The development of dark circles under the eyes is one of the early signs of periorbital aging, lending a fatigued and aged appearance to the face. Loeb, in 1961, used the term “nasojugal groove” to describe the concavity at the border of the eyelid and the cheek medially. Flowers, in 1969, first named this groove the “tear trough.” In the present article, the author presents a detailed description of the anatomy and nonsurgical correction of this deformity. Nonsurgical correction of the tear trough deformity with hyaluronic acid is effective and safe and is associated with high patient satisfaction. The procedure offers both an adjunct to surgery and an alternative to it in some patients. It also provides an opportunity for global midfacial volume correction. Careful patient selection and attention to technique will minimize side effects. (Plast. Reconstr. Surg. 125: 699, 2010.)

Multiple surgical techniques have since been described to correct the tear trough deformity. Most blepharoplasty techniques do not fully correct the tear trough deformity, and some can accentuate it. Surgery may not be well justified or accepted in the young patient, or in a patient who has undergone a blepharoplasty with residual or worsening concavity in the tear trough.

Nonsurgical correction of the tear trough deformity has traditionally been performed using autologous fat. Although fat is a good filler, its limitations are labor intensiveness, particulate consistency, unfavorable flow characteristics, risk of lumpiness and long-lasting irregularities, possibility of volume distortion with weight changes, and prolonged edema. Fat can be useful in patients with significant orbital and midface volume loss, especially in conjunction with surgery. However, hyaluronic acid has the advantage of gel consistency, favorable flow characteristics, and reversibility, with less potential morbidity. Its nonpermanence is a plus.

Other fillers such as calcium hydroxylapatite are used in the periorbital area; however, they do not offer similar versatility in this unforgiving region. Similarly, L-poly(lactic acid) injections have been performed; however, this method suffers from a lack of precision and a higher risk of complications.

ANATOMY

The “tear trough” refers to the medial one-third of the periorbital hollow, and in early aging, it may be the only area of concavity visible (Fig. 1). The tear trough is not exclusively the product of age. A mild trough is seen in youth in many individuals. It is the deepening of this groove that leads to true indentation and significantly impacts facial appearance. To devise the optimal correction for the tear trough, understanding the anatomy of this area is critical.

The indentation that defines the tear trough deformity is at the junction of thin eyelid skin above and the thicker and different nasal and...
cheek skin below, with attenuated subcutaneous tissue overlying the maxillary bone. The skin in the area of the concavity is indeed of different quality, texture, and color compared with either area. In some individuals, there is a distinct melanocytic hyperpigmentation in the skin of the tear trough. In some instances, this skin takes on an almost transparent appearance.

The tear trough is at the inferior orbital rim most medially but very quickly falls inferior to the rim, with the maximal distance from the rim occurring centrally. Volume loss can be present laterally in more advanced aging, at or just below the orbital rim, where the retaining ligaments are thicker and less distensible.

The concavity in the groove is often associated with orbital fat herniation superiorly in the lower lid fat compartments, accentuating its appearance. The presence of herniating lower lid fat distacts from the deficiency in the trough, which is an independent problem. There is individual variation in depth and morphology of periorbital volume loss. Anatomical illustrations in cadavers reveal that the location of the indentation is along the fibers of the orbicularis oculi in the medial third at the orbital rim (Fig. 2).

The orbicularis oculi muscle has a direct attachment to the inferior orbital rim from the anterior lacrimal crest to the medial limbus or approximately 30 percent of the orbital rim length. Lateral to this, the attachment to the bone is by means of the orbicularis retaining ligaments, which have variable length at different points along the inferior orbital rim. The length increases to a maximum centrally and then decreases laterally until the orbicularis retaining ligaments merge with the lateral orbital thickening in the lateral canthal region. The levator labii superioris originates just below the orbicularis oculi muscle attachment to the medial orbital rim.²⁴–²⁷ (Fig. 3).

It is in this medial area, along the attachment of the orbicularis oculi muscle to the orbital rim, that the tear trough deformity first manifests as a depression that becomes deeper with time. There is scant subcutaneous tissue between the skin and the orbicularis muscle in this area; therefore, the

Fig. 1. Patient with the tear trough deformity.

Fig. 2. Anatomical illustration on a preserved cadaver showing the depression in the orbicularis oculi in the medial lower orbit where the tear trough deformity forms. 3, Orbicularis oculi; 9, levator labii superioris alaeque nasi; 10, levator labii superioris (From McMinn HRM, Hutchings RT. Color Atlas of Human Anatomy. Chicago: Year Book Medical; 1985. Permission pending).

