Treating the tear trough-eye bag complex: Treatment targets, treatment selection, and injection algorithms with case studies

Hsien-Li Peter Peng MD\textsuperscript{1,2} | Jui-Hui Peng MD\textsuperscript{3}

\textsuperscript{1}P-Skin Professional Clinic, Kaohsiung City, Taiwan
\textsuperscript{2}Department of Dermatology, Tri-Service General Hospital, National Defense Medical Center, Taipei, Taiwan
\textsuperscript{3}Kaohsiung Chang-Gung Memorial Hospital, Kaohsiung City, Taiwan

Abstract

Background: The tear trough is a commonly requested area for aesthetic correction, but is difficult to treat well, especially when concurrent with other deformities such as eye bags. There are multiple possible treatment methods for the tear trough and eye bag, such as surgery and hyaluronic acid (HA) filler injection, with the latter gaining popularity in recent years.

Aims: To explore tear trough and eye bags etiology, describe the process for treatment selection, outline possible contraindications for filler injection, and expand upon the previously published atrophy-bulging-laxity (ABL) system of tear trough classification and treatment algorithm, with special focus on tear troughs complicated with eye bags.

Methods: Six major etiologies of the eye bag were described, and three main contraindications for HA injection were outlined. Three useful tests (snap test, push test, lift test) to aid in treatment selection were described. A comprehensive treatment algorithm was developed to counteract each etiology: “Lifting” injections at the zygoma and anteromedial cheek help counteract senescent or congenital bone deficiency; “Supporting” injections into the anteromedial cheek fat pads help counteract fat atrophy or prolapse; and “Volumization” injections directly at the deformity help smooth out structural grooves or troughs.

Results: Patients with pronounced eye bags and tear troughs were treated according to this algorithm and obtained good, long-lasting outcomes.

Conclusions: Tear troughs complicated with eye bags can be successfully classified and treated with the ABL system and the additional procedures described by this report.

Keywords: algorithm, eye bag, filler, hyaluronic acid, injection, tear trough

1 INTRODUCTION

The tear trough deformity is a common target for correction in modern aesthetic dermatology, though one of the most difficult to treat successfully. Aside from possible complications, the tear trough frequently combines with the eye bag to create complex regional anatomical variations, necessitating a tailored treatment plan. Treatment options differ in invasiveness, indication, safety, result duration, and efficacy, and further include injectable fillers, surgical intervention, or a combination of other nonsurgical approaches. Though recent trends have favored the less invasive approach of injectables such as hyaluronic acid (HA), traditional surgery remains...
popular. In patients with concurrent tear troughs and eye bags, treatment method selection and treatment protocols depend greatly on the profiling and categorization of the patient’s deformity, for which the author has developed a comprehensive evaluation and treatment method (the atrophy-bulging-laxity method, or ABL method; Table 1, Figure 1) published in 2018. Building on the ABL method, this report aims to further explore the etiology, evaluation, and treatment specifically of tear trough deformities that occur together with eye bags.

2 | TREATMENT TARGETS: ETIOLOGIES OF THE EYE BAG

Before treatment of the eye bag and the tear trough, one must understand the underlying etiologies of these deformities, which can help physicians develop a rational, logical sequence of treatment with focused and appropriate correction targets. The eye bag may result from a number of anatomical differences and remodeling events, including changes or conditions of bone structure, retaining ligaments, fat pads, and musculature.

Firstly, the various facial retaining ligaments are known to cause the prominent grooves and troughs of the face. The zygomatico-cutaneous ligament (ZCL) and the orbicularis retaining ligament (ORL), also known as the orbitomalar ligament (OML), are both osteocutaneous ligaments that contribute to the tear trough and eye bag. These ligaments create strong “stapling” or “tethering” effects between their periosteal origins and their cutaneous insertions, which in turn create natural grooves or troughs in the orbicularis oculi muscle (OOM) and the overlying skin. The ZCL extends from the inferior border of the zygomatic arch to just below the inferior-medial orbital rim and forms the anatomical basis of eye bags, malar mounds, and malar festoons. The ORL is a true periorbital ligament which extends from the orbital septum and traverses the entire OOM circumference. The ORL’s inferior-lateral portion consists of a multilamellar plexiform meshwork of collagen and elastin fibers, which form the anatomical basis of the palpebromalar groove (PMG). Medially, it merges to form a short, tough ligament commonly known as the tear trough ligament (TTL), which form the anatomical basis of the tear trough deformity. Please see Figure 2 for these ligaments and their corresponding deformities. Weakness of ligamentous structures and weakened orbital septa also contribute to the formation of eye bags.

Another major etiology of the eye bag is the lack of facial bone structure, whether due to congenital or senescent bone loss. The human bone experiences constant remodeling throughout our lives, a process highly dependent on genetics, nutrition, and age. In the facial bones, the effects of aging can be seen through bone resorption in the periorbital, maxillary, mental, and piriform aperture regions; in particular, maxillary bony resorption is the most pronounced, resulting in loss of support and volume in the infraorbital region and contributing to the subsequent sagging appearance of the eye bag. In addition to senescent bone loss, Asian faces experience additional, congenital bone deficiencies. According to a 2016 consensus report on the differences between Asian and Caucasian faces, Asian faces tend to display a retrusion around the medial maxilla bone, resulting in the appearance of an “under-eye dark shadow” and a “concave central midface,” both of which contribute to the appearance of the eye bag. This is a key reason why eye bags are often more noticeable in Asian patients at a younger age, especially in combination with tear troughs or other facial features.

Beyond its bone remodeling effects, aging also causes significant changes in facial fat pads (Figure 2), which undergo changes in thickness, volume, and distribution. One sectional anatomical study in 2013 found significant “malar fat atrophy and loss of support” in the sagittal sections of an elderly patient when compared to sections from a younger patient, and an injection of saline to volumize the deep medial cheek fat (DMCF) pads results in multiple potentially rejuvenating effects, including the smoothing of the nasolabial fold and the tear trough (nasojugal trough), demonstrating its importance in maintaining a smooth facial contour. Overall, while the DMCF and medial cheek fat (MCF) pads (including the intraorbital and infraorbital fat pads) help volumize and support the aforementioned natural grooves caused by the various retaining ligaments in younger individuals (Figure 3A), they experience marked atrophy in the elderly, making tear troughs and eye bags more prominently seen (Figure 3B).

Similarly, while the infraorbital areas are supported by the DMCF, the prezygomatic areas are supported by the suborbicularis oculi fat (SOOF) pads, which are distributed laterally along the zygomatic arch. These fat pads serve a similar function as the DMCF, the prezygomatic areas are supported by the suborbicularis oculi fat (SOOF) pads, which are distributed laterally along the zygomatic arch. These fat pads serve a similar function as the DMCF, the prezygomatic areas are supported by the suborbicularis oculi fat (SOOF) pads, which are distributed laterally along the zygomatic arch.

Finally, musculature and connective tissue integrity also play a part in the formation of facial deformities, with both having long been

<p>| TABLE 1 ABL (Atrophy, Bulging, Laxity) classification score for the tear trough deformity |</p>
<table>
<thead>
<tr>
<th>Category</th>
<th>Score</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrophy</td>
<td>A0</td>
<td>No tear trough, No PMG, No AMC volume loss</td>
</tr>
<tr>
<td></td>
<td>A1</td>
<td>Tear trough medial portion only</td>
</tr>
<tr>
<td></td>
<td>A2</td>
<td>Tear trough medial portion and PMG</td>
</tr>
<tr>
<td></td>
<td>A3</td>
<td>Tear trough medial portion and PMG and AMC volume loss</td>
</tr>
<tr>
<td>Bulging</td>
<td>B0</td>
<td>No bulging in the lower-eyelid-AMC area</td>
</tr>
<tr>
<td></td>
<td>B1</td>
<td>Lower eyelid bags/bulging only</td>
</tr>
<tr>
<td></td>
<td>B2</td>
<td>Malar festoons only</td>
</tr>
<tr>
<td></td>
<td>B3</td>
<td>Lower eyelid bags/bulging and Malar festoons</td>
</tr>
<tr>
<td>Laxity</td>
<td>L0</td>
<td>No lower eyelid laxity, No cheek laxity</td>
</tr>
<tr>
<td></td>
<td>L1</td>
<td>Lower eyelid laxity only</td>
</tr>
<tr>
<td></td>
<td>L2</td>
<td>Cheek laxity only</td>
</tr>
<tr>
<td></td>
<td>L3</td>
<td>Lower eyelid laxity and Cheek laxity</td>
</tr>
</tbody>
</table>

Abbreviations: AMC, anteromedial cheek; PMG, palpebromalar groove.
recognized as key effects of aging. Regionally, increased thickness of the OOM is significantly correlated with reduced orbital fat prolapse, while increased age is significantly correlated with both reduced OOM thickness and increased orbital fat prolapse. In a younger individual, the ORL prevents the prolapse of orbital fat and soft tissue (Figure 3A), but as a person ages, the ORL, OOM, and orbital septum begin to weaken, allowing prolapse of orbital fat (Figure 3B). Senescent laxity of the lower eyelid skin is likewise complicit: aging is associated with a decrease in horizontal eyelid fissure length and an inferior shift in the lower eyelid, causing conditions such as involutional entropion. Eventually, this structural weakening may contribute to the formation or exacerbation of tear troughs or eye bags.

3 | TREATMENT SELECTION: INDICATIONS AND CONTRAINDICATIONS

While filler injection is gaining popularity as a treatment choice for the tear trough and eye bag deformities, not all patients are suitable for injection, and careful evaluation and physician-patient consultation should always be done to determine the appropriate treatment plan. Evaluation is simple and consists of three metrics: the quantity of the lower eyelid skin, the quality of the lower eyelid skin, and the overall severity of the deformity complex. Figure 1A summarizes the evaluation process.

The quantity, or excess, of the lower eyelid skin is a relative contraindication for filler injection, because the folds produced by the excess skin make it difficult or impossible to gauge the correct target point of injection. Depending on the amount of excess skin, the eye bag might also see none or very little improvement, even after large amounts of filler volumization, and patient expectations should be clearly communicated. The first line of recommendation for these patients is an evaluation for surgical correction. However, since multiple studies have confirmed the efficacy of lasers and energy-based devices in stimulating collagen and elastin formation, these treatment methods may be used in conjunction with filler injections as a second-line option for patients who insist upon nonsurgical approaches.

The quality, or elasticity of the lower eyelid skin, is determined by its degree of laxity. Overly lax lower eyelid skin is another relative
contraindication for injection, for reasons similar to the above. Depending on the degree of laxity, a surgical approach is preferred due to uncertain volumization benefits and the difficulty in creating a smooth contour at the lid-cheek junction. Two useful and clinically quantifiable methods to check for suspected lower eyelid laxity are the "Snap-back" and the "Distraction" tests, respectively.20 The Snap-back test, or snap test (Figure 4A), is done by pinching and pulling down the lower eyelid and quickly letting go, then measuring the time needed for the eyelid to return to normal position. The test is positive if the eyelid does not return to its normal position immediately, and if the eyelid takes longer than 2-3 seconds to snap-back into place, more severe lower eyelid laxity is suspected. The distraction test is done by gently pinching and distracting the eyelid from the eyeball, and measuring the distance of distraction; values of >2 mm are considered to be abnormal, and values of >6 mm indicate eyelid laxity. For the purposes of pre-treatment evaluation, the snap test is recommended. In cases with severe laxity, the lower sclera may also remain visible even with the patient staring straight ahead, which may be a sign to look for.

While surgery is preferred in patients with lower eyelid laxity, noninvasive techniques are still possible. Additional modalities should be used in combination with filler injection for optimal results in the absence of surgical intervention; clinically tested and statistically effective modalities for eyelid laxity include monopolar radiofrequency (RF),16 high-intensity focused ultrasound (HIFU),17 and fractional CO₂ laser.18,19 The physician should communicate with the patient and work together to select the desired treatment option. A useful evaluation test to aid in communication and decision is the lift test (Figure 4B), which is done by placing a finger gently on the zygoma, and lightly pushing in the direction of the temples. This mimics a "lifting" effect and helps physicians and patients visualize the potential treatment outcome. Similarly, the push test (Figure 4C), which is done by placing a finger gently on the anteromedial cheek (AMC) and pushing toward the eye, mimics a "volumizing" effect for the AMC.

Finally, the severity, or size of the eye bag, is another variable in the decision to inject or operate. Very large, pronounced eye bags are more difficult to correct nonsurgically and is a relative contraindication for injection. The push test may be used to determine the possible volumization benefits of injection and gauge patient response: if the anticipated result is not satisfactory to the patient or physician, then injection should not be considered. However, if the patient refuses surgery and is willing to accept mild to moderate improvement results, nonsurgical approaches may still be viable after proper communication. For patients who exhibit laxity in both the cheek and the lower eyelids, and remain undecided or apprehensive about treatment, a combination of the Lift and push tests can be performed to evaluate possible injection outcome for communication and reassurance.

4 | TREATMENT PROTOCOL: INJECTION SEQUENCE AND RATIONALE

Any injection procedure aiming to treat tear troughs and eye bags have three general goals: to lift and anchor the local area, to provide support for soft tissue below the deformity, and to volumize the deformity itself, in respective order. The rationale behind this approach corresponds to the etiologies of the eye bag. Lifting is required for any loss of bone support or the presence of extensive age-related bone remodeling; soft tissue support is required to counteract any atrophic or displacement changes of the underlying fat pads; and volumization is required to smooth and hide the natural grooves caused by retaining ligaments and exacerbated by the aging process. The location, depth, product, tool, and volume of injection will be discussed in detail below. For ease and accuracy of communication, all injection points discussed will reference Dr de Maio’s MD Codes™ system (Figure 5).21 Treatment protocols are summarized in Table 2.
1. Lifting

The first step in treating the eye bag with injection is to provide a substitute lifting effect in the event of any sagginess or laxity of the cheek or lower eyelids, or in the event of significant bone deficiency. This can be done through injection at the periosteum level to simulate the presence of bone structure.

The first step is an injection along the zygomatic arch (Ck1), which simulates additional bone support from the zygoma, and tightens, or "lifts," the medial areas of the mid and lower face.

Inject three points around the Ck1 area using a 27G needle onto the periosteum level, and deposit 0.1 mL of Vycross 20 mg/mL HA (VYC-20L HA; Juvéderm® Voluma™, Allergan) per point, for a total of 0.3 mL per side. Each point injection should be about 0.5 cm apart.

To further bolster the lifting effects, the zygomatic eminence (Ck2) can be injected. Inject Ck2 using a 27G needle onto the periosteum level and deposit a bolus of 0.2 mL of VYC-20L HA per side. This step should be avoided in patients with malar festoons, because the Ck2 point is already prominent in Asians, and excessively...
so in Asian patients with malar festoons (itself a result of SOOF bulging). In these patients, injection will result in a disproportionately wide face.

The AMC, also known as the infraorbital area (Ck3), is a crucial area of volume management for tear trough treatments, especially in Asian patients. For patients with maxillary bone deficiency and a "sunken" appearance in this area, an injection should be performed to simulate a "bone-graft-like effect" and to enhance the anterior projection of the face. