However, this encompasses a broad area without clear definition, and provides no concrete guidance as to location of incision placement. Finally, the study is limited in determining the value of placing an incision at the inferior vascular arcade. Prior to initiating the study, the authors, in error, did not define recording the location of the inferior arcade as a study parameter. This was not documented until after the study began when the authors identified its value. Also, the authors routinely injected anesthetic agent with epinephrine prior to initiating surgery. In many cases, this blanched the presence of the vasculature, masking the location of the arcade. As such in only 35% of cases was the arcade noted, and in 70% of these cases the incision placement was below this level. The authors think it is important to note that in the upper eyelid a marginal and peripheral arcade are generally consistently present, but in the lower eyelid the peripheral arcade is often less well defined, discontinuous, or absent.[29] As such, the true value of this landmark is unknown. In addition, this vessel, when present, has been shown on average to be between 4 and 5 mm below the lower eyelid margin,[29] above where anatomy would dictate incision placement for postseptal fat access in TCB. However, the authors concede that a definitive association of the peripheral arcade and postseptal incision placement cannot be made without its definitive and consistent identification and measurement prior to administering injected epinephrine. As such any conclusions drawn from this report with regards to the lower peripheral arcade are inconclusive.

Transconjunctival blepharoplasty is now a mainstream part of aesthetic eyelid surgery. Over the years much has been learned regarding the surgical plane of dissection,[3,4,18] the addition of fat transposition,[8,9,12,16] the significance of septal violation,[18] and patient satisfaction, and outcomes to surgery.[19] What has remained unclear is the optimal location of conjunctival incision placement. This is especially important for the postseptal approach to surgery for those desiring to spare the orbital septum. In this report, the authors provide quantitative data demonstrating that when the incision is placed just posterior (0.5 mm) to the most superiorly visualized fat, when posterior anatomy is maximally exposed, that the postseptal space is entered in 82% of cases. An incision in this location, with the exposure technique described, has not led to an increased incidence of eyelid/globe complications. In this series, the mean incision placement was 6.5 mm inferior to the inferior tarsal edge, close to what has been seen in cadaveric study.[24] However, the authors stress that surgeons base the location of incision on posteriorly visualized fat, and not on a defined distance, as anatomical variations will guide this location.

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The Spectrum of Aesthetic Canthal Suspension

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KEYWORDS

• Canthal suspension • Canthoplasty • Canthopexy • Lower blepharoplasty • Lower-eyelid retraction

KEY POINTS

- Canthal suspension can be an important adjunct to lower blepharoplasty surgery.
- Understanding canthal anatomy, nomenclature, and function is an essential element of surgical success.
- The correct canthal suspension procedure selected depends on preoperative findings and the nature of the blepharoplasty procedure performed.
- A canthoplasty is a more complex and powerful procedure, which often leads to more patient complaints than canthopexy.
- Aesthetic canthal suspension surgery has evolved into less invasive procedures, which tend to preserve canthal anatomy and integrity.

INTRODUCTION/PHILOSOPHY

Aesthetic canthal suspension (CS) is an often challenging stand-alone or adjunctive surgical procedure for the facial cosmetic surgeon. The authors believe this is because the procedure, and its variants, receives far too little detailed attention during surgical education (unless subspecialty trained), and because the literature is inconsistent in descriptions of canthal anatomy, nomenclature, and surgical interventions.[1,2] This weakness of surgical education makes operating in this very delicate area of the eyelid cumbersome and intimidating to many. The best way to develop a comfort with canthal surgery is to start at the beginning and attain a detailed and systematic understanding of these aspects of surgery.

Initial descriptions of aesthetic CS surgery surfaced in the 1960s as a means of suspending the lower eyelid as an adjunct to lower blepharoplasty.[1–4] At the time, this surgery was almost exclusively performed via an open transcutaneous approach.[2,4] Postblepharoplasty lower eyelid retraction (PBLER) was, and still can be, a devastating complication of surgery.[5–11] One of the primary etiologic factors predisposing to PBLER after lower blepharoplasty is unaddressed lower eyelid laxity.[1,2,6,10,11] Because PBLER is a complex revisional procedure and, even in the best and most experienced of hands, often leads to ongoing functional and aesthetic issues and low patient satisfaction,[11] CS has become an important adjunct to aesthetic lower blepharoplasty.[9,12–16]

Some of the early accepted CS procedures involved complete disarticulation of the canthus, plus-minus eyelid shortening, with subsequent canthal reconstruction.[1,2,17,18] These interventions reliably aid in addressing age-related, posttraumatic, and other forms of acquired functional lower eyelid malposition.[17–22] However, whenever the canthus is “taken apart,” modified, and reconstructed, it is never the same.[1,2,11] The way the

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canthus looks, feels, and functions is usually altered.[1,2,11] In functional surgery, patient complaints related to these changes are typically buried in their satisfaction with eyelid repair as their primary problem is resolved. In aesthetic interventions, where the drive for surgery is appearance and well-being, adding a potential canthal compliant to surgery is hazardous, at best, to the surgeon. For example, the patient with an acquired involutional ectropion or entropion who needs such a procedure to relieve symptoms will often forgive a postoperative change in lower lid slant, canthal height disparity, or a minor canthal web. This is not true of the patient seeking cosmetic lower blepharoplasty. When canthal integrity is altered negatively in aesthetic surgery, an elective procedure can lead to functional and cosmetic impairment, which is not an acceptable outcome. This thinking fueled the development of various modifications of canthal surgery, which have evolved into more sophisticated and less-invasive procedures, which are less disruptive of canthal anatomy, and which often access of the canthus through smaller incisions and via distant sites.[1,2,12,23–25] The sole purpose of these modifications is to preserve canthal structure and function as much as possible to reduce the incidence of patient complaints and postoperative complications. This is where the challenge of aesthetic CS surgery surfaces. There is a delicate balance between preserving canthal architecture while performing a procedure that meets the task of supporting the lower eyelid adequately. The aesthetic eyelid surgeon must understand this and evolve in their palate of CS techniques to have success with lower blepharoplasty surgery.[1,2,7,15]

It should also be noted that good CS surgery is not about a belt-and-suspenders tightening of the lower eyelid.[1,2] This is an antiquated view of surgery, which unfortunately is still pervasive today. Eyelid malposition after lower blepharoplasty is more related to poor patient evaluation and selection, and to how the skin, muscle, and fat of the lower lid are addressed, than to the CS procedure performed. No CS procedure can overcome poorly planned and performed blepharoplasty.[1,2,11] Contemporary thought on CS surgery is that it is about creating a physiologic and tension-free degree of lower eyelid support, which acts to re-create a normal canthal angle. It is not about pulling tighter; rather, it is about support and maintaining appearance and integrity. This concept is the first and most basic concept to understand to yield reliable, consistent, and generally complication-free outcomes with aesthetic CS surgery.

In this article, the authors guide the reader through their perspective on canthal terminology, anatomy, aging changes, procedure variants, preoperative evaluation, postoperative course, and complications of surgery. Although this is just 1 view, the authors have found it to be very predictive of good surgical results.

CANTHAL ANATOMY/FUNCTION

The lateral canthal tendon (LCT) is a fibrous continuation of the terminal pretarsal and preseptal (palpebral) orbicularis fibers, which attach to the lateral orbital rim.[1,2,7,26] There is an upper and lower lid contribution to the tendon, the upper crus and the lower crus, which are collectively called crura. The LCT is approximately 1 mm thick, 3 mm wide, and 7 mm in length.[27] It is a 3-dimensional structure with both horizontal and vertical components. Horizontally, it has both an anterior and a posterior component, which attaches to the lateral orbital rim. The most critical attachment is 3 mm posterior to the lateral orbital rim at the Whitnall tubercle, which sits approximately 10 mm below the frontozygomatic suture (**Fig. 1**A).[1,2,7] This posterior horizontal attachment maintains eyelid apposition to the globe and must be re-created surgically to prevent both eyelid and ocular surface deficits. It is also attached anteriorly to the orbital rim to provide a degree of structural integrity to the tendon. The significance of this insertion is far less than the more critical posterior attachment. Vertically, the LCT sits 2 mm higher than the medial canthal tendon, giving rise to the normal canthal tilt.[7,28] If this slant is altered during CS surgery, patient satisfaction is reduced significantly.

Traditional thinking is that the LCT solely provides support to the lower eyelid to maintain its position after surgery. This thought pattern is flawed, which underscores the many facets of this very complicated anatomic structure. The LCT plays a role in upper (not just lower) eyelid position, as it is associated with the orbital septum and the lateral horn of the levator aponeurosis (**Fig. 1**B).[1,2,7] If these structures are imbricated during CS surgery, temporary or permanent ptosis can occur. Similarly, this can occur if the upper crus of the tendon is inadvertently “tucked” in surgery. The tendon plays some role in ocular motility, as the check ligament of the lateral rectus is closely associated with it, leading to a few millimeters of lateral movement of the canthus with globe abduction.[1,2,7,29] There is also a fat pad (Eisler fat pad), which is thought to be distinct from orbital/eyelid fat pads and rests in a pocket between the lateral horn of the aponeurosis and the LCT.[29] Its exact function is

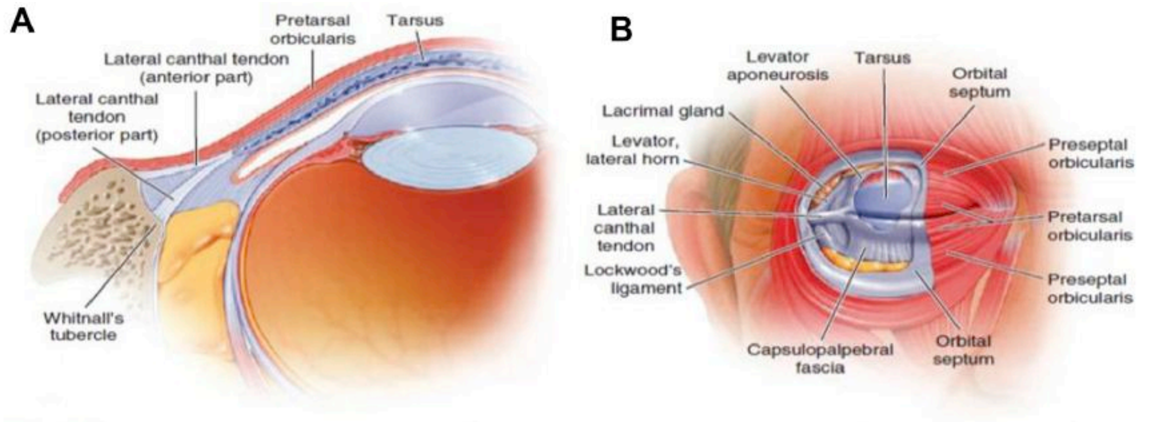

Fig. 1. (*A*) The lateral canthal tendon (LCT) has both an anterior and a posterior attachment to the lateral orbital rim. The posterior attachment is the most critical, as it maintains lower lid apposition to the globe. The posterior attachment site is the Whitnall tubercle. (*B*) Note the proximity of the LCT to other adjacent eyelid structures, including the orbital septum and Levator aponeurosis. (*From* Massry G. and Kossler A. The Spectrum of Canthal Suspension Techniques in Lower Blepharoplasty. In: Azizzadeh B, Murphy M, Johnson C, editors. Master Techniques in Facial Rejuvenation, 2nd edition. Canada: Elsevier; 2018; with permission.)

unknown.[7] The authors believe it may play a role in smooth movement of the aponeurosis over the tendon. Finally, the tendon is an active part of normal eyelid closure. The orbicularis muscle, or eyelid protractor, functions as a sphincter as it passes circumferentially around the eyelid aperture. For normal eyelid closure to occur, the muscle must be anchored medial and lateral by the canthal tendons. When the LCT dehisces or is anchored poorly, eyelid closure changes from a strong and primary vertical excursion (ie, up and down) to one that is weaker with medialization of the lateral canthus with each attempt at closure. This has been referred to as "fishmouthing" (**Fig. 2**)[30] and is presumed to reduce the biomechanical function of the orbicularis sphincter. As such, eyelid closure is deficient. Each described aspect/function of the LCT can be altered by CS surgery, and modern CS should primarily be founded on an understanding of this. Therefore, in the setting of aesthetic canthal surgery, when the correct blepharoplasty procedure

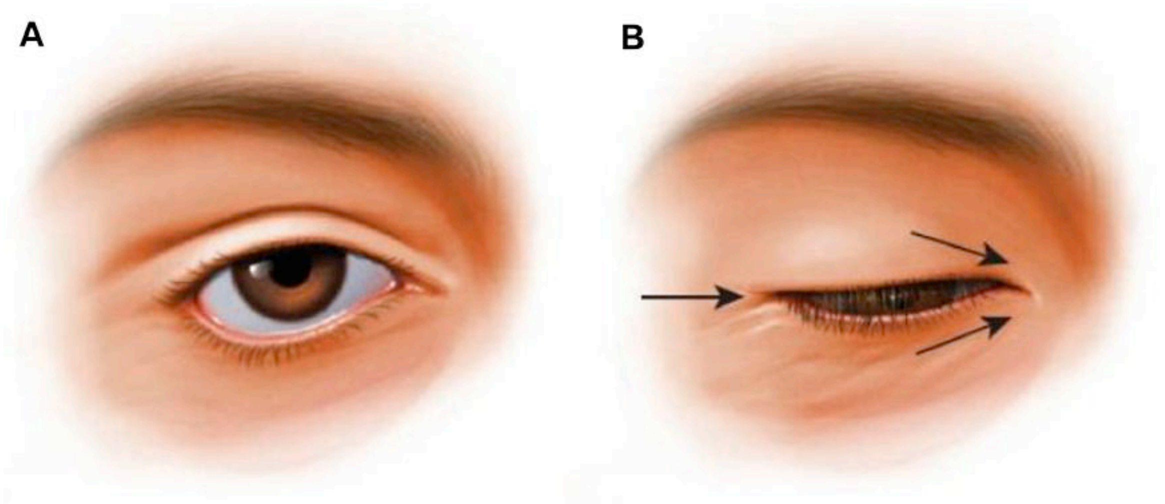

Fig. 2. (*A*) There is poor lateral canthal tendon (LCT) integrity with dehiscence. (*B*) In this scenario, the normal vertical forces applied by the sphincteric action orbicularis oculi biomechanically change as canthal support is lacking, and the lateral canthus medializes with eyelid closure (arrows). This leads to a biomechanical reduction of the strength of eyelid closure and horizontal shortening of the palpebral fissure with eyelid closure. This has been referred to as fishmouthing. (*From* Massry G. and Kossler A. The Spectrum of Canthal Suspension Techniques in Lower Blepharoplasty. In: Azizzadeh B, Murphy M, Johnson C, editors. Master Techniques in Facial Rejuvenation, 2nd edition. Canada: Elsevier; 2018; with permission.)

is performed (of primary importance), less manipulation of the canthus is prudent and typically enough.