Fig. 3. Anatomical dissections in the tear trough region showing the orbital rim, sub–orbicularis oculi muscle, orbital fat, sub–orbicularis oculi fat, and levator labii superioris near its origin, through a window made in the suborbicularis oculi fat. (From Zide BM. Surgical Anatomy Around the Orbit: The System of Zones. Philadelphia: Lippincott Williams & Wilkins; 2006. Used with permission).
tear trough is composed of thin skin adherent to the orbicularis muscle that is attached to the orbital rim (Fig. 4).

The cause of the tear trough deformity is most likely multifactorial. Volume loss seems to predominate. However, orbital fat herniation, if present, skin laxity, and possible ptosis of tissues below secondary to volumetric changes or other reasons could all play a role. The tear trough is in fact a dynamic area. It would stand to reason, given the fixed attachment of the muscle to the rim and contraction of muscles, notably the orbicularis oculi, that the tear trough would show the consequences of volume loss earlier and more dramatically than the rest of the face.

Volume loss at the orbital rim is of course not an isolated aging event. In truth, it is part of a volumetric involution that occurs globally in the face. Clinically, the periorbital pattern of volume loss can be categorized into three classes (Fig. 5):

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 medially to laterally. This pattern is often associated with more advanced volume deficiency in the medial cheek, central cheek, and malar eminence. Class II and III patients often demonstrate a depression along an oblique cheek crease, between the two fat compartments of the cheek, highlighting the malar bags superiorly, and volume loss in the temporal region, upper eyelid, brow, and lower face.

Patients of any class may present with excess orbital fat or significant skin laxity. The presence of either of these variables identifies a patient who would benefit from surgery or surgery followed by filling of the tear trough for optimal results. These patients are not good candidates for nonsurgical correction alone.

**INDICATIONS AND PATIENT SELECTION**

Patient selection is critical to obtaining good results. The best candidates are patients with good skin tone and minimal skin laxity, with mild to moderately deep tear troughs. This procedure has excellent utility in postsurgical patients who have uncorrected troughs or overresected orbital fat.

Patients with very thin or transparent skin, those with significant skin laxity, and those with extremely deep tear troughs are poor candidates. These patients could still obtain improved appearance with the procedure; however, they need to be counseled as to the higher risk of visibility, irregularity, and overall less-than-perfect results. Many of these patients still elect to proceed and rarely seek reversal even if the results are not perfect.

Patients who would clearly benefit from surgery are those with orbital fat herniation and significant skin laxity. These patients are unlikely to obtain good results from injecting the tear trough alone and should be advised of this. It is helpful to simulate the effect of filling, in the less-than-ideal candidate, by pushing on the soft tissues just under the tear trough with the patient observing in the mirror while their reaction is assessed. This procedure is an effective adjunct to lower lid blepharoplasty and can be recommended as part of the rejuvenation plan at the time of consultation.
TECHNIQUE

Preparation and Anesthesia

The tear trough is marked using a fine-tip marker with the patient sitting at approximately 90 degrees. Upward gaze accentuates the deformity medially and centrally and delineates the borders of the tear trough. Upward outward gaze outlines the deficit laterally on the contralateral side. A comprehensive roadmap of not only the tear trough deformity but also of all adjacent areas that need volume augmentation is marked and reviewed with the patient (Fig. 6).

Fig. 5. Classification of the patterns of periorbital volume loss: (above) class I, limited to the tear trough or medial orbit (sometimes associated with very mild flattening of the central cheek); (center) class II, medial and lateral depression apparent (can be associated with mild volume deficiency in the medial cheek and mild flattening of the central triangle; and (below) class III, full depression visible circumferentially at the orbital rim (often associated with more advanced volume deficiency in the medial cheek, central reverse triangle/midface and malar eminence, and the oblique midcheek crease highlighting the malar bags).
Infraorbital nerve block is administered with a small volume of 0.5% to 1% lidocaine with epinephrine. Direct infiltration of local anesthetic can be used to block the malar area and the lateral orbit. Care should be taken not to distort the volume status of the midface and the tear trough by using large volumes of anesthetic solution.

Cold packs are used before and after the procedure. Patients are advised to avoid antiplatelet agents for 10 days before the procedure. The procedure is performed under semisterile conditions using clear surgical preparation solution, sterile gauze, and meticulously clean technique.

**Personal Technique**

I prefer using a sterile 30-gauge, ½-inch, stainless steel blunt cannula (custom made by Popper & Sons, Inc., New Hyde Park, N.Y.) introduced through a 25-gauge needle hole for injection in the tear trough (Fig. 7). A small volume, approximately 0.01 to 0.05 cc, of hyaluronic acid, is injected in a retrograde fashion with each injection. The injections are deep to or within the orbicularis muscle and just superficial to the periosteum of the orbital rim in the most medial aspect. Centrally, the orbitomalar ligaments are longer and the injection is performed at multiple levels as needed. Hyaluronic acid is injected discontinuously in the deformity medial to lateral (Fig. 8). It is important to avoid injecting a large continuous column of filler along the tear trough because an oval bulge or a “sausage” appearance can result that is accentuated with animation. Alternatively, more entry sites can be made with depot injections to avoid long continuous retrograde injections.

