Evaluation and Treatment of the Tear Trough Deformity in Lower Blepharoplasty

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ABSTRACT

The tear trough deformity is a natural consequence of the anatomic attachments of the periorbital tissues. A variety of techniques have evolved to address this cosmetic issue including subtractive blepharoplasty techniques, elevation of ptotic eyelid and midface tissues, and the injection or implantation of autogenous or alloplastic materials to diminish its appearance. Greater anatomic understanding of the pathogenesis of the tear trough deformity has led to more anatomically conservative and appropriate cosmetic surgical treatments. The decline in purely subtractive surgical techniques in blepharoplasty surgery and the advent of fat-repositioning techniques and new subdermal fillers have improved surgical outcomes.

KEYWORDS: Tear trough deformity, blepharoplasty, hyaluronic acid fillers

Lower eyelid blepharoplasty has evolved since 1907 when Charles Conrad Miller published the first photograph depicting the resection of excess skin from the lower eyelids.¹ Between the years 1907 and 1924, he refined his approach from removing eyelid skin at the eyelid-cheek border to a subciliary incision very similar to that in use today. In 1924, Julien Bourguet of France first described a transconjunctival approach to the resection of herniated periorbital fat.² This combination of skin and fat resection has been an integral part of blepharoplasty, and the modern technique of this “subtractive” approach was codified by Salvador Castañares in 1951.³ As our understanding of the aesthetic and anatomic sequelae of aging and older subtractive surgical techniques has advanced, techniques of periocular rejuvenation have evolved to include volume enhancement of the lower eyelid.

UNDERSTANDING THE TEAR TROUGH DEFORMITY

History

The nasojugal fold was defined initially by Duke-Elder and Wybar in 1961 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 (orbicularis oculi) and those of the upper lip.”⁴ Flowers subsequently renamed this sulcus the “tear trough deformity” in 1969 given the observation that tears will track along this groove.⁵

The abnormal contour of the periorbital soft tissues results in a hollow area that creates a tired appearance. The shadow created by this groove is

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commonly perceived as a dark circle under the eye that is difficult to conceal with makeup. Osseous and fat atrophy with aging may further contribute to the loss of soft tissue support and descent of the cheek, which deepens the tear trough.⁶

Anatomy

In 1993, Loeb described three potential factors hypothesized to produce the tear trough deformity, including fixation of the septum orbitale to the inferomedial arcus marginalis, the existence of a triangular gap between the angular muscle and the orbicularis muscle, and the absence of fat tissue from the central and medial fat pads subjacent to the orbicularis oculi muscle inferior to the nasojugal fold.⁷ Decades of anecdotal evidence and more limited study regarding the anatomic construct of the lower eyelids led to the cadaveric dissection studies of Muzaffar et al.⁸ They describe an orbicularis retaining ligament in the lower eyelid that originates laterally as a reflection of the septum orbitale joining a membrane derived from the preperiosteal fat over the zygoma (Fig. 1).⁸ The medial extent of this retaining ligament is variable, connecting with the orbicularis oculi muscle insertion and thus indirectly to the medial canthus. The central portion of the retaining ligament is the weakest and distends differentially more with age, allowing for greater exposure of the central fat pad (Fig. 2). Greater laxity of the lid-cheek junction with age contributes to the tear trough deformity by accentuating the herniation of orbital fat.⁸ Midface ptosis helps to bare the tear trough, as involutional descent of the midface with the orbicularis muscle tethered over the tear trough by the orbicularis retaining ligament results in thinning of the tissues over the tear trough and increased prominence, readily recognizable as a sign of aging. Other clinically recognized aging changes of the lower

eyelid include orbital fat prolapse, loss of skin elasticity, orbicularis prominence, and festoons.⁹

TREATING THE TEAR TROUGH DEFORMITY

Surgically Invasive Techniques

DRAWBACKS OF TRADITIONAL BLEPHAROPLASTY

Historically surgeons have sculpted prominent orbital fat pseudoherniation posteriorly in an attempt to level the preseptal portion of the eyelid with the orbital rim. Such approaches are generally performed transconjunctivally, as an evolution of Bourquet's technique,² or via an external approach, as an evolution of the techniques described by Castañares.³ Excessive fat sculpting is now well known to lead to a potential increase in the relative prominence of the tear trough and to excess hollowing and a skeletonized eyelid appearance, along with eyelid retraction in the postblepharoplasty patient (Figs. 3 and 4).¹⁰ The inappropriateness of excessive fat sculpting in attempting to cosmetically improve eyelid appearance and decrease the prominence of the tear trough has led to more conservative techniques, which generally involve augmentation along the orbital rim attempting to mask the prominence of the tear trough.