CANTHAL AGING CHANGES

As with all areas of the face, senescence imparts functional, physiologic, and aesthetic alterations of normal anatomy. It is now widely accepted that tissue loss (both bone and fat) plays at least an equal role in facial/eyelid aging as does tissue descent.[31–35] Although historically great awareness has been placed on general facial aging changes as a whole, and on specific facial areas, such as the forehead/eyebrows, eyelids, nose, midface, and neck, little such attention has been placed on lateral canthal aging changes. However, an understanding of these changes is an essential component of mastering CS surgery. With age, the palpebral aperture changes from one that is horizontally oval (wider in that plane) to one that is rounder as the canthus migrates medially.[31] This process is a multifactorial process related to loss of integrity (laxity) of the LCT,[1,2,7] loss of orbital bone in specific areas,[36,37] loss of orbital fat (involutional enophthalmos),[38] and most likely changes in suspensory support of the globe. All these changes collectively affect the canthus, and it's many functions previously stated. This in part explains why more aggressive canthal manipulations can lead to a variety of canthal symptoms/complaints, even in the face of what appears to be excellent surgery.

CANTHAL TERMINOLOGY

One of the most confusing aspects of canthal surgery is deciphering the many names given to canthal structures and procedures.[1,2] For simplicity, the authors will designate all canthal "tightening" procedures as a form of CS. This can further be subdivided into both open and closed variants of surgery, and then into either a canthoplasty or canthopexy. Open canthal surgery involves a canthotomy (canthal incision) to suspends the lower lid,[1,2,17–22] whereas closed surgery does not.[1,2,23–25] Open surgery provides direct access and anatomic visibility to critical canthal structures and allows precision of lower lid placement. The tradeoff is that it can predispose to canthal deformity and malalignment. Conversely, in closed canthal surgery, canthal entry is from a distant site (ie, temporal upper lid crease), which can limit anatomic exposure and precision of lid placement. It does, however, more favorably preserve canthal anatomy and integrity, mitigating the chances of postoperative canthal deformity. Finally, in a canthoplasty, the LCT or terminal lower lid is cut plus-minus shortened and secured to the lateral orbital rim periosteum.[1,2] Alternatively, in a canthopexy, these lid structures are not modified, but rather the LCT or terminal lateral orbicularis muscle is secured to the lateral orbital rim with a plication suture.[1,2] Both canthoplasty and canthopexy can be performed in an open or closed fashion, with the canthoplasty variant being the more powerful and complicated procedure, which is fraught with more potential complication.

In relation to anatomic terminology, the lateral canthus is the general area where the lateral upper and lower lids meet, the commissure is their point of union, and the lateral raphe is the union of the upper and lower orbicularis fibers at and beyond the canthus.[1,2] The LCT is the connective tissue structure that connects the eyelids to the lateral orbital rim. It has also been called the lateral palpebral ligament. The lateral retinaculum is also used to describe the LCT. A retinaculum is a band around tendons to hold them in place. Because the LCT has an association with numerous other and integral canthal components, including the orbital septum, the check ligament of the lateral rectus, and lateral horn of the levator aponeurosis, the combination of these structures can be considered a structural retinaculum (**Table 1**).

PREOPERATIVE EVALUATION

Identifying the need for and type of CS is an essential element of successful lower blepharoplasty. This begins and ends with a proper preoperative assessment. First, a determination of the need for lower eyelid skin excision made. This is performed by having the patient look up and open their mouth widely. This places the lower eyelid on maximal stretch. There should not be inferior displacement of the eyelid with mouth opening. Such induced retraction suggests there is not a quantitative skin excess for excision. In this setting, skin excision predisposes to PBLER. If skin excess exists, conservative excision can be performed. When skin excision is added to lower blepharoplasty, the authors almost always add CS to surgery. Although this is not an absolute, the authors believe even minimally invasive CS is a safeguard against PBLER in these cases. The other essential element of the preoperative examination is to identify the presence of lower eyelid laxity, which is the primary factor that mandates the need for CS surgery. This can be assessed in 2 basic ways. First, the eyelid distraction test is performed (**Fig. 3**). The lower eyelid is pulled horizontally away from the lobe. If the lower eyelid can be distracted more than 8 mm from the globe, the

Table 1
Canthal nomenclature and definitions

Nomenclature	Definition
Open canthal suspension	Requires a canthal incision (canthotomy) to access the canthal tendon or terminal tarsus
Closed canthal suspension	The LCT is accessed through a distant site. The tendon can be modified and suspended, but it is done so without a canthotomy
Canthoplasty	The temporal lower lid is modified and/or shortened and secured to the lateral orbital rim, with or without surgery on the LCT
Canthopexy	The lower eyelid is suspended to the lateral orbital rim with a plication suture without modification of the LCT
Canthotomy	Lateral canthal skin incision
Lateral canthus	The general area where the upper and lower lids meet laterally
Lateral commissure	The point of union of the upper and lower lids at the lateral canthus
Lateral canthal tendon	Connective tissue structure that secures the upper and lower terminal eyelid to the lateral orbital rim
Lateral retinaculum	Another name used to describe the LCT. The confluence of several of the soft tissue structures of the lateral upper and lower eyelid that have connections with the LCT
Lateral palpebral ligament	Another synonymous name for the LCT
Lateral raphe	An area of fine fibrous bands where the terminal orbicularis muscle of the upper and lower lids meet
Orbitofacial vector	The relationship of globe projection to the lower lid and midface. When the globe and midface are aligned in a horizontal plane, the vector is neutral. When the globe projects more anterior than the midface, the vector is negative; when the globe sits posterior to the midface, the vector is positive
Ab externo	Suture passage starts outside the wound (outside in) to secure the lateral retinaculum to the Whitnall tubercle
Ab interno	Suture passage starts inside the wound to secure the lateral retinaculum to the Whitnall tubercle

LCT, lateral canthal tendon

Modified from Massry G. and Kossler A. The Spectrum of Canthal Suspension Techniques in Lower Blepharoplasty. In: Azizzadeh B, Murphy M, Johnson C, editors. Master Techniques in Facial Rejuvenation, 2nd edition. Canada: Elsevier; 2018; with permission.

test is positive and confirms lower eyelid (canthal tendon) laxity exists.[1,2] The second test is the eyelid snap-back test (**Fig. 4**). This test is performed by displacing the lower eyelid inferiorly and assessing its return to normal position without patient blink. If this is delayed, it suggests orbicularis deficit and the presence of lower eyelid laxity.[1,2] In the setting of lower blepharoplasty, it is prudent to lower one's standards for positive tests, as even subtle degrees of laxity can lead to changes on lower lid position. With the evolution to less invasive and disruptive CS techniques, it is best to err on the side of caution when determining the need for CS and add minimally invasive surgery as needed. This is especially true (as stated) if lower lid skin excision is added, as this step increases the risk of postoperative lower eyelid malposition.

An important morphologic variant to identify when planning CS is the negative vector globe. This is present when the tip of the globe is more anterior in the vertical plane than the maximal projection of the

Fig. 3. The eyelid distraction test. If the lower lid can be "pulled away" more than 8 mm from globe, lower lid laxity exists. (*From* Massry G. and Kossler A. The Spectrum of Canthal Suspension Techniques in Lower Blepharoplasty. In: Azizzadeh B, Murphy M, Johnson C, editors. Master Techniques in Facial Rejuvenation, 2nd edition. Canada: Elsevier; 2018; with permission.)

midface[1,2,7,39] (**Fig. 5**). This topography predisposes the globe to bowstringing and lower lid retraction with CS. The authors call this the canthus at risk (CAR)[1] and believe such cases should be referred to a surgeon well versed in CS surgery. This can be addressed by correcting eyelid vector via midface enhancement with autologous fat,[40] synthetic filler, or alloplastic implants,[39] or by setting the globe back with custom orbital fat/bone, or combination, decompression.[40,41] The latter is reserved for specific and complicated cases, as these procedures are complex and require specialized orbital surgery training. The most common way of dealing with the CAR is by supra-placing and/or hanging back the CS suture[1,2,7] (**Fig. 6**). Hanging back the suture effectively increases the horizontal length of the lower eyelid to compensate for the increased surface area of the prominent globe. When suture supra-placement is added, it may help mitigate lower lid malposition in these cases. Finally, in prominent globe cases, orbital rim suspension sutures can be anteriorized from the inner orbital rim, again to mitigate tension on the globe with inherent induced lower lid bowstringing and retraction.

A last comment on the evaluation for CS surgery is that one should critically observe the native lower lid tilt. As previously stated, the lateral canthus typically sits 2 mm higher than the medial canthus (normal canthal tilt). If this is not the case, it is important to document this variation and maintain it postoperatively unless the patient suggests a different desire. As a rule, however, the authors have noted patient dissatisfaction when the shape of the eyelid aperture is altered. Be very careful when altering the acuity of the canthal, angle, or slope of the lower eyelid during surgery. This can be a recipe for surgical failure.

SURGICAL PROCEDURES

Numerous variations of CS have been described to provide eyelid support during lower blepharoplasty. This spectrum of procedures involves variable degrees of canthal disarticulation and reconstruction. The following are the 3 primary CS procedures (all canthoplasties) the authors use as adjuncts to aesthetic lower blepharoplasty. A few words on canthopexy will also be included, although the authors rarely use this in approach in isolation. The procedure of choice is based on physical examination findings and surgeon clinical judgment. All surgeries are performed under general or monitored conscious sedation anesthesia depending on patient preference, and associated procedures are added. The authors have reviewed the clinical outcomes of these procedures in

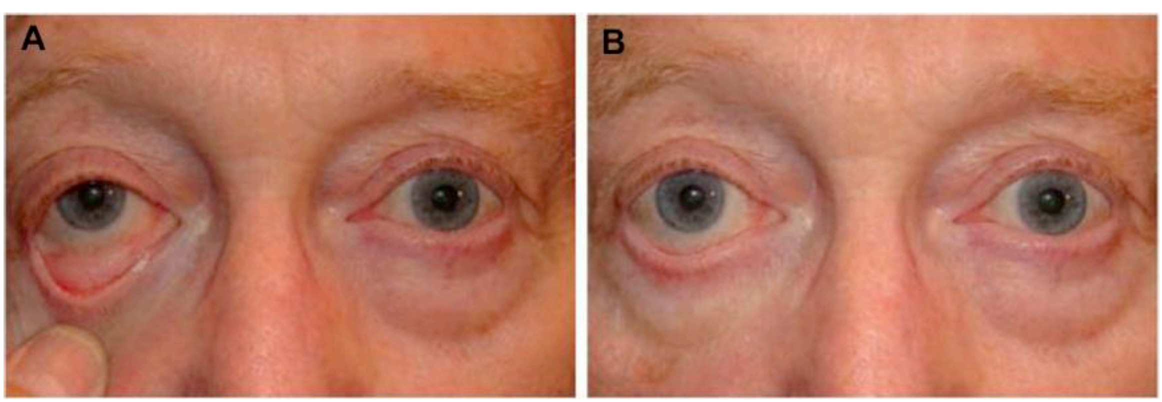

Fig. 4. The snap-back test. (*A*) If the lower lid is inferiorly displaced and (*B*) does not return to normal position without a blink, as in this example, lower lid laxity exists. (*From* Massry G. and Kossler A. The Spectrum of Canthal Suspension Techniques in Lower Blepharoplasty. In: Azizzadeh B, Murphy M, Johnson C, editors. Master Techniques in Facial Rejuvenation, 2nd edition. Canada: Elsevier; 2018; with permission.)

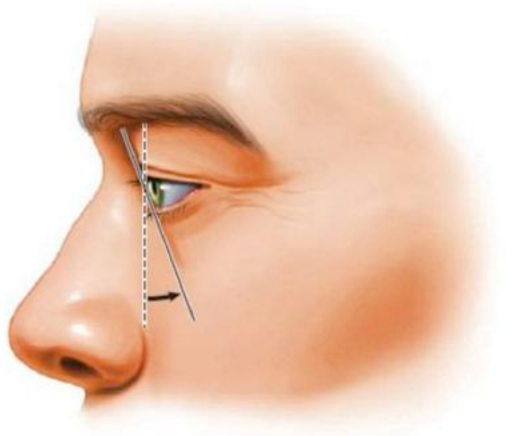

Fig. 5. A negative vector globe is demonstrated, as the tip of the globe is more anterior than the prominence of the cheek (*solid line*). The dotted lines show what would be considered a neutral vector, as the tip of the globe and cheek are in the same vertical plane. The size of the arrow correlates to the degree of negative vector. (*From* Massry G. and Kossler A. The Spectrum of Canthal Suspension Techniques in Lower Blepharoplasty. In: Azizzadeh B, Murphy M, Johnson C, editors. Master Techniques in Facial Rejuvenation, 2nd edition. Canada: Elsevier; 2018; with permission.)

depth.[42] The data collected have allowed a basis for the insights and recommendations the authors adhere to.