The tear trough is at or below the infraorbital rim in 100 percent of cases; thus, injections above the orbital rim are not necessary in the absence of volume deficiency within the confines of the orbit. Typically, two to three entry sites are used medially and centrally, and one to two entry sites are used laterally. Gentle digital massage, or massage with a cotton-tipped swab, is performed to disperse the filler in the intended location. Overcorrection is not recommended. The most common total volume injected into the periorbital area is 0.2 to 0.5 cc on each side.
The key to aesthetic correction of the tear trough is to think beyond the tear trough. Depending on the depth and extent of volume loss, further injections are indicated to correct the central and lateral aspect around the orbital rim and all adjacent areas. Typically, there is a flattened area centrally in the shape of a reverse triangle that should be filled. The medial cheek, if left deflated, will contribute to an unnatural appearance, especially with facial expression. The oblique malar depression line that often develops in later stages highlighting the malar bags is corrected, as is the submalar area. Augmentation of the malar eminence may be needed. It is important, though

Fig. 9. (Above) A 37-year-old man immediately after injection (1.5 cc total; 0.75 cc on each side for circumferential treatment). (Center) A 39-year-old woman before and 6 months after injection (0.8 cc total; 0.45 cc on the right and 0.35 cc on the left). (Below) A 43-year-old woman before and 7 months after injection (1 cc total; 0.5 cc on each side).
often neglected, that patients be evaluated in animation throughout the procedure to identify and correct bulging or dimpling that can occur with motion (Figs. 9 through 11).

Though not as essential, conservative injection of the subbrow eyelid, medial upper lid A-frame deformity, and the brow, when indicated, can create harmonious and soft periorbital enhancement. In fact, periorbital volume augmentation is ideally performed in conjunction with volume correction in the whole face to preserve harmony and aesthetic proportions of facial features.

In specific instances, very superficial subdermal injection using a 32-gauge needle is performed to “lift” the overlying skin. This is usually a “spot” application over a 1- or 2-mm surface area. I initially designed the blunt cannulas to eliminate the risk of inadvertent intravascular injection; however, it is now my method of choice in the tear trough for independent reasons. The blunt needle glides easily through the tissue once past the orbicularis oculi with minimal pressure. Medially, it is easy to feel for the periosteum with the tip of the cannula and to direct it superior to the periosteum. Thus, the most medial part of the tear trough is accessible safely and precisely. Additional advantages include fewer entry sites and safe use above the orbital rim near the globe for correction of postblepharoplasty overresection of fat or generalized volume deficiency in the area above the orbital rim.

I have been using Restylane (Medicis Aesthetics, Inc., Scottsdale, Ariz.) since its approval in 2003, as an off-label application, and more recently Juvederm (Allergan, Inc., Santa Barbara, Calif.). There does not seem to be any major advantage to using the more robust preparations of either formulation. In addition, Juvederm, which is more hydrophilic, can result in prolonged edema around the eyes in

Fig. 10. A 38-year-old woman with significant midface volume loss, before and early after injection at 2 weeks. There is some visibility and edema medially that resolved over time about which patients need to be counseled (1 cc total; 0.45 cc on the right and 0.55 cc on the left).

Fig. 11. A 41-year-old woman before and 6 months after injections (2.0 cc total: 1 cc on each side).
certain patients, whereas Restylane may be more prone to exhibiting the Tyndall effect in some. Presently, I recommend Restylane preferentially for the tear trough. For patients with thin transparent skin or those prone to significant ecchymosis, lower concentration hyaluronic acids, such as Prevelle Silk (Mentor Corp., Santa Barbara, Calif.), should be considered.

**Postprocedure Care**

After injection, patients are instructed to use gentle digital pressure if areas of edema or irregularity persist after the first few days. Generalized massage is not recommended. Regular makeup and skin care can be resumed and camouflage makeup can be applied immediately. Cold packs in the hours following the procedure help reduce edema.

**TECHNICAL PITFALLS AND SOLUTIONS**

The most commonly encountered pitfall is overcorrection, which results in an unnatural bulge. A baggy appearance can also result from injections that are too superficial. Hyaluronidase can be used in both instances to salvage the correction. The Vitrase (ISTA Pharmaceuticals, Irvine, Calif.) preparation can be used starting in the range of 25 to 50 units per site and titrated as needed. The patient should be advised that multiple sessions and revision with the filler may be required. Much like the nasolabial folds, it is not necessary to completely obliterate the trough in most individuals because a slight trough is present in many young people. “Less is more” applies well in this case, and softening of the hollow often suffices. A 1:1 correction at the time of the procedure is recommended.

