



Management of Tear Trough Deformity: A Review of Current Anatomic Concepts, Non-Surgical, and Surgical Treatment Strategies

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Abstract

Background: Tear trough deformity is a defining feature of periorbital aging and one of the most common concerns prompting patients to seek lower eyelid and midface rejuvenation. Its correction has evolved considerably over the past three decades, moving away from indiscriminate fat excision toward volume-preserving and volume-restoring strategies grounded in a more precise understanding of periorbital anatomy. Management now spans a wide spectrum, from hyaluronic acid and biostimulatory fillers, through autologous fat grafting, to a range of surgical techniques including fat repositioning, tear trough and orbicularis retaining ligament release, and adjunctive midface lifting. Each modality carries a distinct risk-benefit profile, and the optimal choice depends on deformity severity, skin quality, lower eyelid laxity, and patient goals. This review describes current anatomic concepts, classification systems, and the comparative evidence base for non-surgical and surgical management of tear trough deformity, with attention to complications and emerging directions in the field.

Keywords: Tear Trough Deformity, Anatomic Concepts, Surgical Treatment Strategies



1. Introduction

The tear trough is the depression extending obliquely from the medial canthus toward the midpupillary line, where it transitions into the palpebromalar or nasojugal groove as it continues laterally.^{1,2} Its visibility contributes to a tired or aged appearance, often prompting aesthetic consultation well before other signs of facial aging become apparent.² As understanding of the region's ligamentous and fat-compartment anatomy has matured, so too has the range of available treatments, and practitioners today can choose from a continuum of options rather than a single default approach.^{2,3,4}

This shift reflects a broader change in philosophy across periorbital and midface rejuvenation: early descriptions of lower blepharoplasty emphasized aggressive fat excision to eliminate herniated fat pads, but this approach was increasingly recognized to worsen tear trough hollowing in many patients by removing tissue that, if repositioned rather than discarded, could instead fill the adjacent deficiency.^{5,6} The result has been a steady move toward fat-conserving and fat-augmenting strategies, whether through surgical repositioning, autologous grafting, or injectable volumization, each intended to restore a smoother, more youthful lid-cheek junction.^{6,7,8}

This review outlines current concepts in tear trough deformity: anatomic and pathophysiologic understanding, classification and grading systems used to guide treatment selection, non-surgical injectable approaches, autologous fat grafting, and the major surgical strategies in current use, before considering the comparative evidence base and directions the field is moving toward.^{2,4,6,8}

2. Anatomy and Pathophysiology

The tear trough overlies the junction between the orbital and palpebral portions of the orbicularis oculi muscle and is anchored by a discrete fibrous structure, variably termed the tear trough ligament or the medial aspect of the orbicularis retaining ligament (ORL).^{2,3} This ligament arises from the maxilla at the medial orbital rim and inserts into the overlying dermis, tethering the skin to the underlying bone and creating a visible groove where the orbital fat pads above meet the flatter, less padded cheek below.^{2,3,9} With aging, three processes tend to converge at this junction: herniation or pseudoherniation of orbital fat anterior to an attenuated orbital septum, descent and atrophy of the malar and suborbicularis oculi fat (SOOF), and progressive skin thinning and loss of elasticity.^{2,6} The combination produces the classic contour of a convex fat bulge immediately above a concave, tethered trough, an appearance sometimes described as the tear trough triad.⁶

Because the deformity arises from this interplay between a fixed ligamentous attachment, a mobile or herniating fat compartment above it, and a volume-deficient compartment below it, treatments that address only one element in isolation — for example, filling the trough without addressing an overhanging fat bulge, or excising fat without releasing the ligament or restoring volume below it — often produce incomplete or unsatisfactory correction.^{6,9} This anatomic understanding underlies the current preference, across both non-surgical and surgical management, for approaches that either release the tethering ligament, redistribute or restore volume across the deformity, or combine both strategies.^{3,6,9,10}