Open Canthal Suspension

Open canthal suspension (OCS) is the most aggressive and powerful technique. This surgery yields the most frequent postoperative complaints, and it carries the longest postoperative recovery time.[1,42]

Surgical Indication

The surgical indication is for significant lower eyelid laxity where lid shortening is typically needed. This procedure is usually performed in older patients and is the least common CS procedure the authors perform.[1,42]

The authors-preferred open CS is similar to the original description by Anderson and Gordy[17,18] of the lateral tarsal strip procedure. An 8- to 10-mm canthotomy incision is drawn with a marking pen using an existing canthal rhytid (smile line) if possible. This area is infiltrated with 1 to 2 mL of 1% Xylocaine with 1:100,000 epinephrine. An incision is made through the skin with a scalpel blade, and the underlying muscle is divided to the periosteum with the pure cutting mode of an electrocautery unit, or with a Westcott scissors. The commissure is then divided similarly to the orbital rim. The terminal eyelid is grasped with forceps and pulled anterior to the orbital rim. The traction created puts the LCT on stretch. A Westcott scissors is used to identify the inferior crus of the LCT. This is done by directing the tip of a Westcott scissors into the wound between the terminal lower eyelid and the lateral orbital rim. The scissors is moved in a side-to-side motion and will catch and then strum the inferior crus of the LCT, which is then lysed, dynamically releasing the lower eyelid. The terminal lower lid is then pulled to the lateral orbital rim at the level of the Whitnall tubercle to

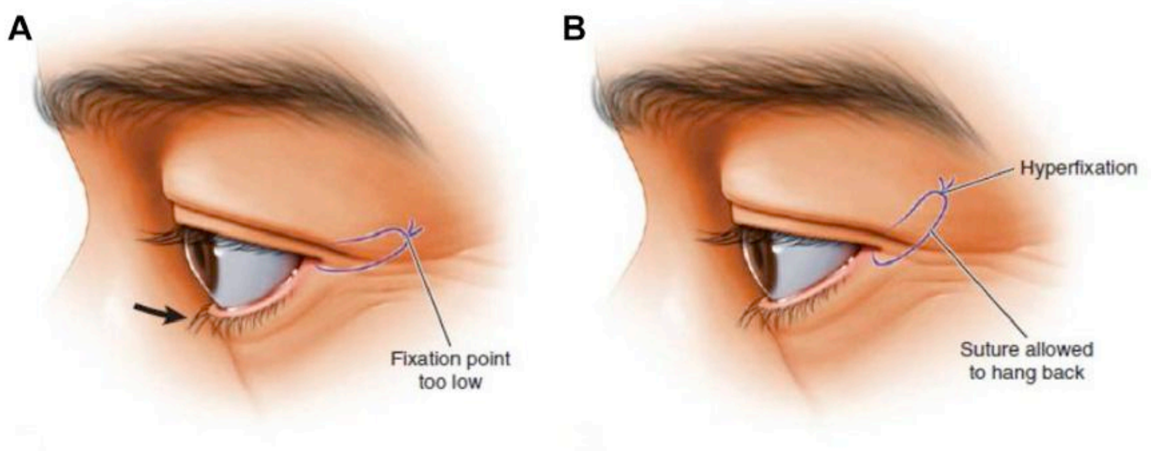

Fig. 6. (*A*) Suture fixation of the lower lid with a prominent globe. Note the bowstringing of the globe with lower eyelid retraction (arrow). (*B*) These changes are mitigated with supra-placement or hyperfixation and hanging back of the canthal suspension (CS) suture. (*From* Massry G. and Kossler A. The Spectrum of Canthal Suspension Techniques in Lower Blepharoplasty. In: Azizzadeh B, Murphy M, Johnson C, editors. Master Techniques in Facial Rejuvenation, 2nd edition. Canada: Elsevier; 2018; with permission.)

approximate how much eyelid tissue to excise before resecuring the eyelid to the orbital rim. Globe position must be considered with this calculation. A prominent globe requires more lid length to cover its surface area.[1,2] An overresection of eyelid in this setting can lead to bowstringing of the globe and lid retraction.[1,2,39] Conversely, if the globe is sunken (enophthalmic), more aggressive resection may be appropriate. Once the amount of lid shortening is determined, a tarsal tongue, or strip, is fashioned. The anterior and posterior lamellae are split, and the mucocutaneous junction is excised for this distance. The remaining triangle of anterior lamella overlying the tarsus is excised; the conjunctiva and lower eyelid retractors attached to the formed strip are cut from it, and the posterior surface of the tarsal tongue is deepithelialized with debriding with a scalpel blade. This is an important step, as it prevents postoperative inclusion cysts from forming. A strip of tarsus (tarsal tongue) free of surrounding tissue is now fashioned. The tarsus is then shortened as planned. A 4-0 Vicryl suture on a P-2 half-circle needle engages the tarsus from the side facing orbicularis muscle and exits on the side facing the globe. This directionality is important to assure orientation of the eyelid (tarsus to orbital rim). The tarsus is engaged with 1 or 2 suture passes and then secured to the inner orbital rim periosteum at the level of the Whitnall tubercle. The suture is tied with a tension determined by lower eyelid position (ie, avoid bowstringing or laxity). A 5-0 Vicryl suture is then used to reform the commissure. This is a critical strep to recreate the appearance of the canthal angle. The suture is passed from the terminal lateral upper and lower lid entering external to internal wound at the gray line of both eyelids. A periosteal bite can be taken in between the eyelid bites to further sharpen the canthal angle. The canthotomy incision is then closed with interrupted 6-0 nylon suture (**Figs. 7** and **8**).

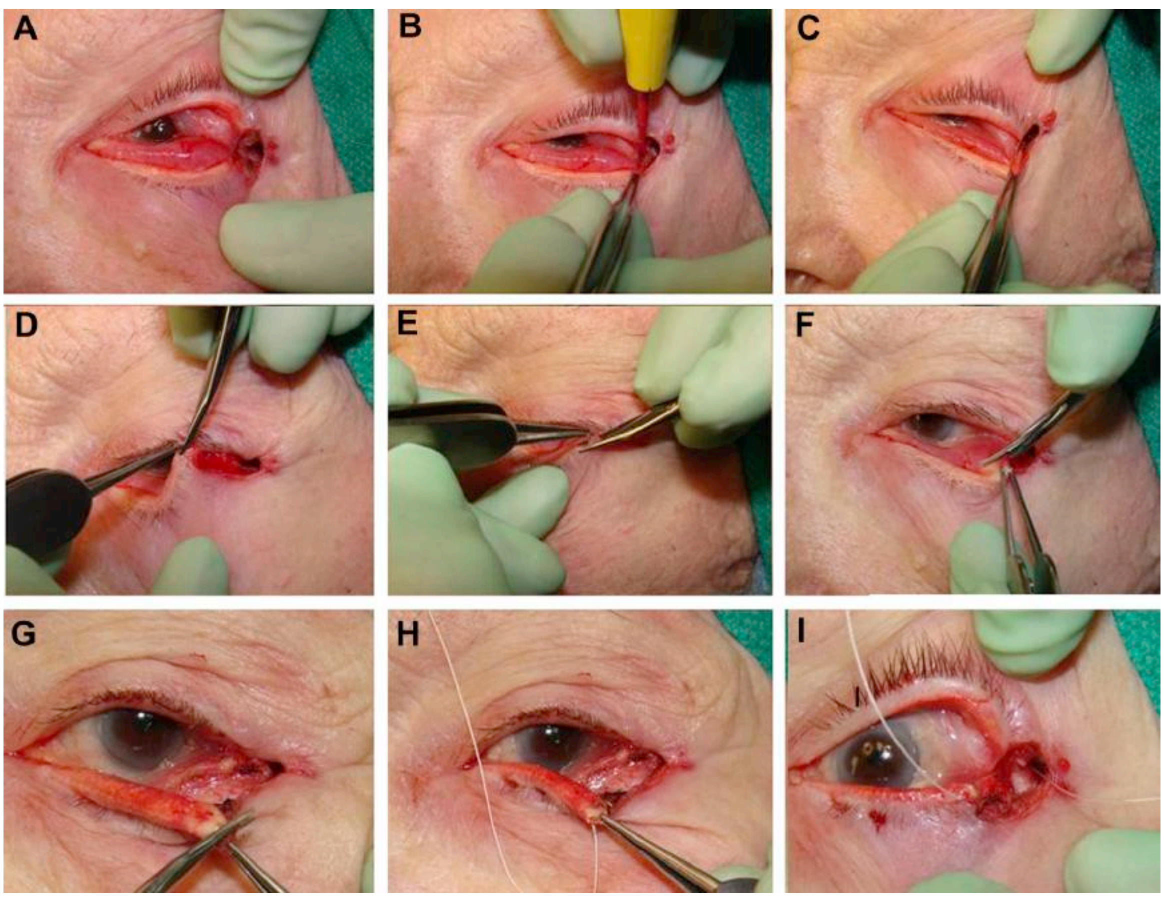

Fig. 7. Open canthal suspension (OCS) vis lateral tarsal strip procedure: (*A*) Canthotomy, (*B*) cantholysis, (*C*) dynamic release of the lower eyelid, (*D*) trimming mucocutaneous junction, (*E*) anterior lamellar excision, (*F*) tarsal release from conjunctiva and retractors, (*G*) shortening of formed tarsal strip, (*H*) tarsal strip engaged with fixation suture, (*I*) fixation suture secured to periosteum. (*From* Massry G. and Kossler A. The Spectrum of Canthal Suspension Techniques in Lower Blepharoplasty. In: Azizzadeh B, Murphy M, Johnson C, editors. Master Techniques in Facial Rejuvenation, 2[nd] edition. Canada: Elsevier; 2018; with permission.)

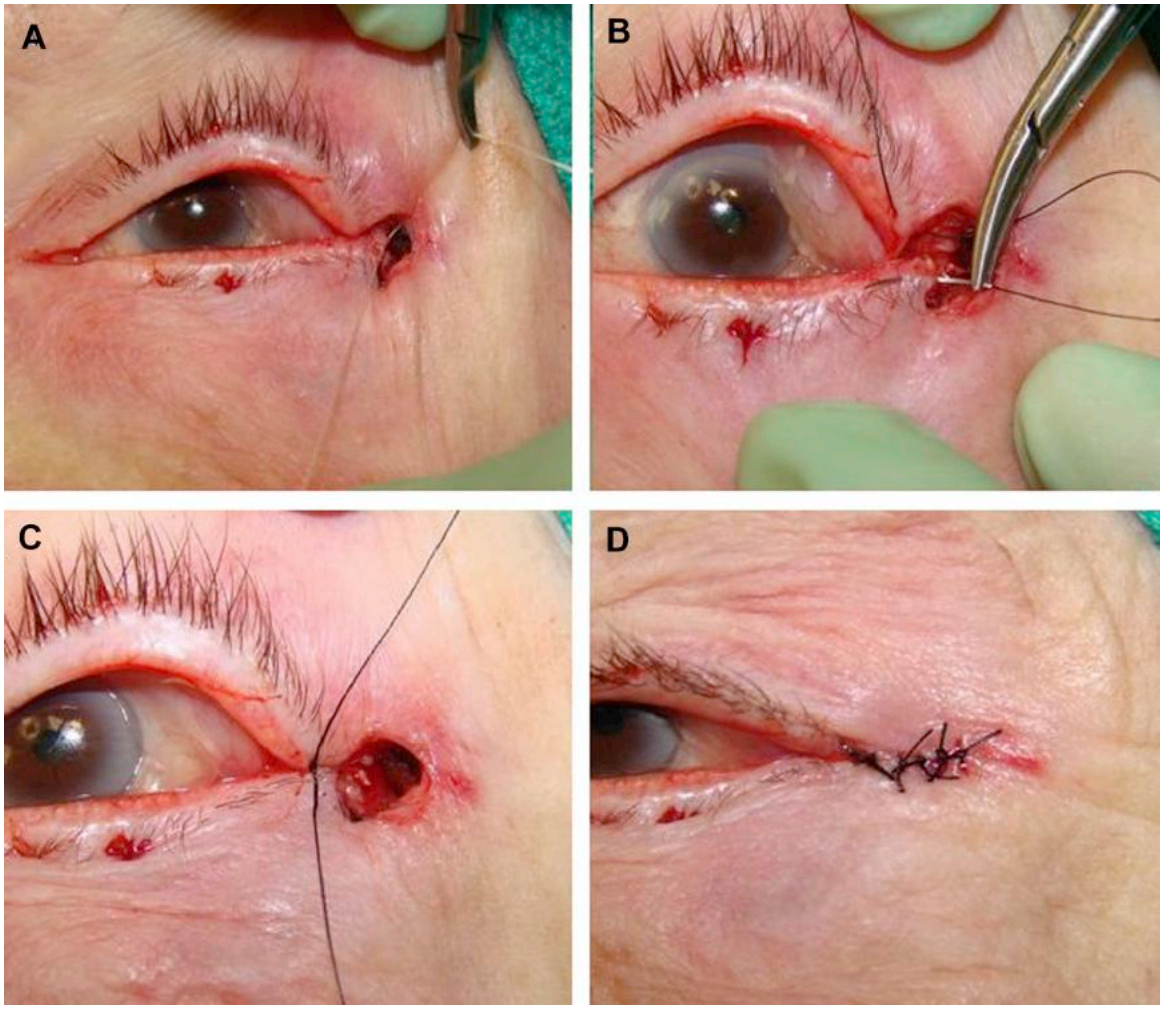

Fig. 8. (*A*) Canthal fixation suture tied, (*B*) terminal eyelid gray line (gray line placed to reform commissure), (*C*) commissure reformed, (*D*) canthotomy closed. (*From* Massry G. and Kossler A. The Spectrum of Canthal Suspension Techniques in Lower Blepharoplasty. In: Azizzadeh B, Murphy M, Johnson C, editors. Master Techniques in Facial Rejuvenation, 2nd edition. Canada: Elsevier; 2018; with permission.)