Another commonly encountered scenario is inadequate correction. It is critical that the peri-orbital pattern of volume loss is fully evaluated and a comprehensive strategy for injection planned. A corrected tear trough in the absence of repletion of volume loss at the lateral orbit or of the midface results in an overall unaesthetic appearance at rest and especially with animation. Further evaluation and correction effectively corrects this issue.

Poor candidates, as identified previously, are likely not to obtain the best results and may not be satisfied with this procedure. The goal is to identify these patients at the outset. If a patient who is a surgical candidate is injected with suboptimal results, reversal is indicated. Often, injections can complement surgery in these patients to optimize their results.

Occasionally, unevenness or undercorrection is seen on follow-up. This is easily corrected with additional application. Patients should be advised of this possibility before the procedure.

**RESULTS**

We have evaluated the efficacy and longevity by estimating the percentage correction after the procedure and at 1 month, 6 months, and 1 year. The initial group of patients were followed closely and the results were reported in 2005.17 Review of the last 100 consecutive patients has confirmed its efficacy with a high level of patient satisfaction (unpublished data). Longevity of the effect in this area has proven unexpectedly long. Most patients can expect to have good effect on average for 1 year. Younger patients, or repeat patients, can expect acceptable correction well over 1 year and some up to 2 years. The effects wear off slowly over time, and reapplication or touch-ups are based on subjective parameters.

The longevity could be related to less motion in this area and possibly a stimulation of collagen production as has been reported. Applying hyaluronic acid filler changes the aging process in the areas treated beyond the expected longevity of the product. It is not uncommon to see patients who require volume in areas not originally treated before they need reapplication in the treated tear trough. Patients should be counseled as to the need for such maintenance.

Botulinum toxin in the lateral orbicularis oculi or in the medial third along the orbital rim is a useful adjunct for preventing distortion of the filler by muscular action and for increasing longevity.

**COMPLICATIONS**

The most common complications are ecchymosis and edema. Ecchymosis can occur at the injection sites and takes 1 week to 10 days to resolve. Variable but subtle edema is not uncommon because of the hydrophilic nature of this filler, and resolution may take 2 to 3 weeks.

The most significant complication is visible irregularities, which are more prevalent in patients with thin or lax skin. These irregularities are managed effectively with massage over several weeks. Irregularities that are caused by superficial injections are difficult to resolve and can persist well over 2 years. They require hyaluronidase treatment.

Visibility is another possible complication. Deep injections decrease its risk; however, in rare patients, tissue characteristics exist that make
formity with hyaluronic acid is effective and safe and midface. 

Moreover, compared with traditional methods, creation can be achieved represent a significant improvement in aesthetic results that have been acceptable. The injection of the tear trough with hyaluronic acid in a discontinuous and retrograde manner. 

Filling should only be injected under low pressure, to minimize risk of intravascular injection leading to visual compromise. Rare cases of blindness, stroke, and skin necrosis after injections with needles in the face have been reported in the periorbital area (glabella, forehead, temple, crow’s feet), nose, cheeks, nasolabial folds, and lower lip. Injected materials reported include fat, Cymetra (LifeCell Corp., Branchburg, N.J.), collagen, silicone, and steroids. There are reports of tissue injury with presumed intravascular injection of hyaluronic acid; however, to date, there have been no reports of blindness after such injections.

It is not clear what consistency or viscosity could increase the risk of vascular occlusion. It is also difficult to ascertain the true risk of such a rare event.

The blood supply to the eyelid and orbit is through both the internal and external carotid arteries connected by means of a vascular network. The central retinal artery is one of the proximal branches of the ophthalmic artery (a branch of the internal carotid artery), whereas many of the distal branches of the ophthalmic artery supply parts of the face, such as the dorsal nasal, angular, supraorbital, and supratrochlear arteries.

Retrograde and then antegrade movement of a filler within vessels by means of the internal carotid artery and the ophthalmic artery can theoretically account for occlusion of the central retinal artery. To minimize risk of intravascular injection, whether a sharp or blunt needle is used, filler should only be injected under low pressure, in a discontinuous and retrograde manner.

Overall, the complication rates associated with injection of the tear trough with hyaluronic acid have been acceptable. The aesthetic results that can be achieved represent a significant improvement compared with traditional methods, creating a more effective rejuvenation of the lower lid and midface.

**CONCLUSIONS**

Nonsurgical correction of the tear trough deformity with hyaluronic acid is effective and safe and is associated with high patient satisfaction. The procedure offers both an adjunct to surgery and an alternative to it in some patients. It also provides an opportunity for global midfacial volume correction. Careful patient selection and attention to technique will minimize side effects.

**REFERENCES**