"PEARL" GRAFT TRANSPLANTATION

Autogenous "fat pearls" have been used since the 1980s, with good results reported when used as an adjunct to lower eyelid blepharoplasty.^{7,11-13} During lower and upper eyelid blepharoplasty, excess herniated fat pads are readily amenable to becoming donor fat grafts to areas of depression. Alternatively, fat or dermis-fat grafts may be harvested from other body sites. These fat grafting techniques have special application in the correction of the patient with contour deficits as a result of prior blepharoplasty surgery.

Figure 1 Dissection within the prezygomatic space. The upper border is indicated by the blue line. Medially, the orbicularis oculi (OO) originates directly from the orbital rim above the origin of the levator labii superioris (LLS). More centrally, the orbicularis has an indirect attachment to the orbital rim by means of the orbicularis retaining ligament (ORL), which courses directly on the orbital side of the zygomatico-facial nerve (ZFN). At the lateral orbital rim, the ligament merges into the lateral orbital thickening. Suborbicularis oculi fat (SOOF) lines the undersurface of the prezygomatic orbicularis (pars orbitalis). Zmaj., zygomaticus major muscle; Zmin., zygomaticus minor muscle. (From Muzaffar AR, Mendelson BC, Adams WP. Surgical anatomy of the ligamentous attachments of the lower lid and lateral canthus. *Plast Reconstr Surg* 2002;101:873-884. Reprinted with permission.)

Figure 2 Schematic overlay showing the pathogenesis of a double convexity deformity in the eyelid and prezygomatic area due to laxity of the orbicularis retaining ligament (ORL) and a lesser laxity of the zygomata-cutaneous ligament (ZL) with a malar mound in the prezygomatic space and prominent tear trough. (From Mendelson BC, Muzaffar AR, Adams WP. Surgical anatomy of the midcheek and malar mounds. *Plast Reconstr Surg* 2002;101:885–896. Reprinted with permission.)

LIPOSCULPTURE TECHNIQUE

Autogenous fat grafting by lipoaspiration and lipoinjection (liposculpture) is a method of small incision filling of facial defects that provides a potentially permanent result. Advantages over collagen and synthetic fillers are

Figure 3 After subtractive blepharoplasty, the aging orbit is wider and deeper than preoperatively with fat removal having exacerbated the depth. (From Hamra S. The role of orbital fat preservation in facial aesthetic surgery: a new concept. *Clin Plastic Surg* 1996;23:17–28. Reprinted with permission.)

the autogenous nature and easy accessibility of fat. Introduced in this area by Silkiss and Baylis¹⁴ and popularized by Sidney Coleman and others, the injection of fat is performed from many different angles and in multiple planes to achieve optimal consistency and contour (Fig. 5). The survival of microfat globules depends on oxygen diffusion and the proximity of a well-vascularized bed to provide for the nutritional requirements of the grafted fat. Irregular fat necrosis can lead to palpable and visible contour abnormalities.¹⁵ Typically multiple treatment sessions are needed. The difficulties with contour, initial overcorrection, replacement by scar tissue, and fat necrosis are encountered with microfat injections just as with fat pearls.

EARLY INCISIONAL APPROACHES

Loeb reported a novel surgical procedure in 1981 involving vascularized fat pad “sliding” into the cheek to correct for the nasojugal depression.¹² His technique was performed through a subciliary skin incision with full exposure of the medial and central lower eyelid fat pads. The orbital septum is then partially resected to free the two fat pads, and excess fat can be sculpted as necessary. Blunt dissection is performed in a preperiosteal plane up to the anterior border of the angular muscle, which is at the inferior border of the nasojugal groove. The orbital fat is then sewn to the anterior surface of the angular muscle, with careful attention paid to avoid excess traction on the orbit.