Closed Canthal Suspension

Closed canthal suspension (CCS) is the least aggressive and powerful technique the authors use, yet it is sufficient in most aesthetic cases. Typically, there are few postoperative complaints; it yields the quickest recovery, and by nature, is the most "aesthetic".[1,42]

Surgical Indication

The surgical indication is for the presence of eyelid laxity (minimal to slightly moderate) whereby clinical judgment dictates CS in the least invasive way. Most patients fall into this category of CS procedure.

A temporal upper eyelid crease incision is demarcated 10 mm in length. A preexisting rhytid is used if present. This area and the canthus are each infiltrated with 1 to 2 mL of 1% Xylocaine with 1:100,000 epinephrine. An incision is made through the demarcated skin with a scalpel blade. If an upper blepharoplasty is also performed, access for CS is attained through the temporal wound. As with OCS, the remaining surgery can be performed with the pure cutting mode of an electrocautery unit or a Westcott scissors. The orbicularis muscle is divided, and a suborbicularis dissection ensues to the periosteum over the superolateral orbital rim and proceeds inferiorly until the LCT is identified. The tendon is then put on stretch and can be strummed and then lysed in a graded fashion depending on how much support of the eyelid and/or elevation of the canthus is desired. This is simplified by placing the Westcott scissors or electrocautery tip into the dissection pocket with one hand while elevating the canthus with forceps of the other hand. Most patients undergoing this variant of CS have mild laxity and only require little canthal support. In this instance, partially lysing the LCT is adequate. This creates a raw surface for re-adhession once the canthus is suspended. Because the entire inferior crus is not cut, canthal position rarely changes, which is a very important and desirable aspect of this technique. In cases whereby true minimal laxity exists, the tendon can be secured without incision, which allows plication only. The authors refer to this as a "chicken CS." In reality, it is a canthopexy plication suture. This is used when surgeons are equivocal about the need for CS but add it for mental comfort. Finally, a full release of the LCT is performed for added suspension or, rarely, to elevate the canthus. To ensure suspension to the inner orbital rim periosteum (important step) is complete, the orbital septum adjacent to the canthal tendon is incised, which often exposes the lacrimal gland (which is not an issue, as it can be displaced for suture placement). A double-armed 5-0 PDS suture on an RB-2 needle is passed both ends through the same hole in the commissure (external to internal wound), or if more support desired, through the terminal tarsus. Both ends are then passed through the exposed periosteum at the inner orbital rim. Because exposure is limited, it can be helpful to use the wooden end of a cotton-tipped applicator to identify the inner orbital rim periosteum and deflect away the lacrimal gland and adjacent levator aponeurosis while passing the CS sutures. This ensures nonimbrication of these structures in the suspension when the sutures are tied. As with OCS, suture placement is dictated by globe position. The orbicularis muscle can then be closed with a few interrupted buried absorbable sutures and the skin with running 6-0 nylon suture (**Fig. 9**).

Commissure-Sparing Open Canthoplasty

Commissure-sparing open canthoplasty (CSOC) is a hybrid approach between the OCS and CCS. It has an intermediate level of patient complaints and recovery time between the 2 previous procedures and is more powerful than the closed surgery and less invasive than the open technique.[1,42]

Surgical Indication

The surgical indication is for intermediate eyelid laxity, and if added, midface support is needed.

A demarcation of a canthotomy incision, anesthetic infiltration, and a canthotomy with dissection to the orbital rim are performed as with the OCS variant. In this case, when the canthotomy is performed, the commissure and canthus are spared division for 3 mm. This leaves a bridge of the canthal angle intact. With direct view, septal

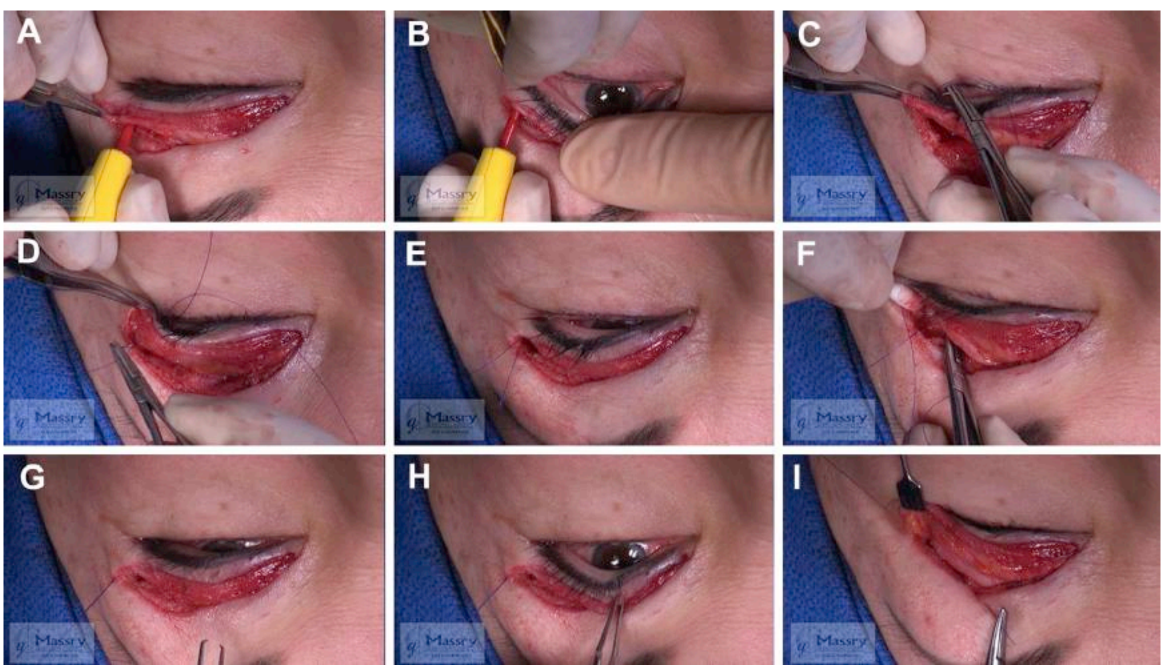

Fig. 9. Closed canthal suspension (CCS) procedure. This patient had entry through an upper blepharoplasty incision, as this was a planned procedure. (*A*) Suborbicularis/preperiosteal dissection to LCT, (*B*) cantholysis, (*C*) suture entering commissure, (*D*) suture exiting commissure, (*E*) both ends of suspension passed through commissure and exiting wound, (*F*) suspension suture engaging periosteum, (*G*) suspension suture pulled, (*H*) lower lid tension shown with upper lid elevated, (*I*) suspension suture tied. (*From* Massry G. and Kossler A. The Spectrum of Canthal Suspension Techniques in Lower Blepharoplasty. In: Azizzadeh B, Murphy M, Johnson C, editors. Master Techniques in Facial Rejuvenation, 2nd edition. Canada: Elsevier; 2018; with permission.)

attachments to the orbital rim/LCT are freed, isolating the tendon from the orbital rim periosteum. As with the CCS, the LCT is lysed in a graded fashion depending on clinical indication and degree of suspension desired. A single-armed 5-0 PDS suture on an RB-2 needle is passed through the inner orbital rim periosteum, then to-and-fro from the internal canthal wound, exiting the commissure, and then from external to internal. Terminal lower lid tarsus can be engaged as needed again per clinical judgment to control eyelid tension. The suture is then passed a second time through the periosteum and tied. Alternatively, as with the CCS, both ends of a double-armed similar suture can be passed through the same hole in the commissure external to internal wound and secured to the orbital rim periosteum. Should less vertical tension be desired on the canthus, or if a frank midface lift is needed, dissection can proceed through the canthotomy in a suborbicularis and preperiosteal plane. The orbitomalar ligament is released as needed to enter the prezygomatic space. The terminal preseptal orbicularis can then be engaged with the same 5-0 PDS suture and secured to orbital rim periosteum or deep temporalis fascia above, depending on the lift and support desired. The canthotomy is then closed with interrupted 6-0 nylon suture (**Figs. 10** and **11**).

CANTHOPEXY

As stated, a canthopexy is a plication suture of the LCT or orbicularis muscle. In the authors subspecialty aesthetic eyelid practice (oculoplastics), they have not found this to be predictably adequate in preventing postoperative eyelid malposition after lower blepharoplasty. Their belief has been substantiated by post–lower blepharoplasty eyelid retraction cases sent to their referral practices for evaluation and management, many of which underwent canthopexy to support the lower eyelid. Again, it is typically not the CS choice, but rather the blepharoplasty performed that predisposes to retraction. However, using a plication suture in cases whereby lower lid skin

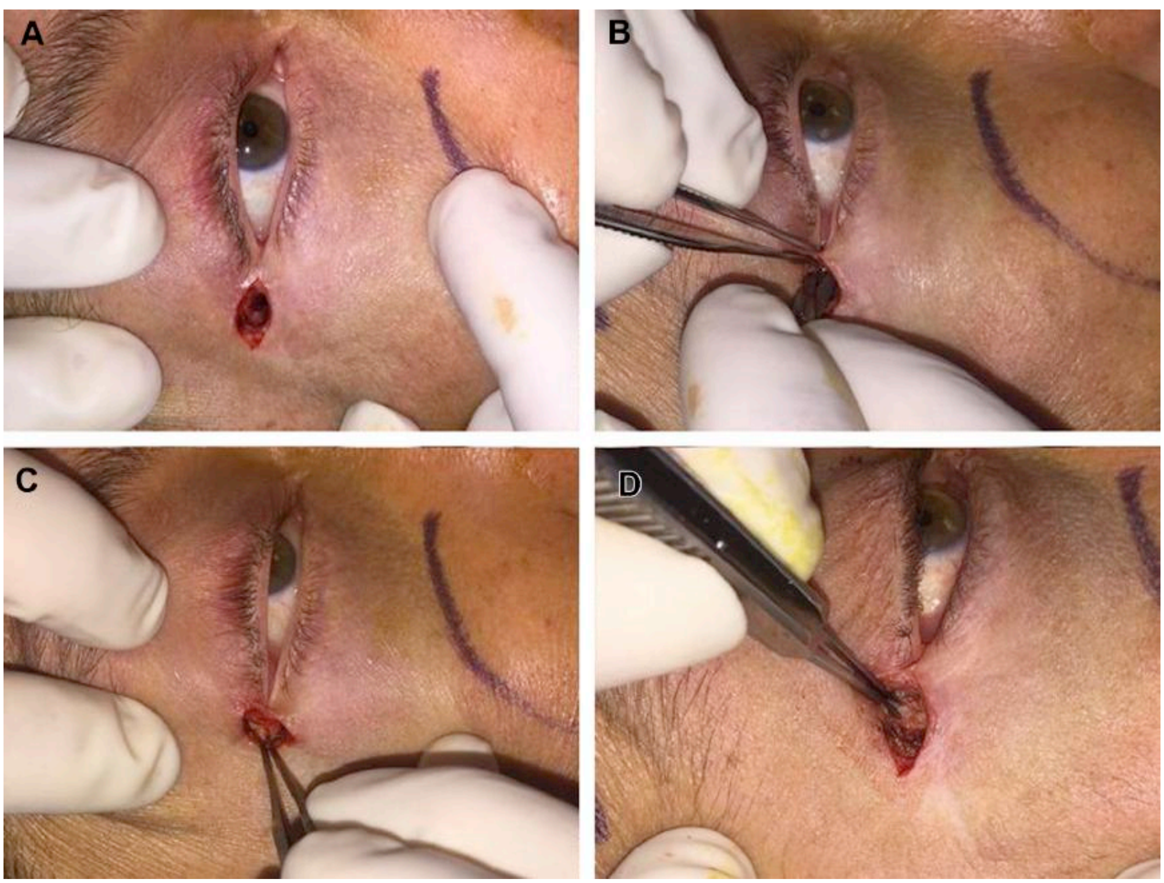

Fig. 10. Commissure-sparing open canthoplasty (CSOC) procedure. (*A*) Canthotomy-sparing commissure, (*B*) cantholysis, (*C*) grasping LCT, (*D*) grasping periosteum. (*From* Massry G. and Kossler A. The Spectrum of Canthal Suspension Techniques in Lower Blepharoplasty. In: Azizzadeh B, Murphy M, Johnson C, editors. Master Techniques in Facial Rejuvenation, 2nd edition. Canada: Elsevier; 2018; with permission.)

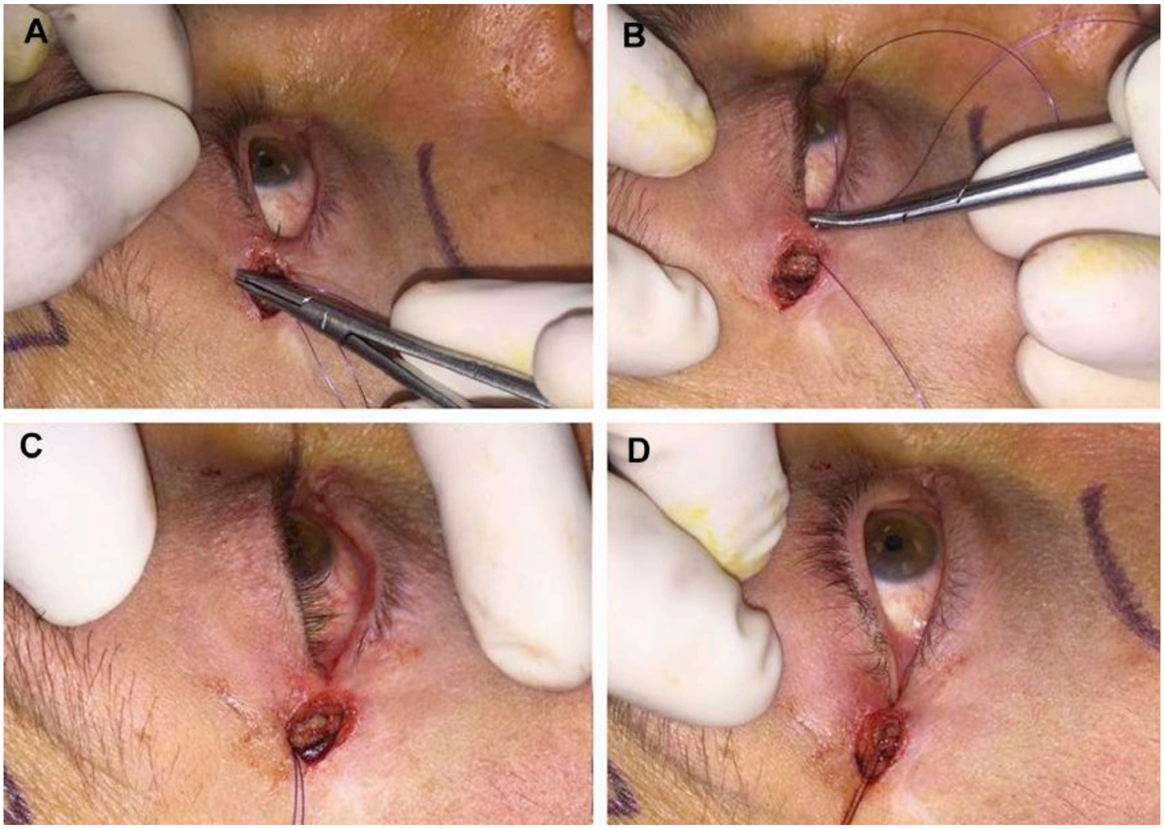

Fig. 11. Canthal suspension (CS) suture (*A*) passed internal to external at commissure, (*B*) then passed external to internal at commissure, (*C*) passed through periosteum, (*D*) placed on tension demonstrating suspension. (*From* Massry G. and Kossler A. The Spectrum of Canthal Suspension Techniques in Lower Blepharoplasty. In: Azizzadeh B, Murphy M, Johnson C, editors. Master Techniques in Facial Rejuvenation, 2nd edition. Canada: Elsevier; 2018; with permission.)

and/or muscle is excised can be a setup for this complication. Conversely, this is less frequently the case when formal canthoplasty is performed. As such, the authors rarely use a pure canthopexy for CS, except for the "chicken procedure" mentioned in the CCS section. For a review of the authors' canthopexy technique, please refer to their previous publication.[2]

POSTOPERATIVE CARE

After surgery, patients apply ice compresses 10 minutes per hour every hour while awake for 2 days. They are instructed to reduce heavy physical activity (bending, stooping, and lifting) and sleep with the head of bed elevated with 2 pillows until follow-up in 1 week. They are prescribed erythromycin ophthalmic ointment to be applied to the suture line (canthal or upper lid crease) and topical Tobradex ophthalmic drops to the eye 3 times a day for 1 week. The drops are added, as most patients have had concurrent transconjunctival lower blepharoplasty, and this is the authors' standard for this procedure. In addition, if stand-alone OCS or CSOC is performed in combination with isolated skin excision lower blepharoplasty, drops are added, as these variants of CS have a higher incidence of chemosis. Oral narcotics and bedtime sedatives are dispensed on a case-by-case basis determined before surgery based on patient evaluation. Norco 5/325 (5 mg hydrocodone/325 mg acetaminophen) orally 3 times a day and Restoril 15 mg at bedtime are adequate. In patients with a history of postoperative nausea or motion or car sickness, or in those who are prescribed narcotics, Zofran 4 mg every 8 hours as needed for 3 days is given. Patients are evaluated just after surgery and upon discharge from the surgical center. A general visual acuity is always ascertained. Patients are also instructed to call the office should there be a noted change in vision or pain level, more than mild bleeding, significant discharge, or any constitutional symptoms. Sutures are removed at 1 week, at which time topical drops and ointment are discontinued. Unless there is concern with recovery, normal follow-up is at postoperative month 1 and month 3.

COMPLICATIONS

The discussion of complications is an important part of this article. As stated, blepharoplasty is an elective aesthetic procedure. In these cases, CS is an adjunct to enhance outcome and prevent, not cause, setbacks or complications. The authors cannot overstate the importance of "less is more" in this setting. In other words, add CS as needed but use the least invasive procedure to get the job done. This reduces the risks of complications seen with CS surgery.

The more common complications postoperatively occur within the first month of surgery. These complications include chemosis, suture reactions/infections, cysts, canthal pain/tenderness, and wound dehiscence. Chemosis can typically be managed with topical and/or oral steroids and upwards lid massage to compress and redirect the fluid. If this fails, a lateral temporary tarsorrhaphy can be added for 2 weeks. In more than 95% of cases, this resolves the issue. If chemosis persists, light conjunctival epithelial burns in a grid pattern with a low-temperature handheld cautery after lidocaine subconjunctival infiltration is highly effective. The authors believe the epithelial burns tack down the conjunctiva and prevent fluid accumulation. The external appearance of the burns typically resolves within 4 days. A conjunctival cut down can also be used in recalcitrant cases, but the authors have noted frequent recurrence and prefer the epithelial grid burn approach more. Suture reactions can be inflammatory or infectious. In either instance, a small cut down over the suture is performed, and the suture is removed. Should cellulitis be present, oral antibiotics are added. Epithelial-lined inclusion cysts are rare but can occur as with any conjunctival or cutaneous incision. These cysts are easily managed with excision. Canthal pain and tenderness are troublesome. Fortunately, they usually resolve with time and manual massage. If this fails, a cocktail of injections with wound modulators (see later discussion) can help. Should pain persist, a trial of oral tricyclic antidepressants or GABA drugs can, at times, alleviate symptoms. Finally, if permanent sutures to suspend the lid were used, their removal can be considered. The authors have only rarely noted permanent persistence of canthal pain after all measures stated for treatment are undertaken.

The most difficult complications to manage are canthal asymmetries/malalignment (dystopia), webs, and scars. Asymmetries often resolve over time with or without manual massage. If they persist, revision is warranted. As a rule, raising a lower canthus is significantly easier and more predictable than lowering a higher one. Please keep this mind, that the best way to treat this issue is prevention. Surgical intervention typically includes extensive periosteal release at the orbital rim before resecuring the canthus. Canthal webs and scars require time and massage, and chemomodulation as first-line therapy. Kenalog 5 mg/mL (0.2 mL) or 5-fluorouracil (5-FU) 50 mg/mL (0.2 mL) is helpful.[43–45] The authors prefer 5-FU, as it is not particulate (prevents rare vascular visual compromise) and tends not to cause skin dyschromia, telangiectasis, and atrophy. Injections can start as early as 2 weeks after surgery (0.2-mL aliquots) and be given every few weeks until stability is reached (typically 4 injections total).[45] Botulinum toxin A can be given in microdoses (2–4 units). This has been shown to inhibit myofibroblasts and scar formation/contraction.[44,46] The authors have anecdotally noted improvements with this form of therapy with or without added 5-FU injection. Should webs persist, surgical modification is a last option.[47] Although webs can be improved, rarely are they eliminated. Patients must be aware of this before further intervention. Finally, there is a small subgroup of patients who complain of canthal tightness and, eyelid tightness, that "my eyes feel different," and in the face of what appears as a normal appearance, that "my eyes just are not the same."[42] Fortunately, these patients are rare. Unfortunately, the authors have found no good solution in these cases. Reassurance and acknowledgment are the most helpful remedies here.

SUMMARY

CS is an integral adjunct to lower blepharoplasty, which can yield predictable and reliable outcomes when surgery is based on a detailed understanding of relevant anatomy and preoperative evaluation nuances, which dictate appropriate procedure choice. It is critical to understand that CS is about creating physiologic and tension-free lower eyelid support. CS cannot overcome the vertical traction inherent to overzealous lower blepharoplasty. In this instance, eyelid malposition can occur irrespective of how the canthus is addressed. In addition, canthal complaints and complications are more frequent when more distortion of canthal anatomy and architecture occurs. The take-home message is to add CS to support the lower lid during blepharoplasty when needed, to be familiar with the various CS procedures available to you, and to develop a comfort with these interventions. Finally, keep in mind that although CS is a critical part of successful lower blepharoplasty, when blepharoplasty is performed correctly, less is often more, and all that is needed, to achieve successful result to CS surgery.

DISCLOSURE

Dr G.G. Massry received royalties from Elsevier, Springer, Quality Medical Publishers, and Osmotica Pharmaceuticals. Dr. Holds received royalties from Springer, and is a consultant and shareholder for Horizon Pharmaceuticals, and a shareholder of Cypris Medical, Revance Thereapeutics and Panbela Therapeutics. Dr R.S. Douglas received Royalties from Springer, Osmotica Pharmaceuticals, and Horizon Pharmaceuticals.

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The Brow Fat Pad Suspension Suture: Safety Profile and Clinical Observations

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Purpose: To evaluate the safety, subjectively assess outcome, and emphasize surgical pearls and critical clinical observations of upper blepharoplasty performed in conjunction with the brow fat pad suspension suture procedure, previously referred to as a "browpexy variant" or "brassiere suture procedure."

Methods: A retrospective 4-year analysis of patients who underwent the brow fat pad suspension suture with upper blepharoplasty was performed. Adjunctive procedures (brow lift and ptosis repair) were categorized. The surgical technique is detailed with emphasis placed on nuances to aid in optimal outcome.

Results: Two hundred and sixteen patients (149 women and 47 men) underwent upper blepharoplasty with the brow fat pad suspension suture. The average patient age is 54 years and follow up is 11 months. One hundred patients had adjudicative brow lift or ptosis repair, and in 20 patients the blepharoplasty was a revision procedure. Subjective assessment of outcome showed excellent aesthetic results with improved brow projection, and enhanced lateral tarsal platform show and eyebrow/eyelid contour. Surgical complications were infrequent and patient satisfaction was high.

Conclusions: This initial large series description of the brow fat pad suspension suture demonstrates that it is a safe adjunct to upper blepharoplasty, which the authors believe subjectively improves overall outcome. Evidence-based quantitative assessments of objective measures of surgical results are currently underway.

(*Ophthal Plast Reconstr Surg* 2016;XX:00–00)

Upper blepharoplasty continues to evolve from what was once a procedure founded on fat excision,[1–4] to one which now gives consideration to native eyelid fat preservation (fat transposition) and autologous fat augmentation (fat grafting).[1,5–17] This paradigm is founded on contemporary thought, which emphasizes recreating a more youthful fullness and contour to the eyelids and periorbital area.[1,5,7,9,12,14–17] Native upper eyelid fat transposition techniques, performed in conjunction with upper blepharoplasty, have been described to preserve eyelid volume,[9–11] fill adjacent periorbital hollows,[12] and act as a tissue substrate to prevent multiple crease formation in Asian patients.[13] One of the authors of this report has been transposing upper eyelid fat flaps for the last 6 years in hopes of minimizing postoperative upper periorbital and sulcus hollows, and improving eyelid contour, volume, and appearance.[9,12] While, to date, no evidence-based reports have documented statistical efficacy in this regard, the procedure has been generally complication free, and anecdotally has yielded excellent results with high patient satisfaction (author experience). Furthermore, while more commonly accepted in lower blepharoplasty[18–22] upper eyelid fat preservation procedures are becoming accepted by oculofacial surgeons as well. This is substantiated by a 2013 survey of members of the American Society of Ophthalmic Plastic and Reconstructive Surgery, which showed that 36% of respondents transpose upper eyelid fat during routine upper blepharoplasty.[23]

In this report, the authors emphasize another fat preservation and repositioning refinement performed as an adjunct to upper blepharoplasty, specifically involving the brow fat pad. The procedure secures the free ends of orbicularis muscle present at the upper and lower edges of the blepharoplasty incision to the superior arcus marginalis periosteum. The union of these structures mechanically elevates and repositions the ptotic brow fat pad to a more youthful location. The authors have noted this minor addition to surgery creates an anterior projection of the brow, a more prominent lateral tarsal platform, and an enhancement of the brow/eyelid contour and transition, all characteristic of a youthful brow and upper eyelid complex. The authors present their 216 patient experience with the procedure, emphasize its safety, and elaborate on surgical pearls and clinical observations they believe are of value.

METHODS

A 4-year retrospective chart review (2012 to 2015) of patients who underwent upper eyelid blepharoplasty surgery with adjunctive brow fat pad suspension suture (BFPSS) by 1 author (G.G.M.) was performed. All patients are from the private practice of this author and all surgeries were performed at an outpatient surgical center where the senior author has privileges. As such, institutional review board

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approval was not obtained, but the study adhered to the standards of the Declaration of Helsinki. Informed consent was obtained prior to each procedure. After surgery, patients were seen for regular postoperative visits to assess postoperative course, recovery, and complications.

Surgical Technique. All cases were performed under local, conscious sedation or general anesthesia depending on patient preference and associated procedures performed. An eyelid crease and ellipse of skin for excision is marked with the patient supine in the operating room. The demarcated area of the upper eyelid is infiltrated with 2 ml to 3 ml of 1% lidocaine with 1:100,000 epinephrine subcutaneously. A scalpel blade is used to incise the skin and a monopolar electrocautery device is used to perform skin excision. After skin removal, a central transverse incision is made through the exposed nasal orbicularis muscle and orbital septum until fat is identified. The wooden end of a cotton-tip applicator is inserted beneath the muscle and septum for the full width of the eyelid (nasal to temporal) (Fig. 1A). The Q-tip is elevated to tent up the septum and muscle, what the authors refer to as the *orbicularis tent*. This provides a stable backstop, which can be cut down on to divide the muscle/septum while protecting underlying structures such as the levator aponeurosis. The muscle should be divided centrally along its horizontal axis to create equal distribution of muscle above and below the incision. This allows centered fixation of muscle to the arcus marginalis. The brow fat pad is identified just below the orbital orbicularis muscle and above the frontal bone periosteum. A 5-0 chromic suture is used to engage the inferior edge of orbicularis just lateral to the temporal corneal limbus. The chromic suture is passed perpendicularly through the arcus marginalis periosteum (Fig. 1B) and lastly, the upper edge of orbicularis muscle (Fig. 1C). The suture is tied and its end cut short (Fig. 1D). Typically, 1 or 2 additional interrupted sutures are placed in the lateral third of the eyelid. Care is taken to avoid engaging the levator aponeurosis or prolapsed lacrimal gland, if present, with the chromic suture. Functionally, the suture serves to suspend and tuck the brow fat pad superiorly to create a volume-enhancing effect. The skin incision is closed with interrupted and running 6-0 nylon suture at the completion of the procedure (Video, Supplemental Digital Content 1, http://links.lww.com/IOP/A145).

