While lower lid bags are more commonly caused by protruding orbital fat, there may be a concave deformity caudal to the orbital fat that is noticeable as a result of inherited anatomic differences and aging. This concave, obliquely-oriented groove has been named the “tear trough deformity” (Figure 1). Patients presenting with tear trough deformity often complain of dark circles or a tired, aged, and/or aesthetically-displeasing depression in that region. The aesthetically-attractive lower eyelid should display a relatively-smooth transition between the preseptal and orbital portions of the orbicularis oculi muscle and continue into the upper malar region without a definable transition point. There has been some debate regarding the contributing anatomy of tear trough deformity and the appropriate treatment options. In this review article, we discuss the anatomy of the tear trough region and describe the most common surgical and nonsurgical treatment options.

ANATOMY

In 1932, Whitnall first described the lower eyelid depression as a “fascial interstice fixed to the bone between the orbicularis oculi and angular head of the quadrates labii superioris muscles.” The term “nasojugal fold” was first introduced in 1961 by Duke-Elder and Wybar; it was defined as “running downwards and outwards from the inner canthus, the junction of the loose tissue of the lower lid with the denser structure of the cheek, marking the line along which the fascia is anchored to the periosteum between the muscles of the lid and those of the upper lip.” Later, Loeb and Flowers better defined this area in an effort to clinically improve the deformity. Loeb and Flowers better defined this area in an effort to clinically improve the deformity. Loeb and Flowers better defined this area in an effort to clinically improve the deformity.
hypothesized that the “nasojugal groove” was caused by the following: (1) fixation of the orbital septum at the level of the inferomedial portion of the arcus marginalis, (2) existence of a triangular gap limited by the lateral portion of the angular muscle on one side and the medial portion of the orbicularis oculi muscle on the other, and (3) the absence of fat tissue from the central and medial fat pads subjacent to the orbicularis oculi muscle in the area below the groove. Flowers, who coined the term “tear trough deformity,” described several factors associated with the development of a tear trough, including descent of the cheek, loss of facial volume, underdevelopment of the infraorbital malar complex, and a muscular defect between the orbicularis muscle and angular head of the quadrates labii superioris muscle.

Several reports have described and illustrated the tear trough deformity as a triangular defect bordered by the orbital portion of the orbicularis oculi (superiorly), the levator labii superioris (laterally), and the levator labii superioris alaeque nasi muscle (medially). However, results from more recent investigations have contradicted past anatomic descriptions. The position of the tear trough is most accurately described to be within the boundary of the orbicularis muscle. Normal changes in the insertion of the orbicularis muscle, from medial to lateral, have permitted a better understanding of the anatomy and treatment. As a result, the term “tear trough deformity” should be applied to the medial periorbital hollow extending obliquely from the medial canthus to the midpupillary line. Lateral to this, the depression is better referred to as the “palpebromalar groove,” “nasojugal groove,” or the “lid-cheek junction” (Figure 2).

Haddock et al performed anatomic dissections of the lower eyelid and midfacial regions and identified two distinct tissue layers contributing to the tear trough and lid-cheek junction: the subcutaneous plane and the deep plane. In the subcutaneous plane, there was no distinction or separation between the tear trough and the more lateral lid-cheek junction. Superficially, the tear trough was found to correlate with the junction between the preseptal and orbital portions of the orbicularis oculi muscle, with changes in skin texture and underlying fat as contributing factors. In the deep plane, the authors found a separation between the tear trough and lid-cheek junction. Medially, the orbital orbicularis was firmly attached to the maxilla at its origin, while a ligamentous attachment was identified laterally between the maxilla and the orbicularis. The ligamentous attachment found in the deep plane was first identified by Kikkawa and termed the “orbital malar ligament.” He defined it as “a fibrous structure extending from thickened periosteum along the inferior orbital rim through the submuscular fat, becoming lamellar in nature while passing through the orbicularis oculi muscle, and subsequently inserting into the skin.” More recently, Mendelson referred to this as the “orbicularis retaining ligament,” due to the attachment to the underlying zygoma, caudal to the arcus marginalis at the orbital rim.