Attempting to avoid the complications of free fat grafts and pedicled fat grafts, Flowers developed a silicone tear trough implant of differing thickness and contour.¹⁶ The selection and placement of these implants must be performed with the patient supine, and careful markings should be made on the skin to delineate the necessary pocket dimensions. The implants are then placed via five possible routes: subciliary blepharoplasty incision, transorally, transconjunctivally, direct incision through the overlying skin, or via facelift incisions. Numerous tear trough implants derived from Flowers original concept exist. Problems with these implants, including infection, migration, and palpability or visibility, have limited their popularity with many surgeons.

FAT REPOSITION OR TRANSPOSITION

In 1995, Hamra popularized the use of vascularized fat in the filling of the tear trough by modifying Loeb’s fat sliding technique.¹⁷ He also developed a skin-muscle flap with complete exposure of the orbital septum and malar eminence. The arcus marginalis is incised at the level of the orbital rim with removal of a strip of septum orbitale to prevent postoperative scarring. The medial and central fat pads are sculpted and advanced over the orbital rim, suturing to the preperiosteal fat of the malar eminence (Fig. 6). Additionally, the orbicularis oculi

Figure 4 (A) Preoperative photograph of young patient with familial prominent fat pseudoherniation, classically considered an excellent candidate for transconjunctival fat removal. (B) Postoperative photograph following transconjunctival blepharoplasty with fat removal only. Note the increased prominence of the tear trough medially and the deeper supratarsal fold.

muscle is repositioned with shortening of the vertical height of the lower eyelid.

Hamra further revised his lower eyelid blepharoplasty surgery to the “septal reset” technique in 2004, 10 years after his initial study described above.¹⁰ The “septal reset” technique is aimed at correcting problems with postoperative orbicularis muscle hypotonia, inability to suspend the cheek tissue with advancement of the skin-muscle flap alone, and difficulties in fixating orbital fat to the preperiosteal fat. Through a subciliary incision, the orbital septum is released at the level of the arcus marginalis. Transcanthal canthopexy is added to the procedure to support the eyelid margin, and then the septum is fixated inferiorly over the orbital rim with multiple interrupted 5-0 Vicryl sutures. Hamra’s technique provides a significant evolution of prior techni-

ques, in that they comprehensively deal with the tear trough medially and the aging changes in the inferior eyelid and orbit in a conservative fashion. His “septal reset” update attempts to optimally integrate eyelid surgery into a comprehensive approach to the midface.

Fat repositioning through a transconjunctival approach was soon described by Goldberg et al in 1998.¹⁸ The transconjunctival approach, first described in 1924, had been primarily used for fat excision surgery. As newer pathophysiological concepts of the aging face and volume rejuvenation of the face were being discovered, so transconjunctival lower eyelid blepharoplasty has continued to evolve. Goldberg et al describe release of the medial and central lower eyelid fat pads with sculpting as needed. The inferomedial orbital rim is then palpated, and the orbital septum is incised at the junction of the arcus marginalis. Dissection is then performed over the orbital rim with periosteal elevation and careful cautery of perforating vessels. The orbital fat could then be fixated in a subperiosteal plane using buried sutures or externalized sutures (Figs. 7 and 8).

Advantages of Goldberg and coauthors’ approach include avoidance of a skin incision and potential middle lamella scarring with an excellent ability to address the contour changes of the tear trough. Disadvantages include the use of the less anatomic and more difficult subperiosteal plane with potential concerns of fat palpability and survival.

AUTHORS’ CURRENT TECHNIQUE

Our current surgical technique combines the concept of septal reset with a transconjunctival approach to the lower eyelid. Exposure of the arcus marginalis is achieved through a transconjunctival incision. A CO₂ laser is used in office procedures, mainly due to the minimal discomfort when cutting and the excellent hemostasis. The orbital septum is then incised at the level of the arcus marginalis. Medial and central fat pads are trimmed minimally for excess herniation. A modest resection of the medial portion of the lateral fat pad is

Figure 5 Liposculpture technique in the lower eyelid with multiple overlapping passes via multiple insertion sites may effectively treat the tear trough deformity. (From Cook T, Nakra T, Shorr N, Douglas RS. Facial recontouring with autogenous fat. *Facial Plast Surg* 2004;20:145–147. Reprinted with permission.)