RESULTS

The study cohort consists of 216 patients (432 eyelids) of which 149 are women (69%) and 67 are men (31%). The mean patient age is 54 years (range 34–86 years) and the mean follow up is 11 months (range 3–34 months). A number of patients underwent concurrent procedures to the brows and/or upper eyelids in addition to upper blepharoplasty at the same setting. These included 42 endoscopic brow lifts (22%), 22 direct brow lifts (12%), and 36 ptosis repairs (17%). All brow lifts and 30/36 ptosis repairs were bilateral. One hundred and sixteen patients (54%) had a BFPSS and blepharoplasty without other brow/upper eyelid procedures performed. Twenty of the patients (9%) studied underwent secondary (revision) upper blepharoplasty.

The BFPSS was a well-tolerated upper blepharoplasty adjunct with infrequent complications. Two patients (1%) had erosion of the chromic suture through the skin. In both cases this resoled uneventfully by secondary intention healing within 1 month. One patient had a postoperative notch (<1%) at the location of suture placement (Fig. 2,

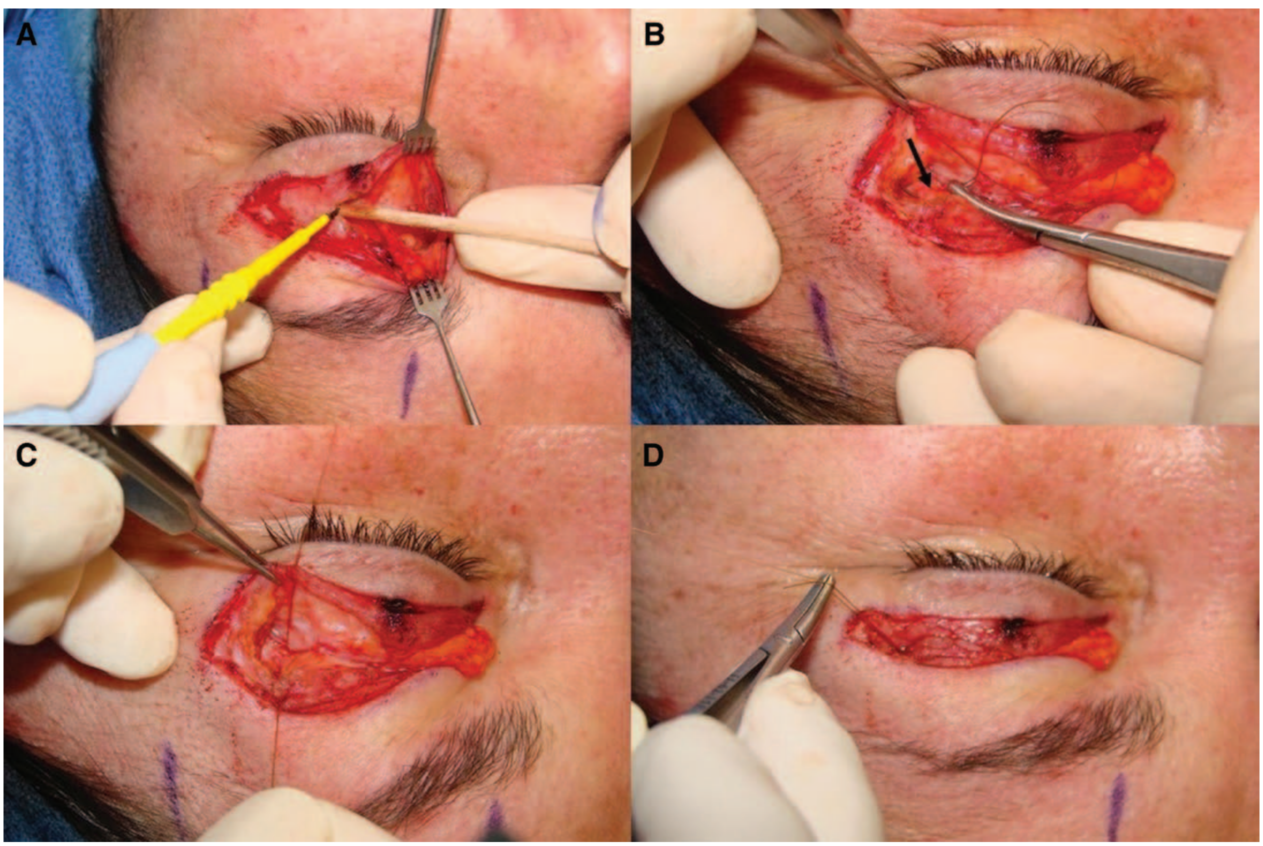

FIG. 1. **A,** The *orbicularis tent*: wooden end of cotton-tip applicator elevates the orbicularis muscle and orbital septum superiorly to act as backstop for division of these tissues. This maneuver protects underlying structures from damage. The muscle is incised centrally along its horizontal plane. **B,** Suture passed through arcus marginalis periosteum (*black arrow*). **C,** Suture shown to engage inferior wound edge orbicularis, arcus marginalis periosteum and superior wound edge periosteum. **D,** Suture tied.

FIG. 2. All patients are before (**left**) and after (**right**) surgery on frontal view. **Top**: Nine months after blepharoplasty with BFPSS. Note symmetric tarsal platform and enhanced brow fullness and brow/eyelid contour. **Second**: One year after temporal endoscopic approach brow lift with blepharoplasty and BFPSS. Note brow fullness and tarsal platform. **Third**: Eight months after isolated upper blepharoplasty and BFPSS. Similar improvement as previous patients. **Bottom**: Note small notch left upper eyelid after surgery.

FIG. 3. All patients are before (**left**) and after (**right**) surgery on oblique view. Top 2 patients are 11 and 14 months after temporal endoscopic brow lift, blepharoplasty, and BFPSS. The bottom patient had isolated blepharoplasty and BFPSS (7 months after surgery). In all cases, note improvement in tarsal platform and brow/eyelid contour.

bottom). This was noted by physician and not the patient. Two patients (1%) noted exposure symptoms (dryness and foreign body sensation) for an extended period after surgery. They both had lagophthalmos for greater than 3 months, which resolved on its own with conservative management (lubrication and eyelid squeezing). In each case symptoms and findings were related to orbicularis deficit, and both of these patients were secondary upper blepharoplasties. Two patients (5.5%) out of 36 who had concurrent ptosis repair required ptosis revision with appropriate outcome, and 2 patients (1%) had postoperative lateral upper eyelid induration with inflammatory signs, which resolved with oral steroid use in each case. Two patients (1%), both the ptosis revisions, stated dissatisfaction with their initial surgery, but were satisfied with their final outcome after staged adjustment.

DISCUSSION

In 1997, Dr. Zarem[24,25] introduced his interpretation of the BFPSS as a *browpexy variant* in hopes of elevating the lateral brow, and in his words, *defining the tarsal sulcus (sulcoplasty) and producing a sculpted upper eyelid*. In his technique, after standard skin and fat (nasal and preaponeurotic) excision, he secured the free superior cut edge of orbicularis muscle to the superior arcus marginalis periosteum. His series included 208 patients and he suggested excellent results with few complications. Again his focus was directed at a lateral brow lift and a defined upper sulcus, which was en vogue at the time.

In 2010, Jonathan Hoenig, M.D. (personal communication) described his variation of the BFPSS to one of the authors (G.G.M.), not for the purpose of lifting the brow or sculpting the upper eyelid, but as a means of elevating and supporting the ptotic brow fat pad as an adjunct to fat grafting the brow. He noted the procedure also improved the brow/eyelid contour. Dr. Hoenig, who began adding brow fat pad suspension/elevation to upper blepharoplasty in 1996, further noted that the inferior orbicularis has also been included in the orbicularis/arcus marginalis suspension suture, and that it was Robert Goldberg, MD who coined the name the *brassiere suture*[26] to this maneuver, as it acts as a brassiere to elevate the ptotic brow fat pad.

The current authors' interpretation of the procedure is founded, with minor variation, on Dr. Hoeing's description. While they have not subjectively noted a persistent obvious brow lifting effect as Zarem[24,25] suggested, they agree with Dr. Hoenig that the brow/eyelid transition and contour are improved. The authors perform conservative skin excision, without removal of orbicularis muscle, and only rarely removal of preaponeurotic fat as to preserve upper eyelid and sulcus volume. Their goal is not to deepen the upper sulcus but to naturally recreate the youthful transition of the brow to the upper eyelid. In addition to improved brow/eyelid contour, the authors have also found that the lateral tarsal platform is consistently enhanced. This technique, with these same observations, was formally presented to the American Society of Ophthalmic Plastic and Reconstructive Surgery membership by Robert Goldberg, M.D. at the 2012 American Society of Ophthalmic Plastic and Reconstructive Surgery Fall Meeting in Chicago, Illinois,[27] but to date no large series of patients undergoing this variation of the procedure has been published.

What the author's experience with surgery has shown is as follows. 1) The procedure itself is a technically straightforward addition to standard upper blepharoplasty, which eyelid surgeons should be able to perform easily. 2) Exposure is the same as if the lacrimal gland is to be repositioned (common intervention when needed) in which the temporal retroseptal space is opened. 3) It is critical to assure nonengagement of the levator aponeurosis or lacrimal gland (in close proximity to the lateral superior orbital rim) during suture suspension to the arcus marginalis. 4) The orbicularis muscle should be divided along its central horizontal axis prior to suture placement (Fig. 1A). This allows centered muscle fixation to periostium without undue or unequal tension on the eyelid below and the brow above. 5) The described *orbicularis tent* (see Methods section) facilitates central muscle division and protection of underlying orbital structures (Fig. 1A). 6) While suture suspension of the orbicularis muscle to the orbital rim is more traumatic than standard blepharoplasty surgery, the authors have not noted a substantial increased healing or recovery time compared with similar septal division upper eyelid procedures. 7). A 5-0 chromic suture for fixation is preferred by the authors, as it dissolves (no long-term foreign body), and is proinflammatory, stimulating the formation of a tissue barrier (cicatrix). The authors have noted 2 cases of prolonged (1 month) lateral upper eyelid inflammation/induration, which was steroid responsive. However, this accounted for less than 1% of total cases. A monofilament suture can be exchanged should this be a concern. 8) Typically 2 fixation sutures are placed. However, more can be added depending on surgeon judgment. 9) Fixation sutures are placed lateral to the supraorbital neurovascular bundle. However, not included in this report are 3 patients who had similar sutures placed nasally (care to avoid the supraorbital nerve and blood vessels) to address nasal brow eyelid contour issues in patients with deficits related to previous surgery. These 3 patients had uneventful recovery and were satisfied with their outcome.

This report demonstrates procedure safety; however, clinical observations of outcome are subjectively based on surgeon experience and require further study (see comments below). What the authors have consistently identified are 3 findings which they believe improve aesthetic surgical results. First, the brows appear fuller (less flat) and have more anterior projection (Figs. 2 and 3). Currently this assessment is anecdotal, but the authors are starting a prospective study using 3-dimensional camera technology to assess volumetric changes pre- and post-surgery. Secondly, the authors believe that the lateral tarsal platform is enhanced compared with standard blepharoplasty without the BFPSS. In conjunction with the aforementioned brow projection study, the authors will evaluate this parameter with standardized photographs and measurements comparing patients undergoing blepharoplasty with the BFPSS to patients undergoing standalone blepharoplasty. Finally, because of the 2 findings above, the brow/eyelid transition and contour have consistently been enhanced (more youthful) among the study population. A masked surgeon comparison of outcome, and a patient satisfaction survey, will be added to the prospective study pending to critically evaluate this assumption.

Why this procedure may improve aesthetic surgical outcome, as stated, is a matter of conjecture. The authors believe when the brow fat pad is elevated during blepharoplasty, this, in itself, better defines and enhances the lateral tarsal platform. Also as the brow fat pad is supraplaced with a fixation barrier below, a step-off is created with enhancement or bunching of volume above (Video, Supplemental Digital Content 1, http://links.lww.com/IOP/A145). As the upper lip of the blepharoplasty wound is secured to the arcus marginalis, it may further act as a hammock to the brow fat pad, leading to both improved support, and brow/eyelid transition and contour. Finally, when the cut edges of the divided orbicularis muscle are secured to the superior orbital rim periosteum, a new insertion for the upper orbicularis and origin for the lower orbicularis are created. The forces of orbicularis contraction are now directed to this fixation point, which, by virtue of muscular pull, may further improve tarsal platform and brow fat pad elevation.

When the BFPSS was first added by the authors, the most significant concern was how the manipulation would affect dynamic function of the upper eyelid. While assessment of eyelid closure strength (attempted eyelid opening against forceful eyelid closure by patients) was not routinely performed, only 2 patients (<1%) reported exposure symptoms and manifested lagophthalmos beyond the immediate postoperative period (first 4 weeks). These patients were both upper blepharoplasty revisions, and their findings and symptoms resolved with time. This confirms other's experience with variations of the surgery.[17,24–27] Other complications were equally rare.

An important element of this report was to identify which patients would benefit from addition of the BFPSS. What the authors found is that in most patients, with even early signs of aging of the eyebrow/eyelid complex, the procedure is a useful adjunct. Relative exceptions may include those patients who have had previous blepharoplasty (2 such patients in this report had prolonged lagophthalmos), those undergoing concurrent ptosis repair (2 patents in this series required revision), and possibly those with concurrent inflammatory eyelid disease (i.e., thyroid eyelid disease, etc.). This last potential contraindication is an author assumption and was not identified from the surgical results. The authors excluded these patients as not to potentially stimulate their primary disease process. Finally, the authors subjectively did note that those patients with preoperative volume depleted eyebrows and upper eyelids (typically thin women 50 years old and above) had less anterior brow projection after surgery. These patients still had an improved lateral tarsal platform and brow/eyelid transition, but may benefit from simultaneous fat transfer to the brows to maximize the overall aesthetic outcome.

In an ongoing effort to improve aesthetic outcomes to both upper and lower cosmetic blepharoplasty, fat preservation and relocation procedures have been added to standard surgery. While not always anatomical or conventional surgical adjuncts, all these procedures have been *subjectively* reported to improve final eyelid and periorbital appearance.[9–12,17–22] Currently, the introduction of 3-dimensional cameras, which can assess soft-tissue volume pre- and postsurgery, may be the best means of statistically verifying these subjective statements. One study, substantiating the efficacy of fat transposition in lower eyelid blepharoplasty using this technology has recently been reported.[28] To the authors' knowledge this is the first report to document such results. Like other volume relocation interventions added to blepharoplasty, this initial large series report of the BFPSS is a surgeon experience description only. With this in mind, the authors have subjectively found the BFPSS, previously called a *Browpexy Variant*, or *Brassiere Suture*, to be a useful aesthetic addition to upper blepharoplasty. A definitive statement of procedure efficacy will follow with the formal prospective evaluation as stated. However, the authors believe the surgical series reported herein does demonstrate procedure safety with few postoperative complications.

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Vectorial Analysis of Deep Plane Face and Neck Lift

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Abstract

Background: The vector of aging and consequently the vector of lift in rhytidectomy has aided surgeons in improving movement of tissues during facial rejuvenation procedures.

Objectives: The goal was to analyze the vector of lift in patients undergoing primary and revisional facelift to achieve proper vectorial lifting.

Methods: Patients undergoing deep-plane facelift surgery were included for analysis. Intraoperative photographs and measurements were taken of the skin, superficial musculoaponeurotic system (SMAS), and platysmal suture suspension with mastoid crevasse inset. Measurements were compared between patients who were undergoing primary vs secondary surgery, site of lift, age, and gender.

Results: Seventy-one patients (90% female, mean age 57.8) with a total of 142 hemifaces were analyzed, 57 (73%) of which were primary and 14 (27%) secondary facelifts. The average vector of SMAS lifting was 70.8°. Females had a more vertical vector than males (71.3° vs 65.4°; $P < .01$). The average vectors of platysmal and skin lift were 87.0° and 58.2°, respectively. There was intrapatient difference between hemifaces. Despite there being more intersuture disparity in secondary cases than primary cases (16.9° vs 4.5°; $P < .05$), the mean vector of lifting was similar between them.

Conclusions: Proper release of the deep plane helps determine the appropriate vectors of lift, without relying on guidelines based on population averages. Each patient presents with a unique vector required to correct their descent. This technique provides an optimal result by directly suspending against the vectors of greatest descent.

Level of Evidence: 3

3
Therapeutic

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Facial aging and rejuvenation surgery are complex and multifactorial. The evolution of facelift surgery has explored the concepts of removal of wrinkles, pulling, tightening, overcorrection, redistribution of tension, and powerful fixation.[1-5] Deep-plane release has changed the paradigm, shifting toward glide plane release and tension-free positioning.[1,4,6,7] Surgeons have always known tension as the enemy—we are finally translating this into concepts in aesthetic surgery more reliably.

Research in the field of facelift surgery often focused on various surgical techniques, including types of wrinkle removal or rhytidectomy, the choice of vectors, and their impact on the aesthetic and functional results of the procedure.[4,5-9] One of the most debated topics has been

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choosing the proper vector of superficial musculoaponeurotic system (SMAS) suspension. This often has only focused on 2-dimensional (2D) pull, in the x and y, or horizontal and vertical, axes, and has failed to fully describe the proper method of finding vectors in the midface, jawline, and neck.

Despite advances in facelifting surgery and literature, the method for best determining the vector of lifting in patients undergoing facelift surgery remains unclear. Better understanding of vectorial release and correction may help improve patient outcomes and results. A large proportion of patients and surgery fail secondary to inadequate or improper correction, sometimes due to inadequate release. Analyzing the vectorial movement of the skin, SMAS, and platysma independently may help interpret the findings of previous articles that have described more appropriate vectors of movement and lift.[1,4,6,9-11]

In this paper, patients undergoing primary and secondary facelift surgery with a deep-plane release are examined for vectorial changes. Although many studies describe one vector of lift, the average findings within a study population do not universally apply to any individual patient. Similarly, angulation differs between facial skin, SMAS, and platysma, even if the lift is composite.

METHODS

Study Design

Patients undergoing an elective modified, extended deep-plane rhytidectomy were prospectively consecutively enrolled over a 3-month period (January 2023 to April 2023) in the practice of B.T. and retrospectively reviewed. All patients seeking rhytidectomy for aesthetic indications were evaluated, including those undergoing secondary rhytidectomy. All surgical procedures were performed by B.T. at a private practice surgery center. Intraoperative measurements were taken during routine surgery for B.T., and no experimental studies were performed on patients, in accordance with the Declaration of Helsinki. Patient demographic data, history, and operative details were recorded. Notations were made to the record if the surgery was a secondary case or if a brow lift was performed because this may have affected the vector of skin movement. The vector of suture elevation was measured to assess the vector of lift of the facial SMAS flap, lateral platysmal inset, and skin excision. Interpatient intrasuture angulation differences were recorded in primary and secondary surgeries. All patients in this study gave full informed consent to be included in the analysis and publication.

Operative Technique

The surgical technique utilized has been described by B.T. previously.[12] A brief description is provided to illustrate the movements obtained for this article. All patients underwent an extended deep-plane facelift.

Surgical Approach

Platysmaplasty and Submental Contouring

A submental incision was made, and the supraplatysmal plane was opened and dissection was carried inferiorly to the thyroid cartilage and laterally as far as the dissection could reach easily. Lateral and paramedian tissues were evaluated and reduced as deemed appropriate, followed by central structures. This was followed by a horizontal deep cervical fascia fasciotomy in front of the hyoid, permitting separation of the inframandibular and cervical platysma and allowing for tighter approximation of the platysma during plication. Platysmaplasty was then performed with a midline plication technique in the submentum between the submental incision and the hyoid.

Vertical Face and Neck Lift

Temporal tuft incisions were made, continuing into the prehelical crease, extending retrotragal or pretragal and then around the earlobe continuing into the postauricular sulcus to a posterior hairline incision. The skin was then elevated lateral to the deep-plane entry point, drawn with a sailboat modification, across the midline and inferiorly. The facial platysma was then incised at its lateral extent of the gonial platysma and elevated off the fixed attachments to the underlying parotid, then progressing anteriorly over the masseter into a more mobile plane. At the jawline, the dissection was continued anteriorly to the facial artery toward the anterior border of the masseter. Blunt dissection was performed for elevation and further continuation into the neck. The midface was then elevated directly over the plane of the zygomaticus muscle complex, with minimal dissection over the outer rim of the orbicularis only extending toward the anterior extent of the zygomaticus complex. Just inferior to this, the zygomaticocutaneous ligaments were released, and the remainder of the lower zygomaticus complex was dissected along with the remaining buccal decussation line to release the facial SMAS-platysma surgical flap. B.T. is a strong proponent of releasing beyond the junction of the fixed SMAS and mobile SMAS, because there are still dense connections, such as the buccal decussation that exists at the most cephalic portion of the facial platysma. This must be released over the buccal capsule to permit full mobilization of the platysma-SMAS complex surgical plane. The cervical retaining ligaments were then released, and the cervical platysma was dissected off the parotid tail fascia with minor mobilization needed inferior to the parotid tail over the SCM and external jugular vein.

The facial SMAS-platysma complex was then suspended vertically toward the individual patient's vector of greatest distraction or elevation. This was free of pleating or bunching on either side of each suture, which would indicate an

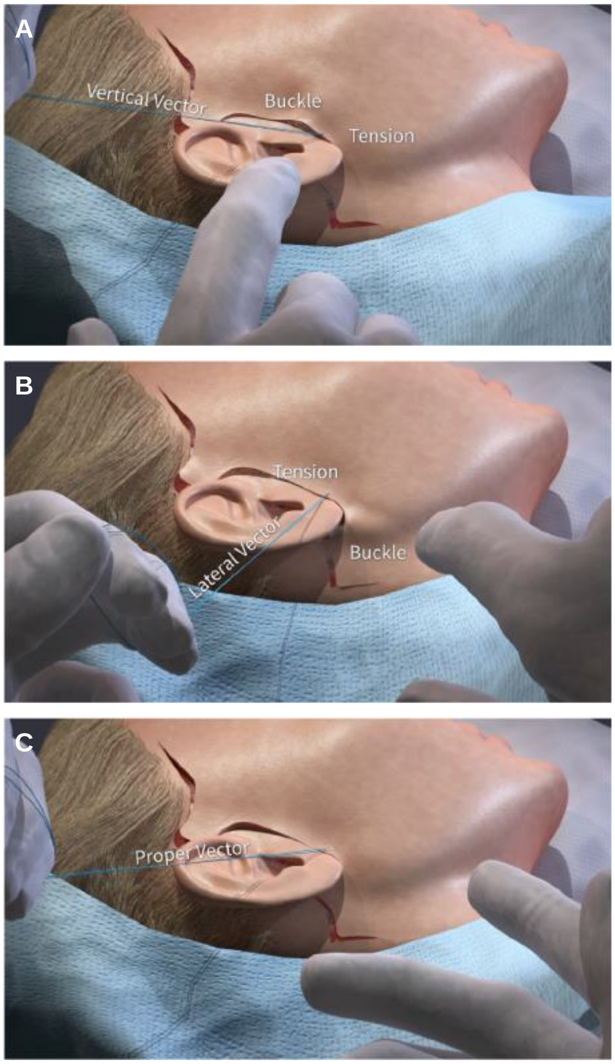

Figure 1. Vectors of suspension. (A) Too vertical vector of suspension, with superior buckling and inferior flap tension. (B) Too horizontal vector of suspension, with superior flap tension and inferior pleating. (C) Optimal vector of suspension, free of pleating, with maximal movement level of distraction.

improper vector of lift (Figure 1). These angles opposed the vector of aging for that particular patient and provided the greatest degree of lift with the least amount of surrounding pleating or dog ears. This helped enable tension-free repositioning, and sutures were then sequentially secured.

The lateral cervical platysma that was elevated off the parotid tail fascia was then suspended and inset to the anterior mastoid wall as vertically as possible while burying it under the ramus with the mastoid crevasse technique previously described by B.T.[12] This technique was performed by making an incision along the anterior mastoid line and suspending the platysma to the mastoid fascia along the anterior mastoid wall. This movement had the strong mechanical advantage of utilizing the fulcra around the gonial angle and hyoid to lift the entire submentum and submandibular triangle with ease. Last, the facial skin flap was suspended and trimmed. The vector was again chosen by movement in the vector of greatest distraction, which was nearly in the same direction as the suspension of the facial flap, albeit with a different pivot point that changed the measured angle. The skin was moved superiorly and laterally to the point that no excess, bunching, or pleating existed on either side of the pull. It was then set there without tension.

Measurements

Intraoperative photographs were taken of the suture suspension vector relative to the suture line drawn across the Frankfurt horizontal plane from the inferior orbital rim to the top of the ear canal. This was performed on each side of the face after the suspension. The facial SMAS and platysma flap suspension sutures were analyzed by placing a digital protractor over the intraoperative photographs (Figures 2, 3). The individual suspension suture vectors were measured to obtain average vectors of lift along with any intersuture angle disparities. Next, the cervical suspension vector was measured. Photographs were analyzed to obtain the x-axis and y-axis measurements relative to the Frankfurt horizontal line, as was done in the other photographs. The increase in depth along the z-axis was obtained in a previous publication.[12] The facial skin was then vectored and positioned properly, and a line was drawn from the apex of the skin flap that began at the upper helical rim to the point it came from and distally (Figure 4). A digital protractor was used to calculate each vector relative to the Frankfurt horizontal plane.

Statistical Analysis

Descriptive statistics were utilized to summarize characteristics of the study cohort, and compared between groups (primary vs secondary, age, and gender). Statistical analysis was also performed between left and right hemifaces, and site of lifting. The concurrent brow lift procedure was considered relevant for analysis of the vector of lift in patients undergoing facelifting. Other procedures were not considered relevant for analysis and so were not included. Frequency (percentage) was provided for categorical variables, while mean and ranges were presented for continuous variables. Comparison between variables were performed with chi-square tests and *t* tests. Analyses were performed with Excel (Microsoft Corporation, Redmond, WA). All *P* values were 2-tailed, and a value of $P < .05$ was considered statistically significant.

Figure 2. Intraoperative facial superficial musculoaponeurotic system (SMAS) suspension sutures compared to suture across Frankfurt horizontal plane shown in a 61-year-old female patient.

Figure 3. Intraoperative cervical platysmal suspension sutures approximately 90° relative to suture across Frankfurt horizontal plane shown in a 61-year-old female patient.

RESULTS

Seventy-one patients were included in this study, allowing an analysis of 142 hemifaces. Sixty-four patients were female and 7 were male. The mean age was 57 years (range: 39-80 years). Fifty-seven were primary facelifts, with 14 secondary facelifts and no tertiary patients. Submental platysmaplasty was performed in 90% of cases and was performed at the beginning of surgery. Low-volume fat grafting was performed in 70% of cases, ranging from 2 to 14 mL total to the entire face. Sixty-one percent of patients had brow lifting during the procedure.

Measurements were taken of the SMAS and platysmal suspension sutures and the skin prehelical tacking suture for temporal skin excision, as described above. On average, the vector of SMAS suspension was 70.8° (±5.5 standard deviation [SD]). This was not a purely vertical vector of suspension but rather an oblique vertical vector. Four to six facial SMAS suspension sutures were typically placed as needed to redistribute the flap in a flat and even fashion in each patient on each side of the face. These facial suspension sutures were found to be on average within 6° of each other. There was no observed trend for more vertical or horizontal vectors between most caudal and cephalic suspensions. The average vector of lift of the cervical platysma was 87.0° (± 6.4°), with mastoid crevasse inset performed to improve gonial angle depth and repositioning of the submandibular triangle and larynx. There were 2 cervical platysmal suspension sutures on each side for each patient. A line was drawn as described and was measured to an average vector of skin excision of 58.2°.

There was variability between the patients' hemifaces in the degrees of lifting, including the SMAS-platysma complex and the skin suspensions. The left side of the facial skin lifted at a mean of an almost 10° difference from the right face in all cases (63.0° vs 53.5°; $P < .01$). This trend was observed for SMAS and plastysmal suspension (73.9° vs 67.6°, $P < .01$; and 88.0° vs 86.0°, $P = .1$).

In our study, females had a more vertical vector of SMAS lifting than their male counterparts (71.3° vs 65.4°; $P < .01$). This trend was not observed for platysmal lifting, or vector of skin suspension ($P = .4$, and $P = .1$ respectively). Interestingly, there was no statistically significant difference between the degree of SMAS lifting in patients who did vs did not undergo brow lifting as an adjunct to the facelift procedure (71.6° vs 69.0°; $P = .06$). Similarly, there was no impact of brow lifting surgery on the vectors of skin suspension (58.6° vs 57.7°; $P = .7$). Although not statistically significant, with an age cutoff of <65 years of age, we found that patients under the age of 65 had a slightly more acute degree of lifting than those age 65 and above, who were more obtuse (71.4° vs 68.2°, $P = .08$).

Primary vs Secondary Lifts

There was more intersuture disparity in secondary cases for facial SMAS suspension vectors compared to primary

Figure 4. Intraoperative temporal skin suspension compared to suture across Frankfurt horizontal plane shown in a 61-year-old female patient.

cases. Intrasuture SMAS vector variation ranged between 0° to 15° in primary facelifts and between 6° to 32° in secondary facelifts (mean 4.7° vs 14.4°, respectively; $P < .05$). Cervical platysmal suspension vectors were similar in primary and secondary cases ($P > .05$). Despite the differences in the range of vectors, interestingly there was minimal disparity in the mean degree of lifting in the SMAS and platysma between primary and secondary cases (71.1° vs 69.9° for SMAS, and 87.1° vs 86.5° for platysmal lifting between primary and secondary cases, respectively). This trend was similar for the vector of skin suspension (59.0° and 55.2°).

DISCUSSION

This article seeks to expand upon the understanding of vectorial aging and lifting by exploiting the benefits of deep glide plane release and repositioning. It provides a more consistent means of angular measurement of lift as related to the movement of the skin, SMAS, and platysma in facelift surgery. This is the first study to review the variability found in the angles of lift and how this varies between sides of the face and between the sites of lifting (ie, from skin to SMAS to platysma). It showed higher intersuture vector variability in secondary cases than primary cases, and differences between vectors of lifting by gender and age. These results suggest that no specific measurement can be routinely applied to any individual patient, and that deep-plane release with palpatory feedback allows surgeons to determine vectors of accurate lift to perform the most thorough and natural lift. In B.T.'s experience, it does demonstrate improved results with more vertical vectors of lifting in the neck by utilizing the novel mastoid crevasse.

In the study recently published by B.T. on the mastoid crevasse, the authors sought to characterize changes along the gonial angle through a detailed set of measurements in the correct dimension and vector to demonstrate physical changes on the table. In this study we similarly seek to add measurement with real data to the decision-making process behind facial rejuvenation. The time for real data in facelifting is now.

Vectors of Lifting

The determination of the correct vector for facelift surgery is a topic that has been extensively discussed among facelift surgeons. This article echoes the findings of previous surgeons and builds upon the knowledge base to better detail angles of lifting.[4,6,12,13-15] The vertical degree of movement appeared to increase from face to neck suspension when the flaps were moved to their vector of greatest distraction and minimal redundancy. The vectors of lifting differ between facial SMAS and cervical platysmal suspension by almost 20° (71° and 87°, respectively). This finding is very interesting given the composite nature of facelift dissection and relatively uniform vector of lift between the midface and the neck. The skin vector was measured more horizontally at a mean of 58°. The disparity of angles measured in the skin, SMAS, and platysmal suspension are likely a consequence of the variations in the fulcrum or pivot point of each portion of the lift rather than the true disparities in lifting seen in biplanar or bilamellar lifts. Furthermore, the differences between the left and right sides of lifting were on average different between patients. The reason for this is less certain and may be due to more significant aging seen on the left side of the face due to UV-associated acceleration in facial aging on patients' left side (ie, driving side).

The average measurement of the temporal-facial skin flap excision was consistent with measurements described previously.[4] The fulcrum of this skin flap is the cephalic apex of the anterior limb of the temporal tuft, because the skin hinges laterally from this point. The movement of the platysma and neck is more interesting, because recent advancements in gonial angle depth restoration have provided improvements along the entire submentum, inframandibular region, hyoid position, and inferior neck as well.[12,15-17] In our patients, the average vector of movement at the lateral border of the platysma was measured at almost 90° but ranged from 63° to 98°. This is more vertical than described in previous studies. Maximal submental and cervical restoration results from maximal vertical lifting and inset to a deeper vector. The entirety of the

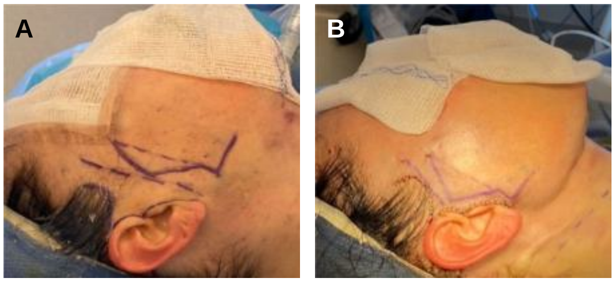

Figure 5. Intraoperative gonial angle and cervicomental definition (A) before and (B) immediately after cervical platysmal suspension shown in a 61-year-old female patient.

submentum and submandibular soft tissues are suspended by the inframandibular platysma from a point more cephalad than the hyoid, resulting in a more substantial improvement in this region along with a better hyoid position. This was achieved by performing a deep-plane release and adjunctive techniques, including the mastoid crevasse.[12] The modification helps to improve the cervicomental angle more effectively with a significant mechanical advantage of utilizing the internal deep side of the gonial angle as a fulcrum to vertically reposition the hyoid, against which it pulls. The change in infragonial depth achieved by performing the mastoid crevasse maximizes the vertical y-axis and z-axis improvements across the entire neck and submentum (Figure 5). Gauging the appropriate vector of movement by palpatory feedback rather than searching for the greatest improvements noted at a distal site has been suggested.[6] Visual inspection while the patient is swollen and supine may be misleading (ie, looking at the neck or submentum for suspension). Releasing the deep plane allows the proper vector of lift to declare itself by moving maximally in the direction of greatest distraction, opposite the vector of descent with age in that particular individual.

Analysis of the intersuture angle differences in primary facelifts was performed to dispute the belief that the vector of lifting must taper more horizontally toward the upper midface or more caudal portions of SMAS lifting.[11,17] As shown in Figure 2, in primary cases, facial SMAS suspension sutures were predominantly within 0° to 10° of each other, without any trends or patterns for angles of cephalic vs caudal portions of facial SMAS lifting. The disparity between these findings and previous articles may be a result of the sailboat modification design for the deep-plane entry point. The sailboat deep-plane entry point is marked 2.5 cm away from the incision line at roughly 70° from the Frankfurt horizontal plane and functions to maximize the composite area of the flap by minimizing the regions of skin-only dissection.[12]

Differences in angles between sutures in each hemiface reinforce that no value can be arbitrarily applied to the surgical degree of lifting, even from one hemiface to the other. This, along with obvious disparities in facial asymmetry noted in all populations, would imply that if a study describes symmetric lifting on all patients, the method of measurement is likely inaccurate. Facial anatomy and aging are complex, and it is uncommon for each side of the face or for different patients to age symmetrically. One radiographic analysis with CT scans confirmed variation in the nasolabial fold depth between gender and age.[18] There was a trend for differences by gender, in that the vectors of lifting were more acute in female patients and more obtuse among male patients (71° vs 65°). This is contrary to some previous findings, however the sample size for males was insufficient to draw any conclusion from this data.[14]

The variability in vectors by sites of lifting are important to note, because previous studies have only described measured and reported vectors collectively as a single value.[4,14] Considering the range of values described in this study, it is important to note that a single correct vector for facelift surgery may not exist.

These measurements may serve as a guideline of generalized, averaged vectors of lifting within the population rather than a dictum to lift each individual patient (or each hemiface). To obtain maximal improvements in the face and neck, the surgeon should focus on more appropriate 3-dimensional (3D) restoration of position and contours rather than obtaining the maximum amount of pull and distraction. This cannot be done without a complete deep-plane release to lift against the direction of greatest descent.

Deep-Plane Lifting

The deep-plane approach may have benefits compared to other techniques. Although the vector of lifting may be similar to the angle of the zygomaticus complex or perpendicular to the nasolabial fold in the midface, the most effective vector of lifting can be determined from proper release and palpatory feedback guiding the most appropriate level of movement and distraction. The full release beyond the fixed SMAS enables the surgeon to visualize and palpate the vectors of greatest distraction that correspond to contrary vectors of greatest descent that occurred with aging, and vertically elevate them back to a more youthful position. This will give the patient the maximal lift. As a composite flap with the skin, the facial SMAS-platysma complex is suspended vertically toward the individual patient's vector of greatest distraction or elevation. This angle opposes the vector of aging for that particular patient and is free of pleating or bunching. The tissues above the glide plane are kept intact in a composite fashion. This technique provides a less traumatic approach to lifting, because the skin including the dermal plexus and underlying hypodermal fat and SMAS should all be considered a single unit.

The deep-plane technique enables the surgeon to dissociate the SMAS-platysma complex en bloc with the overlying skin in the deep plane from the underlying mimetic musculature. Although not scientifically studied, in B.T.'s subjective experience, the facial mimetic musculature is supremely sensitive to changes in support, hydration, and tension, and its release helps avoid dynamic changes that may occur in facelifting that pulls on the SMAS and mimetic muscles, potentially altering their position and function. For instance, minor tethering, tension, or pull may have subtle or substantial negative effects, such as slight widening of the mouth or pull lines on the face, even when pulled in the correct vector. Deep-plane release avoids inadequate release and tethering seen in other techniques.

Full tension-free release and suspension helps return the face to a proper position. Although it is possible to suture the SMAS-platysma under tension, the tension is not maintained and suspension fails as it undergoes the biomechanical process of stress relaxation.[19] On the face and neck, the x and y vectors of lifting can easily be found and visualized. The z dimension may be treated with volume augmentation in the midface or reducing the parotid gland over the lateral mandible. This produces substantially greater results than a greater amount of movement achieved in the 2D x-axis and y-axis. This discussion is focused on the impact of vectorial changes and how to maximize facial rejuvenation irrespective of volumization. Also, the goal is to reduce distortions that result from a purely vertical lift, such as distortion of the hairline or crowding of the lateral canthus.

Inaccurate hypotheses regarding facial aging will inevitably occur. Applying treatments based on incorrect assumptions of the face and neck results in inconsistent outcomes along with sporadic failures that are difficult to avoid. This study has presented a logical interpretation of data extrapolated from average measurements perceived in a population, demonstrating that the range of the findings is more important than the average observed when dealing with any individual patient and trying to provide the most appropriate intervention and result.

Limitations

Despite the strengths of our study, there are some limitations. Notably the sample size for males was small and statistically underpowered for analysis, and there may be trends that need to be confirmed over time. Specifically, there were numerous patient variables, including differences in gender, age, and nature of surgery leading to inherent limitations in our analysis. Although the study included consecutive patients over a period of time in B.T.'s practice, which may have inherent biases, certain biases were reduced by the study design, including selection bias and volunteer bias. In this study, 2D digital images were used for the vectorial analysis. Also, the study was performed "on table," with patients laying supine, and no correlation of vectorial analysis can be performed for patients sitting or standing upright. This is an area of interest for subsequent study that correlates vector direction with the ultimate surgical result. Our analysis could have been strengthened by 3D analysis. Furthermore, patients did have small amounts of fat grafting performed (between 2-14 mL). This may have affected the projection of the cheek or other areas, which may affect the vector of ultimate inset through a tentpole phenomenon. Despite these limitations, this study may help advance knowledge and guide management of patients undergoing facelift surgery.

CONCLUSIONS

Deep-plane release and resuspension is one technique of choice for nearly all face and neck lifting cases. Appropriate and thorough release provides the maximal amount of improvement and durability in the face and neck, with less need for skin delamination and its consequences. Deep-plane release allows preservation of proper mimetic muscle function and volume all around the face. In our experience, thorough release also allows the surgeon to properly evaluate the optimal and maximal vector of lift in each individual patient by relying on palpatory feedback and prevention of dog ears or bulging that would indicate improper vector of lifting and ultimate failure. This approach alleviates the surgeon's reliance on previous articles to dictate the vector of lift in their patients, which may vary substantially from one side of the face to the other and from patient to patient.

Considering these variations, this article provides a more practical and individualized methodology for measurement as well as a more reliable method for measuring the proper vector of lifting in each site for patients. The pendulum has swung toward the deep-plane release, which has many benefits although it does not guarantee a better result. Most important in the performance of this art is the understanding of facial anatomy, acquiring and mastering surgical maneuvers, and the lifelong learning and good taste that must accompany the commitment to performing facelift surgery.

Disclosures

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