Muzaffar et al noted that the orbicularis oculi is integrated with the superficial musculoaponeurotic system. Furthermore, they described multiple retaining ligaments in the periorbital region, similar to the previously-described retaining ligaments of the face. They also identified the direct attachment of the orbicularis oculi muscle medially from the anterior lacrimal crest to the level of the medial corneoscleral limbus. Lateral to the corneoscleral limbus, the orbicularis muscle was attached to the periosteum indirectly through the orbicularis retaining ligament. The orbicularis retaining ligament continued superficially to separate the preseptal and orbital portions of the orbicularis oculi muscle. The orbicularis retaining ligament length was greatest at the level of the arcuate expansion of the orbital septum, measuring 10 to 14 mm and 1.5 to 5 mm in thickness. The length of the orbicularis retaining ligament decreased as it extended farther laterally, until it became negligible at the lateral orbital thickening. The retaining ligament created a V-shaped deformity that correlated with the lid-cheek junction (Figure 3). With age, a combination of soft tissue atrophy and orbital fat herniation can exacerbate this deformity. Similarly, Haddock et al found this ligamentous attachment farthest from the rim at the midpupillary line (4 to 6 mm) and terminated closer to the rim near the lateral canthus (2 to 4 mm). Thus, it is theorized that the tear trough deformity becomes accentuated with age due to attenuation of the orbital septum, which allows fat to herniate through the lax palpebral orbicularis.

Hwang et al aimed to build on the previous work of Muzaffar and Mendelson by providing precise anatomical detail of the periorbital ligaments in terms of breaking strength and histological characteristics. They confirmed the presence of a definite retaining ligament between the orbital rim and orbicularis oculi muscle in 76.4% of dissections. This ligamentous structure, which they termed the “periorbital ligament,” was separated into a medial and lateral component. Histologically, they described the periorbital ligament as a thick fibrous band stretched from...
the arcus marginalis to the skin through the orbicularis oculi muscle at the medial canthus, with a thickness of 0.2 to 0.4 mm. Centrally, thin fibers extended from the arcus marginalis through the orbicularis oculi muscle. At the lateral canthus, a thick fibrous band (1.0 mm thick) was attached to the periosteum spanning between 3 and 4 mm and 10 and 11 mm lateral to the arcus marginalis, with several fibers extending to the skin through the orbicularis muscle. In terms of breaking strength, the medial and lateral periorbital ligaments were both significantly-stronger than the central component, supporting the anatomic basis for the V-deformity.

Lambros studied the tear trough deformity through closely-matched photographs of patients at differing ages. He defined the tear trough as the junction of the thin, pigmented lower lid skin with the thicker cheek skin at the medial canthus to the midpupillary line. He found the lid-cheek junction to be stable over time and said that its perceived descent was due to age-related tissue volume changes and not actual movement. He believes that the unmasking of the tear trough and lid-cheek junction is related to soft tissue volume deflation with age.

The frequent patient complaint of “dark circles” is often caused by tear trough deformity; however, this pigmented change can be multifactorial. Changes in skin thickness and laxity, hyperpigmentation, and actinic changes also play a role. Thin skin or prominent subcutaneous venous pooling accentuates the periorbital darkening. Additionally, prolapse of orbital fat may indirectly cause a shadowing over the lower lids.

Goldberg described three main periorbital hollows: the septal confluence, the orbital rim hollow, and the zygomatic hollow. The orbital rim hollow corresponds with the location of the orbitomalar ligament, the tear trough medially, and nasojugal fold laterally. It is bound by the prominence of the orbital fat above and the suborbicularis oculi fat and cheek fat pads below. In the same

Figure 2. Tear trough anatomy.

Figure 3. This 54-year-old woman demonstrates a V-deformity.
article, Goldberg described a triangular pendant similar to the V-shaped deformity described by Muzaffar. However, Goldberg defined this triangular pendant as bound centrally overlying the bony depression of the inferior orbital nerve foramen and the origin of the levator labii superioris. It is his opinion that the orbital hollow is a result of volume loss in the areas of bony attachments that mimic gravitational descent.

While the tear trough is a common cause of periorbital hollowing, additional anatomical contributing factors must be evaluated for proper treatment of the patient presenting with lower eyelid “bags.” Goldberg et al described six main components of eyelid bags: orbital fat prolapse, eyelid edema, tear trough depression, loss of skin elasticity, orbicularis prominence, and the triangular malar mound. The authors characterized the tear trough by loss of subcutaneous fat with thinning of the skin over the orbital rim ligaments, combined with cheek descent. Furthermore, they stated that the tear trough is often related to underlying bony structure and particularly associated with age-related maxillary hypoplasia. In analysis of all six components, they noted that the tear trough was also accentuated with loss of skin elasticity, whereby the thin skin unveiled an underlying depression. Their study included a “uniqueness score” to specify whether one particular anatomical area was a primary reason for the eyelid bags. While most bags were a result of more than one variable, the two most common reasons for eyelid bags were orbital fat and the tear trough. Additionally, when separating patients by age, patients over 50 were more likely to have eyelid bags caused predominantly by skin laxity and tear trough depression.