3. Classification and Grading Systems

Several classification systems have been developed to standardize assessment of tear trough deformity and guide treatment selection.^{2,6,11,12,13} Hirmand's system, one of the earliest and most widely used, grades the deformity clinically from mild to severe based on the depth of the groove and the degree of associated fat herniation, and remains in common use for selecting candidates for non-surgical filler correction.² The Barton grading system, developed in the context of surgical fat repositioning, similarly stratifies severity on a numeric scale and has become a standard outcome measure in postoperative evaluation.^{6,13}

More recent work has sought to refine these largely subjective, clinician-assessed scales. A five-pattern morphological classification has been proposed that distinguishes deformities dominated by fat herniation ("hill" patterns) from those dominated by volume loss ("valley" patterns) and mixed presentations, reflecting the recognition that not all tear trough deformities share the same underlying mechanism and therefore may not respond equally well to a single treatment strategy.¹¹ Quantitative approaches have also emerged, including three-dimensional photogrammetric assessment¹³ and, more recently, artificial-intelligence-assisted grading trained on the Barton system,¹² aimed at reducing inter-observer variability and providing more objective outcome measures for both clinical practice and research.

4. Non-Surgical Management



4.1 Hyaluronic Acid Fillers

Hyaluronic acid (HA) filler injection has been used to correct tear trough deformity since the mid-2000s and remains the most widely used non-surgical option, particularly for patients with mild to moderate volume deficiency, good skin quality, and minimal fat herniation or lower eyelid laxity.^{2,4,14,15} Direct injection into the deficient trough restores contour by adding volume beneath the tethered skin, while indirect approaches address volume loss more broadly across the midface — for example in the malar or submalar compartments — to improve the lid-cheek transition without injecting the thin, vascular tear trough skin directly.¹⁴ Contemporary practice increasingly favors this dual or combined approach, selecting direct, indirect, or combined strategies based on individual facial anatomy rather than applying a single technique universally.^{4,14}

4.2 Biostimulatory and Hybrid Fillers

Beyond conventional cross-linked HA, biostimulatory and hybrid formulations have gained attention for periorbital use.¹⁶ Poly-D,L-lactic acid/HA hybrid fillers, for example, combine immediate volumization with a secondary, delayed collagen-stimulating effect, intended to improve skin quality over time in addition to correcting volume deficit.¹⁶ Calcium hydroxylapatite and poly-L-lactic acid-based approaches have also been explored for regenerative periorbital rejuvenation, though their use in the thin-skinned tear trough region requires particular caution given the risk of visible nodularity in this location.

4.3 Complications of Injectable Treatment

The tear trough is among the highest-risk sites for filler complications because of its thin overlying skin, limited subcutaneous tissue, and proximity to the angular and infraorbital vascular systems.^{2,17} The Tyndall effect — a blue-grey discoloration caused by superficial placement of HA gel, most visible in this thin-skinned region — is common but generally correctable with hyaluronidase or gentle massage.^{2,17,18} Malar edema, related to the hydrophilic nature of HA and the region's lymphatic drainage pattern, has been reported in a substantial minority of patients and is minimized by selecting lower-hydrophilicity products and avoiding overcorrection.^{17,18} The most serious complication is vascular occlusion, which can result in skin necrosis or, if retrograde flow reaches the ophthalmic or retinal circulation, permanent vision loss; although rare, this risk underscores the importance of detailed anatomic knowledge, aspiration technique, and immediate access to hyaluronidase whenever HA fillers are used in this region.^{17,19,20} Any practitioner offering periorbital filler treatment should be prepared to timely recognize and manage vascular compromise, including urgent ophthalmology referral when visual symptoms are present.^{17,19}

5. Autologous Fat Grafting

Autologous fat grafting occupies a middle position between injectable fillers and formal surgery, offering a biologically compatible, long-lasting volumizing option without a synthetic implant.^{10,21,22,23,24} Harvested fat, often processed into microfat or nanofat to allow injection through fine cannulas into the thin tear trough skin, is placed in the supraperiosteal or subcutaneous plane depending on technique and desired effect.^{21,22,23} Series published in recent years report high patient satisfaction with a relatively favorable complication profile, the most common issues being transient edema, contour irregularity, and, less frequently, volume excess or asymmetry requiring touch-up.^{21,22}

A particularly efficient variant, increasingly reported in the surgical literature, combines fat grafting with transconjunctival blepharoplasty: orbital fat that would otherwise be excised during fat-pad reduction is instead processed and reinjected into the tear trough itself, avoiding a separate donor site while directly addressing both the fat excess above the ligament and the volume deficiency below it.²⁴ This combined approach illustrates a broader trend in the field toward using excised tissue constructively rather than discarding it, echoing the same fat-conservation philosophy that underlies purely surgical repositioning techniques.^{5,6,24}

6. Surgical Management

Surgical correction remains the most predictable and durable option for moderate to severe tear trough deformity, particularly where significant fat herniation, lower eyelid laxity, or skin excess coexist with the volume deficiency.^{4,6,9,25} Contemporary surgical strategies share a common evolution away from simple fat excision toward techniques that conserve, redistribute, or augment fat volume across the deformity.^{5,6,7,8,9,26,27}

6.1 Fat Excision

Traditional fat excision, in which herniated orbital fat is simply removed, remains a legitimate option, particularly for younger patients with isolated fat bulging and no significant tear trough hollowing, or for patients whose primary concern is eyelid bagginess rather than the adjacent groove.^{5,26} However, excision alone does not address the tear trough itself and can, in patients with coexisting hollowing, accentuate rather than improve the deformity by removing the tissue that partially camouflaged it.^{5,6,26}

6.2 Fat Repositioning (Transposition)



Fat repositioning techniques mobilize the herniated orbital fat pads, typically through a transconjunctival approach, and redistribute them over the arcus marginalis or tear trough region rather than excising them, effectively converting a fat excess into a corrective graft for the adjacent volume deficiency.^{4,5,6,7,25,27} Numerous technical variations have been described, differing chiefly in the plane of dissection (preperiosteal versus suprapariosteal), the method of fat fixation (sutured to periosteum, secured with bolsters, or left unsecured within a dissected pocket), and the extent of concomitant ligament release.^{6,7,25,27} Across this variation, the shared aim is a smoother, single-contour lid-cheek transition rather than the stepped appearance produced by an untreated fat bulge sitting above an unfilled trough.^{6,8}

6.3 Tear Trough and Orbicularis Retaining Ligament Release

Because the tear trough ligament itself is the structural tether producing the visible groove, its release has become a central maneuver in many contemporary techniques, whether performed via a transconjunctival or subciliary approach.^{3,9,10} Release is typically carried out in the preperiosteal plane using sharp or cutting-cautery dissection, freeing the ligamentous attachment between the orbicularis oculi origin and the underlying maxilla and allowing the redistributed or grafted fat to lie in continuity with the cheek rather than remaining tethered at the ligament line.^{3,9} Long-term follow-up data suggest this release does not compromise lower eyelid tarsoligamentous support when performed in relative anatomic isolation from more extensive lower-lid dissection, and that its functional effects on orbicularis contraction — including a softened pretarsal bulge and reduced dynamic tethering with smiling — persist well beyond the initial postoperative period.³ Not all comparative data are unanimous, however: some series have found no statistically significant difference in tear trough grade improvement between ligament release and blepharoplasty alone, while noting a possible increase in transient morbidity such as chemosis with release, underscoring that the incremental benefit of ligament release specifically, versus fat repositioning alone, remains an area of active investigation rather than settled consensus.⁹

6.4 Midface Lifting and Adjunctive Procedures

In patients with more extensive midface descent, isolated eyelid-level correction may be insufficient, and adjunctive procedures addressing the malar soft tissues become relevant.^{1,8} These range from limited subperiosteal cheek lifts and arcus marginalis release with SOOF elevation, to more extensive midface lifting performed through facial soft-tissue spaces connecting the preseptal and premaxillary compartments.^{1,8} Such techniques are generally reserved for patients with a low, deflated midface contour rather than an isolated tear trough deformity, and carry correspondingly greater surgical morbidity, recovery time, and risk.⁸

6.5 Surgical Approach: Transconjunctival versus Subciliary

The transconjunctival approach, avoiding a skin incision and violation of the orbicularis oculi and orbital septum from the anterior lamella, has become the preferred access route for lower lid blepharoplasty, whether via fat excision, repositioning, or combined ligament release.^{7,8,26,27} It is associated with a lower incidence of postoperative scleral show and ectropion compared with the subciliary (transcutaneous) approach, attributable to its avoidance of anterior and middle lamellar dissection.⁸ The subciliary approach retains a role where concurrent skin excess requires direct excision, but generally necessitates more attention to lower eyelid support, with some surgeons advocating adjunctive canthopexy or canthoplasty when more extensive periorbital retaining ligament release is performed through this route.^{8,9}

7. Comparative Evidence and Outcomes

Direct comparative data between the major treatment categories remain limited, and most published series report outcomes within a single modality rather than head-to-head comparisons.^{4,9} Within surgical series, fat repositioning is consistently associated with superior tear trough correction compared with excision alone, particularly in older patients and those with more pronounced baseline hollowing, though excision continues to perform comparably well in younger patients whose primary issue is fat bulge rather than volume deficiency.^{6,26} Comparative work between surgical fat repositioning and non-surgical HA filler correction suggests each has a distinct role rather than one uniformly outperforming the other: filler treatment offers a lower-risk, reversible option appropriate for milder deformities, while surgical repositioning offers more durable, structural correction better suited to moderate or severe deformity, particularly where fat herniation itself needs to be addressed.⁴

8. Complications of Surgical Management



Complication profiles differ by technique. Transconjunctival approaches carry a low but real risk of postoperative lower eyelid malposition, including scleral show and, less commonly, ectropion, particularly when more extensive ligament or midface dissection is combined with the procedure.^{8,9} Fat repositioning and grafting techniques share risks of contour irregularity, under- or over-correction, and, less frequently, fat necrosis or nodularity when transposed fat is inadequately secured or vascularized.^{7,21,27} As with any periorbital surgery, rare but serious complications including retrobulbar hemorrhage and vision loss have been reported across techniques, reinforcing the importance of meticulous hemostasis and appropriate patient counseling regardless of the specific approach selected.

9. Emerging Concepts and Future Directions

Several directions are shaping the evolving management of tear trough deformity. Quantitative and AI-assisted grading tools are beginning to supplement traditional clinician-assessed scales, offering the potential for more standardized outcome reporting and, eventually, more individualized treatment algorithms based on objective baseline morphology.^{12,13} Regenerative approaches, including nanofat, stromal vascular fraction, and platelet-rich plasma, are increasingly combined with both filler and fat-grafting techniques in an effort to improve skin quality alongside volume correction, though comparative evidence for these adjuncts remains at an early stage.^{22,23,24} Minimally invasive surgical variants, such as buried-guidance fat fixation²⁷ and refined fat-trimming techniques designed to avoid midfacial overfilling in fat-preserving procedures,²⁶ reflect ongoing efforts to fine-tune the balance between adequate correction and overcorrection as fat-conserving philosophy has become the default. Across all of these developments, the underlying trajectory remains consistent: treatment selection is moving away from a single default technique toward individualized algorithms matched to each patient's specific pattern of fat herniation, ligamentous tethering, and volume loss.^{4,25}

10. Conclusion

Tear trough deformity management has evolved from a narrow focus on fat excision toward a broad, individualized spectrum of volume-preserving and volume-restoring strategies spanning injectable fillers, autologous fat grafting, and a range of surgical techniques centered on fat repositioning and ligament release.^{3,4,5,6,25} Current evidence supports matching treatment intensity to deformity severity and underlying anatomic pattern rather than applying a uniform approach, with non-surgical options best suited to mild deformity with good skin quality, and surgical repositioning or ligament release offering more durable correction for moderate to severe presentations.^{2,4,6,25} Continued development of objective grading tools and longer-term comparative outcome data will be important in refining treatment algorithms further as the field continues to move toward individualized, anatomy-based patient selection.^{4,12,13,25}

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