Figure 6 (A) The skin muscle flap is elevated 1.5 to 2 cm inferiorly, exposing the inferior border of the orbicularis muscle. A suture retracts the ciliary rim. (B) The arcus marginalis is incised from the medial to the lateral orbital rim. (C) The orbital fat is gently freed, and a strip of septum orbitale (green) is removed. (D) The orbital fat is tailored and sutured over the orbital rim with 5-0 Vicryl. (From Hamra ST. Arcus marginalis release and orbital fat preservation in midface rejuvenation. *Plast Reconstr Surg* 1995;96:354-362. Reprinted with permission.)

common. Dissection is then carried out inferiorly with blunt scissors in an intrasuborbicularis oculi fat plane. This dissection is generally carried out 10 to 12 mm inferior to the orbital rim. The extent of dissection is determined by the area of prominent tear trough (Fig. 9), with a fat transposition at the junction of the medial third and lateral two thirds of the inferior orbital rim being desirable in the majority of patients; a more extensive transposition is necessary in a smaller number of patients. One to three mattress sutures (one for each fat pad) of 5-0 nylon are passed from the cheek into the dissected pocket. A robust bite is taken, weaving through the inferior edge of the septum, and the septal reset is achieved through fixation in the intrasuborbicularis oculi

fat plane. More recently the authors have eliminated the externalized sutures in favor of direct suturing of the fat and released septal edge with 5-0 Vicryl suture. The nylon sutures are passed through a foam bolster and tied on the skin, which is removed in 7 days. Most patients undergo light or medium depth erbium-yttrium aluminum garnet (YAG) laser skin resurfacing with a dual-mode erbium-YAG laser (Sciton Inc., Palo Alto, CA) at the end of the procedure. Lateral canthopexy and direct excision of excess skin via a subciliary incision are performed as indicated.

Advantages of this surgical approach include only a moderate increase in complexity from the standard transconjunctival lower blepharoplasty techniques. The

Figure 7 The central and medial fat pads are released for transposition (top) and are placed into a surgically created subperiosteal pocket (bottom). (From Goldberg RA. Transconjunctival orbital fat repositioning: transposition of orbital fat pedicles into a subperiosteal pocket. *Plast Reconstr Surgery* 2000;105:743–748. Reprinted with permission.)

majority of patients can undergo this approach as an office procedure with minimal oral sedation plus local anesthetic. Results are generally excellent with almost all of the few cases of ectropion or residual aesthetic deformity occurring early in the authors' series of over 130 patients treated with this technique (Fig. 10).

MIDFACE LIFTING AND THE TEAR TROUGH

Midface ptosis is a prime causative factor in increasing the prominence of the tear trough with age. Laxity of the eyelid tissues in the preseptal eyelid and pseudoherniation of eyelid fat with age in concert with involutional midface ptosis bares the now thinned skin and orbicularis muscle tethered over the tear trough by the orbicularis retaining ligament.

A variety of techniques of surgical midface elevation, ranging from transpalpebral approaches advocated by Hester and colleagues¹⁹ to endoscopic techniques advocated by Ramirez²⁰ and others, are

Figure 9 Quartered preoperative photo showing anatomy of lax orbicularis retaining ligament (arrow) and surgical area undermined (checkered area) in the authors' technique.

employed to address the tear trough, malar fat pad ptosis, nasolabial fold, and aging changes in the eyelid and midface. Midface elevation is integral to the fat-repositioning blepharoplasty techniques described and is often performed as an adjunctive procedure, as the orbicularis muscle and periorbital midface is already released. Additionally, the tension vector on the repositioned fat elevates the midface and appears to contribute to the harmonious results achievable with these techniques.

Minimally Invasive Injection Techniques

Restoring a smooth contour by volume enhancement has been the mainstay of minimally invasive treatment for tear trough deformities. The number of options available speaks to the inadequacy of any one technique in successfully erasing the tear trough. Minimally invasive transcuteaneous injections are utilized with greater success since the advent of hyaluronic acid tissue fillers (Restylane and Perlane, Medicis Pharmaceutical Corp., Scottsdale, AR, and Hylaform, Inamed Aesthetics, Inc., Santa Barbara, CA).

Figure 8 Three to four externalized loops of suture are used as a "cage" in Goldberg's technique to maintain the position of the repositioned fat. (From Goldberg RA. Transconjunctival orbital fat repositioning: transposition of orbital fat pedicles into a subperiosteal pocket. *Plast Reconstr Surgery* 2000;105:743–748. Reprinted with permission.)

Figure 10 Surgical results with authors' technique: preoperative (above) and postoperative (below). Surgery performed in office with mild oral sedation. Excellent effacement of the tear trough is achieved. (From Mohadjer Y, Holds JB. Cosmetic lower eyelid blepharoplasty with fat repositioning via intra-SOOF dissection: surgical technique and initial outcomes. *Ophthal Plast Reconstr Surg* 2006;22:409–413. Reprinted with permission.)

Table 1 Table of FDA-Approved and Commonly Used Fillers in Facial Augmentation*

Filler	Properties	FDA-Approved Indications	Company
Restylane [®]	Non-animal-derived hyaluronic acid; immediate results that last ~6 mo	Moderate to severe wrinkles around the nose and mouth	Medicis Pharmaceutical Corporation, Scottsdale, AR
Perlane	Non-animal-derived hyaluronic acid; immediate results may last up to 1 y	Not approved in the U.S.	Medicis Pharmaceutical Corporation, Scottsdale, AR
Captique [™]	Non-animal-derived hyaluronic acid; immediate results that last up to 1 y	Moderate to severe glabellar lines, facial wrinkles and folds around the nose and mouth	Inamed Aesthetics, Inc., Santa Barbara, CA
Hylaform [®]	Hyaluronic acid derived from rooster combs; results may last up to 6 mo	Moderate to severe wrinkles around the nose and mouth	Inamed Aesthetics, Inc., Santa Barbara, CA
Hylaform Plus [®]	Large hyaluronic gel acid derived from rooster combs; results may last longer than 4–6 mo	Moderate to severe wrinkles around the nose and mouth	Inamed Aesthetics, Inc., Santa Barbara, CA
Artefill [®]	Bovine collagen with polymethylmethacrylate microspheres; immediate and permanent results; wait 3 mo between injections	Facial wrinkles and scars. Contraindication for lip augmentation	Artes Medical, San Diego, CA
Radiesse [™]	Microspheres of calcium hydroxylapatite suspended in an aqueous gel carrier; immediate results last 1–2 y	Vocal cord paralysis, radiographic tissue marking, and maxillofacial augmentation	Bioform Inc., Franksville, WI
Sculptra	Synthetic polylactic acid contained in microspheres that must be reconstituted prior to injection; immediate results last typically 2 y	Reconstruct HIV patients suffering from facial lipatrophy	Sanofi Aventis, Bridgeton, NJ

*Clinical uses typically go well beyond the FDA-approved indications. FDA, Food and Drug Administration.

Kane described a subcutaneous approach to filling in the tear trough with hyaluronic acid.²¹ Anesthesia is obtained by applying Betacaine-LA[®] (Custom Sprints Pharmacy, Tampa, FL), a topical anesthetic ointment, to the eyelids for at least 20 minutes prior to injection. The injections begin at the deepest part of the medial tear trough in a plane between the skin and orbicularis oculi muscle, with additional threads of hyaluronic filler being injected parallel to the tear trough above and below the corrected depression to fill in horizontal rhytids.

A subperiosteal approach has been described by Airan et al that aims to correct the volume deficit while avoiding the problems of visible or palpable filler when used in a superficial plane.⁶ Anesthesia required infiltration of the periosteum 20 minutes prior to treatment with local anesthetic containing epinephrine (1:200,000). The deepest part of the tear trough was then injected with filler in a plane reported as subperiosteal starting at the lateral orbital rim hollow. Small amounts (<0.1) were injected with digital manipulation to ensure appropriate contour. The medial vascular structures were avoided by advancing filler along the medial rim using digital pressure and small amounts of filler under low infiltration pressure.

The effect of hyaluronic acid fillers lasts 3 to 9 months. Longer-lasting agents such as Sculptra (Sanofti Aventis, Bridgeton, NJ), Artefill (Artes Medical, San Diego, CA), and Radiesse (Bioform Inc., Franksville, WI) are available and have been used for facial soft tissue augmentation; however, little published information is available regarding success in the tear trough region (Table 1).²²⁻²⁵

SUMMARY

Over the past 50 years, we have seen significant advances in our understanding of anatomic basis of aging changes in the periorbital area. This combined with more rigorous examination of surgical goals and results have in turn led to improvements in aesthetic surgery of the eyelid and midface. With this information, surgical techniques continue to evolve and yield a more natural and harmonious rejuvenation of the face.

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