**CLASSIFICATION SYSTEMS**

Multiple classification systems have been introduced to provide an objective means of evaluating the tear trough deformity and to aid the surgeon in choosing appropriate treatment options.

In 2010, Hirmand proposed a classification system of the tear trough deformity based on clinical evaluation (see Figure 4).

- **Class I** patients have volume loss limited medially to the tear trough. These patients can also have mild flattening extending to the central cheek.
- **Class II** patients exhibit volume loss in the lateral orbital area in addition to the medial orbit, and they may have moderate volume deficiency in the medial cheek and flattening of the central upper cheek.
- **Class III** patients present with a full depression circumferentially along the orbital rim, medial to lateral.

Barton et al proposed a grading system based on anatomic analysis in an effort to objectively analyze their postoperative results:

- **Grade 0:** Absence of medial or lateral lines demarcating the arcus marginalis or the orbital rim and a smooth, youthful contour without a transition zone at the orbit-cheek junction
- **Grade I:** Mild, subtle presence of a medial line or shadow; smooth lateral transition of lid-cheek junction
- **Grade II:** Moderate prominence of a visible demarcation of the lid-cheek junction, extending from medial to lateral
- **Grade III:** Severe demarcation of the orbit-cheek junction, with an obvious step between the orbit and the cheek
Sadick et al developed the Tear Trough Rating Scale by objectively and subjectively evaluating the clinical appearance of the tear trough with regard to depth of the trough, hyperpigmentation, volume of prolapsed fat, and skin rhytidosis. A numerical score was then assigned with respect to severity:

Depth of the tear trough: distance from the anterior lacrimal crest to the depth of the trough; each millimeter of depth is given one point.

Hyperpigmentation: dyspigmentation, while not directly contributing to the depth of the trough, creates an illusion of depth; no hyperpigmentation is given one point, mild is given two points, moderate hyperpigmentation is given three points, and intense or deep hyperpigmentation is given four points; subdermal dark casting caused by venous pooling can also be graded as hyperpigmentation.

Prolapse of nasal fat pad/pockets: prominent prolapse of the nasal fat pad accentuates the depth of the trough and is rated as mild (one point), moderate (two points), or severe (three points).

Rhytidosis: lower eyelid skin rhytidosis accentuates the fatty prolapse and the depth of the trough; skin rhytidosis is rated on a scale of one to four (mild, moderate, advanced, and severe, according to Glogau’s scale) and the rating corresponds to the number of points assigned.

**NONSURGICAL TREATMENT OPTIONS**

Correction of a tear trough deformity with nonsurgical techniques presents unique challenges. Unlike other facial hollows (such as the nasolabial folds, which are easily camouflaged), the tear trough requires more technically-demanding treatment due to the breadth of the hollow, skin quality changes (thinning), and the presence of adjacent orbital fat pads.

Lambros stressed that when one engages in nonsurgical treatment for tear trough correction, it is important to evaluate the following factors:

1. Skin quality, as patients with thick, smooth skin will have better results than those with thin, extremely-wrinkled skin;
2. Definition of the hollow, since a more defined hollow is more amenable to filler;
3. The orbital fat pad, as larger fat pads are more difficult to correct due to “puffiness” caused by the injection; and
4. The color of the overlying skin, since filler may improve shadowing but will not improve dark pigmentation.

It is important that any nonsurgical option address these important variables.

**Hyaluronic Acid Filler**

In a 2006 multispecialty consensus recommendation article, the tear trough was listed as the most challenging area to treat with hyaluronic acid (HA). The currently popular HA fillers are produced by bacterial fermentation (Streptococcus strains) and stabilized by chemical cross-linking. The nonanimal-derived products have substantially decreased allergic reactions. The products all differ in their cross-linking methods, concentrations, and particle sizes. These variations determine the product’s resistance to degradability, ease of injection, and gel solidity. HA fillers are most often recommended in the tear trough area, as undesired results can be reversed with injection of hyaluronidase. This has led to a sharp fall in the placement of bovine collagen-based fillers in this area due to increased rates of absorption, hypersensitivity reactions, and irregularities that are often difficult to correct.

Several other semipermanent filler materials are available for tear trough injection and have shown good results, but the nonanimal HA products remain most popular.

**Lambros technique.** After application of an ice pack to the lower lid and cheek, local anesthetic consisting of 0.5% lidocaine with epinephrine (0.2 to 0.4 mL) is injected into the orbicularis within the tear trough boundaries. Finger pressure is applied to flatten the injection area. A half-inch, 30-gauge needle is inserted through the skin at the most lateral extent of the tear trough, advancing fully and potentially indenting the skin with the hub for full reach. The HA is then injected deep to the dermis as the needle is withdrawn. This process is repeated above and below the original injection site. The area is then inspected, and additional passes are made as needed to yield a smooth contour. Last, the area is massaged lightly, compressed with finger pressure, and rolled with a cotton applicator. In his description of the technique, Lambros stressed the importance of not forcefully compressing the product during massage, as this can displace the product into the cheek and exaggerate the tear trough. Postinjection care involves applying ice to the area the night of procedure, and patients are instructed to refrain from massaging the area.

**Kane technique.** After evaluation and marking of the tear trough, Betacaine topical anesthetic ointment is applied to the lower eyelids at least 20 minutes before injection. After skin preparation with alcohol, a 30- or 32-gauge needle is inserted for injection. The deepest portion of the medial tear trough is treated first. The needle is threaded below the surface of the skin above the orbicularis oculi. Parallel threads of filler are injected cephalad and caudad to the tear trough. The raised area of the filler is then tapered off medially along the nasal sidewall—superiorly at the most cephalad significant rhytid, inferiorly at least abutting or immediately caudal to the thick cheek skin, and laterally at least the junction of the medial and lateral third of the inferior orbital rim.

If the tear trough is deep, the direction of the needle is changed throughout the injection so that filler is applied in a crosshatched fashion. For some patients, more than 100 needle passes may be required. The volume range is...
0.1 to 0.45 mL per eyelid, with most patients requiring 0.2 to 0.3 mL.

Kane recommends that patients stop taking all aspirin and nonsteroidal drugs for two weeks preinjection. Postinjection, all patients are instructed to rest, with strict head elevation position and cold compresses applied for two days. Kane also discourages patients from massaging.

**Authors' preferred technique.** Due to the thin skin overlying the tear trough, caution is advised when treating a tear trough deformity with filler. Favorable results can be achieved with proper patient selection, but patients should be counseled that HA injection alone will not address skin pigmentation changes.

With the patient seated, the tear trough deformity and lid-cheek junction are marked with easily-removable white eyeliner. The patient is advised to apply ice packs to the area several minutes before injection to minimize bruising and for anesthetic purposes. After the markings are confirmed with the patient, HA is injected deep in the preperiosteal plane, to reduce visibility of the product. The HA is placed beneath the insertion of the medial orbicularis muscle at the maxilla and continues laterally inferior to the orbicularis retaining ligament. A combination of crosshatching and linear threading is utilized with a 30-gauge needle with care not to inject superficially. The product is lightly massaged with cotton-tipped applicators to disperse any visible irregularities. After injection, the patient is instructed to apply ice to the area over the next 24 hours as needed to decrease edema and ecchymosis (Figure 5).

**Filler complications.** Reported complications of HA filler include:

- ecchymosis and swelling, which can be decreased with application of ice packs and infiltration of local anesthesia containing epinephrine;
- pain and erythema at injection site, which is usually self-limiting;
- irregularities, which usually can be massaged away either at the time of injection or several weeks later—however, more significant irregularities can be dissolved with hyaluronidase (10 units of hyaluronidase per area);

![Figure 5.](image-url)
• discoloration, which may result from superficial injection that renders a faint bluish tint to the skin (Tyndall effect); and
• patients’ lack of perceived effect, which can be resolved through review of preinjection photos, since these will serve as a visual reminder for patients and often alleviate their concerns.

Filler results. The duration of efficacy for HA filler in the tear trough has been reported from six months to two years.\textsuperscript{25,32,34,35} Donath et al\textsuperscript{36} quantified residual HA in the tear trough with a three-dimensional camera and found that, despite the small sample size, 85\% of aesthetic result was maintained at 15 months. This long-lasting effect was hypothesized to be a result of the relative lack of soft tissue movement in the area as compared to the nasolabial folds or lips.

Excellent aesthetic results can be achieved when HA filler is injected with good technique in appropriately-selected patients; previous studies have reported an 85\% to 88\% aesthetic improvement.\textsuperscript{37,38} Patient selection is critical, as patients with thick skin, minimal pigmentation changes, and moderate deformity are the best candidates for HA filler correction of the tear trough deformity. Patients with more significant deformities and lower lid bags require lower lid blepharoplasty.

Fat Grafting

The use of autologous fat has been advocated in facial rejuvenation due to its ready availability and ease of harvest in most patients.\textsuperscript{39-41} Additionally, the absence of foreign material and potential for permanent effect are particularly attractive to many patients. Fat grafting can be performed nonsurgically by lipoinjection or by direct placement in conjunction with open surgical techniques for lower eyelid rejuvenation. Coleman is a proponent of the lipoinjection technique, citing the fact that fat often migrated when grafting was combined with open approaches.\textsuperscript{42}

When one performs lipoinjection, it is recommended that an 18- or 19-gauge blunt cannula be attached to a 1-mL syringe for transfer.\textsuperscript{43} The cannula is introduced into the lower lid via a stab incision, camouflaged laterally into a natural crease in the “crow’s feet” area. The fat is then laid down from the medial to lateral lower eyelid in the supraperiosteal plane.\textsuperscript{6} While volumes of up to 3 mL per side have been described, injection sizes of 1 mL or less should be considered to maximize safety and minimize complications, depending on the depth of the tear trough. To avoid palpability or contour irregularities, it is recommended that the deformity not be overcorrected.

A relatively-unpredictable resorption rate, frequent requirement of several procedures, and risk of permanent contour irregularities are the main drawbacks for fat grafting the tear trough deformity.\textsuperscript{44} A report by Coleman recommended treatment with massage, direct excision, suctioning, and injection of steroids, phosphatidylcholine, or deoxycholate for cases of contour irregularity or overcorrection.\textsuperscript{45} However, some reports caution that surgical correction is required (through a blepharoplasty incision) for correction of contour irregularities resulting from fat grafting,\textsuperscript{46} which defeats the original intent of a nonsurgical approach. Additionally, the potentially-devastating complication of blindness, while never described specifically with fat injection into the tear trough, has been described in treatment of other periorbital areas, specifically the glabellar frown lines.\textsuperscript{46-48} To decrease the risk of this disastrous complication, it is advisable to limit the amount of material or bolus injected in one site, in addition to the recommended use of blunt needles, superficial plane of injection, and minimal pressure upon injection.\textsuperscript{49}

SURGICAL TREATMENT OPTIONS

Blepharoplasty has evolved from the old paradigm of pure fat and skin removal\textsuperscript{50} to the modern practice of preserving orbital fat with limited resection to restore a youthful contour.\textsuperscript{51-53} Similarly, techniques aimed at treatment of the tear trough now address midfacial fat atrophy and descent. Fat transposition and grafting are useful in filling the tear trough and rendering a more youthful lid-cheek junction without causing a periorbital hollow.

Rohrich et al\textsuperscript{54} proposed a “five-step lower blepharoplasty” that addresses both the tear trough and the lid-cheek junction. This approach systematically treats both elements by evaluating and addressing the following: (1) deep malar fat augmentation, (2) orbicularis oculi muscle preservation with conservative fat pad removal, (3) selective release of the orbicularis retaining ligament, (4) lateral canthopexy, and (5) conservative skin excision. Regardless of the particular technique utilized, it is important to evaluate each of these five steps to optimally treat the tear trough deformity.

Transconjunctival Approach

Goldberg technique.\textsuperscript{55} Following preoperative marking of the tear trough deformity, a standard transconjunctival incision is made from the caruncle to the lateral fornix to begin the Goldberg procedure. The lateral and central fat pads are conservatively excised. Dissection is then carried medially, with transection of the arcus marginalis and with subperiosteal dissection extending beneath the preoperatively-marked tear trough. The medial fat pad is then transposed as a random-pattern flap into the subperiosteal dissection. The central fat pad can be added for increased volume after it is freed from the inferior oblique muscle. The transposed fat pads are then secured with three or four externalized, “lazy” loops of 6-0 suture, which are removed after three to five days. The subperiosteal plane is preferred, due to its relative avascularity and ease of dissection (Figure 6). Additional filler may be required, depending on the amount of

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Equation: $\sum_{n=1}^{\infty} \frac{1}{n^2} = \frac{\pi^2}{6}$
fat absorption that takes place. Goldberg acknowledged that use of a supraperiosteal plane may provide transposed fat with a more favorable blood supply, as well as yielding a more natural contour. Therefore, he did caution that his technique can cause hardening of the fat pedicle during the first three months postoperatively, which he attributes to a combination of fibrosis, liponecrosis, and lipogranuloma formation.

**Kawamoto and Bradley technique.** Kawamoto and Bradley also use a transconjunctival technique, termed the “TROUF” (transconjunctival repositioning of orbital unipedicled fat). The TROUF technique is similar to Goldberg’s, except that a supraperiosteal (suborbicularis) plane is dissected beneath the tear trough and the fat pedicles are secured internally with a 5-0 plain gut suture in a horizontal mattress fashion. The supraperiosteal dissection is performed by blunt scissors, spreading to avoid injury to the angular vessels and decrease bleeding. Kawamoto and Bradley reported high rates of patient satisfaction with this technique, with no patients exhibiting lower lid retraction. Adverse events were few and consisted of temporary skin irregularities.

The tear trough deformity presents unique challenges in patients of Asian descent. Kawamoto and Bradley observed an increase in revisionary procedures to remove additional periorbital fat after using their technique. As a result, they recommended that surgeons utilize fat resection in addition to transposition in this patient population. However, the same trend was not observed by Momosawa et al. They specifically studied the effect of transconjunctival lower eyelid fat transposition without resection on young Asian patients presenting for correction of the tear trough deformity. In their prospective study, 90% of patients had an excellent result, as graded by two experienced plastic surgeons uninvolved with treatment. No significant complications were observed in this study; therefore, the Momosawa data provide support for the safety and efficacy of fat transposition without resection in the Asian lower eyelid.

**Hidalgo technique.** Hidalgo prefers a transconjunctival approach that includes both conservative fat resection and transposition. After a standard transconjunctival incision, excess fat is resected from the medial, central, and lateral fat pads. The arcus marginalis is released, and subperiosteal dissection is performed approximately 4 mm caudal to the infraorbital rim, extending laterally to transect the orbicularis retaining ligament. Fat is then transposed into the subperiosteal pocket to fill the tear trough deformity. Hidalgo’s technique differs from Goldberg’s in that he does not develop extensive pedicles of fat. In contrast, the suture is passed through the substantive portion of the medial and central fat pads and sutured transcutaneously without extensive flap development, using 4-0 plain gut suture tied over bolsters (Figure 7). The bolsters are left in place for at least six days postoperatively. Hidalgo also recommends, if needed, simultaneous conservative lower eyelid skin excision, canthal support, and skin resurfacing with 30% trichloroacetic acid to improve hyperpigmentation and fine rhytides.

**Freeman technique.** Freeman also employs a transconjunctival approach; however, his technique utilizes elevation of the suborbicularis oculi fat rather than orbital fat transposition. Observations from a cadaver study and intraoperative experience were the basis for Freeman’s theory that the formation of the tear trough involves both descent of the malar fat pad and a paucity of suborbicularis oculi fat tissue at the level of the arcus marginalis. His technique involves supraperiosteal dissection with elevation and securing of the suborbicularis oculi fat to the infraorbital rim periosteum at the level of the arcus marginalis. Freeman has reported the results of this technique in 64 patients, with good to excellent correction of the tear trough and without significant postoperative complications.

**Transcutaneous Approach**

**Hamra technique.** Hamra advocates lower lid blepharoplasty through a transcutaneous approach with a skin muscle flap. In an effort to avoid a “hollowed out” or “operated” appearance, his technique stresses the importance of preserving lower lid fat. To address the progressive exposure of underlying skeletal anatomy that occurs with age, the arcus marginalis is released with transposition of orbital fat, similar to the technique originally described by Loeb but adding anterior reset of the orbital septum. Hamra recommends minimal removal of fat and septum with repositioning. The remaining fat is then sutured well below the infraorbital rim with multiple interrupted 5-0 Vicryl sutures (Figure 8). Hamra’s report of 152 cases demonstrated a low incidence of postoperative complications and secondary revision procedures. One patient required...
evacuation of a periorbital hematoma, and only two early patients underwent secondary removal of excess medial fat.

Hamra’s technique is often employed with his composite rhytidectomy, which also involves repositioning of the orbicularis muscle and cheek fat. Hamra has advocated the usefulness of this technique for primary and secondary blepharoplasty, especially for patients presenting with a hollowed-out appearance. This technique has also proved beneficial in the correction of malar implant visibility, which can occur as a result of continued facial fat descent with age.

Since this technique places inferior tension on the septum, the theoretical risk of ectropion should be considered, as the septum inserts into the tarsoligamentous sling. Excess tension, scarring, or hematoma may contribute to an increased risk of lid malposition.

Barton technique. Barton et al performed an objective analysis of their experience with arcus marginalis release, fat excision, and septal reset—similar to the technique described by Hamra—for treatment of tear trough deformity (Figure 9). In an effort to reduce potential middle lamellar shortening, their technique included the addition of orbital septum irrigation with 0.5 mL of triamcinolone solution (5 mg/mL), placement of a traction stitch during septal advancement, and routine postoperative upward lid-stretching exercises. Results were analyzed with an anatomic grading system applied to pre- and postoperative photographic comparisons (the classification system was described earlier). Overall, 95% of patients included in the study improved at least one grade postoperatively. The authors concluded that this technique was safe, with the most common complication being prolonged edema. Additionally, no incidence of middle lamellar shortening or contracture was observed.

Carraway technique. Carraway’s technique for correction of the tear trough incorporates two aspects: treating the paucity of tissue between the tear trough and orbital rim and addressing the “bulkiness” of the orbicularis muscle, both cranial and caudal to the deformity. His preferred technique involves lower eyelid blepharoplasty through a subciliary incision with a subcutaneous skin or
Figure 8. Hamra technique with a transcutaneous approach, fat transposition, and anterior septal reset.

Figure 9. Barton’s transcutaneous technique with fat transposition for treatment of the tear trough deformity.

Figure 10. Carraway technique of transcutaneous blepharoplasty with direct lipoinjection into orbicularis muscle for treatment of tear trough deformity.

Skin muscle flap, depending on the amount of periorbital rhytids and excess lower lid skin. Carraway advocates partial removal of herniated fat pads with a strip of superficial preseptal orbicularis and release of the suborbicularis fascia about 2 mm above the arcus marginalis. Direct fat grafting is then performed through a 20-gauge needle to fill the deformity directly within the orbicularis muscle and slightly caudal to the infraorbital rim (Figure 10). He emphasized that fat grafting must not extend past the lateral one-third of the orbital rim, as the thin skin in this area is more prone to contour irregularities. Additionally, he prefers to inject fat harvested from the lateral hip or thigh, which he observed is often more dense and firm than fat from the abdomen, thus making it more suitable for the tear trough area. After skin redraping and closure, any irregularities are massaged with finger pressure or a blunt instrument. Secondary revisions can be performed as needed with either HA filler or percutaneous lipoinjection. Overall, he reported that two-thirds of patients demonstrated good to excellent results with this technique.

Periorbital Skeletal Augmentation

Several studies have identified age-related changes in the bony orbit. These changes are clinically evident at the
inferior orbital rim and lead to a loss of midfacial skeletal projection.62-65 Tear trough deformities can be accentuated by atrophy and/or descent of midfacial soft tissue, combined with infraorbital rim retrusion. Therefore, periorbital skeletal augmentation is another method of treating the tear trough deformity. Yaremchuk recommends periorbital augmentation for improvement of the globe-lid relationship, cheek deflation, lower lid lengthening, widened palpebral fissures, and the anterior outline of the lid-cheek junction.66,67 In patients with a negative-vector globe/orbital rim relationship, the implant can serve as a stable, supportive framework from which suspension of the cheek soft tissues can be advanced (Figure 11).68 Redraping soft tissues over the implant further aids in disguising the tear trough deformity.

Flowers recommends examining the tear trough with the side of one’s finger. If a bony furrow is evident, then a direct tear trough (suborbital malar) implant is advised for correction.1,69 His technique involves placement of the implant in a subperiosteal pocket accessed through a blepharoplasty incision, a transconjunctival incision, a transoral approach, or a direct incision if skin and festoon reductions are also required. Subsequent to implant placement, fixation is accomplished with either a self-tapping screw or a 6-0 Vicryl suture (Ethicon, Inc.; Somerville, NJ) secured to the periosteum. After identification of the infraorbital nerve, an eyelet section is removed from the implant to ensure that pressure is not applied directly over the nerve (Figure 12).68 Dissection then proceeds anterior to the orbital septum to the level of the infraorbital rim. The medial origin of the orbicularis muscle is released from the maxilla, with lateral extension through the orbitomalar ligament in the supraperiosteal plane by cutting cautery. We believe that the supraperiosteal plane more effectively releases the medial insertion of the orbicularis and orbitomalar ligament attachments. After confirmation of the tear trough depression, a small strip of orbital septum is excised. A conservative resection of fat from all three lower lid compartments is performed on an individualized basis. The resected fat is kept in a moist sponge for possible later fat grafting. The medial and central fat pads are then transposed caudally into the supraperiosteal dissection plane. With appropriate supraperiosteal dissection, the senior author (MAC) has found suture fixation unnecessary. In cases of residual depression, the previously-excised orbital fat is minced with scissors and placed directly into the defect as free fat grafts (Figure 13). We routinely advocate providing lateral canthal support and have previously reported excellent postoperative lid contour with this technique.72 To complete the procedure, the skin-muscle flap is


redraped with conservative excision of preseptal orbicularis muscle and lower lid skin (Figure 14).

A video of the surgical procedure is available at www.aestheticsurgeryjournal.com. You may also use any smartphone to scan the code on the first page of this article to be taken directly to the video on www.YouTube.com.

Potential Surgical Complications

While there are several options for surgical correction of the tear trough deformity, as described, all can be successful in the right hands. Each technique has a learning curve, and each has its own advantages and disadvantages. All of these techniques should be considered more advanced and complex procedures, beyond the scope of a traditional blepharoplasty alone and with longer recovery periods. All of the techniques listed have potential for complications, and surgeons are advised to proceed with caution, as improper technique and patient selection can lead to poor results and complications. What follows is a list of common complications.

Chemosis is often reported, due to a combination of postoperative periorbital lymphatic obstruction and dryness of the conjunctiva. Mild to moderate chemosis is often successfully treated with antiinflammatory and steroid eye drops and ointment. Some patients may benefit from patching the eye closed to prevent exposure. Severe chemosis can be treated with the addition of conjunctivotomy and vasoconstrictive eye drops. Persistent chemosis is often caused by lid malposition, which must be treated to correct the chemosis.

Lid malposition can range from minimal scleral show to ectropion, and it may occur as a result of either transcutaneous or transconjunctival approaches. Scleral show can often be corrected conservatively with early postoperative lid massage and taping. Postoperative ectropion should be classified as either early (first postoperative week) or late (first postoperative month). Early ectropion is the result of canthopexy/canthoplasty fixation failure, and treatment requires early surgical correction. Late ectropion will usually present with gradual worsening over the course of the first or second month postoperatively and is a result of anterior or posterior lamellar scarring. The level of scarring can be evaluated by attempting to manipulate the lower lid with the examiner’s finger. If the lower lid can be elevated and is mobile, the scarring is within the anterior lamella. However, if the lower lid cannot be manually elevated and is fixed to the orbital rim, the scarring is within the posterior lamella. Treatment of late ectropion should initially start with a trial of six to eight
weeks of conservative management. However, if the ectropion persists, anterior lamellar scarring should be surgically resected, and posterior lamellar scarring often requires the addition of a spacer graft.

Overdissection in the nasojugal area should be avoided and may result in injury to the buccal branch of the facial nerve. This can result in difficulties with blinking and eyelid closure or decreased tone of the lower lid, and it may affect the eyelid pumping mechanism for the lacrimal apparatus.

Persistent dark circles from periorbital hyperpigmentation are best treated with topical skin care, such as hydroquinone.

Postoperative edema and ecchymosis are to be expected in the early postoperative period. Additional dissection and manipulation of the tear trough may result in more substantial areas of ecchymosis and edema than those seen with less extensive blepharoplasty procedures. The patient should be informed of this possibility preoperatively. While the edema and ecchymosis will resolve without treatment, supportive care in the early postoperative period with ice packs, head-of-bed elevation, abstinence from salty foods and alcohol, and avoidance of strenuous activity is advised. The authors also recommend a regimen of preoperative and postoperative oral supplements Arnica montana and bromelain.

CONCLUSIONS
Lower eyelid rejuvenation with treatment of the tear trough deformity can be a challenging endeavor. Thorough review and anatomic dissection of the anatomy has clarified the location and underlying causes of the deformity. Knowledge of this anatomy, along with a critical evaluation of surrounding periorbital anatomy, is essential for proper treatment. Both surgical and nonsurgical options exist to correct the tear trough deformity. While each method has advantages and disadvantages, the surgeon should base treatment decisions on patient anatomy and surgical preference. Patients with thick skin, minimal skin discoloration, and mild to moderate defects without excessive periorbital fat herniation may be good candidates for HA filler or fat grafting alone. However, patients with more pronounced deformities and fat herniation are often better served by lower eyelid blepharoplasty and either fat transposition or grafting. Treatment of patients with tear trough deformity is complex; however, aesthetically-pleasing results are possible through knowledge of the underlying anatomy and proper treatment selection.

Disclosures
Dr. Codner receives educational grants and is a paid consultant for Mentor Corporation and receives royalties for books published by Quality Medical Publishing and Elsevier Publishing Company. Dr. Stutman has nothing to disclose.

Funding
The authors received no financial support for the research, authorship, and publication of this article.

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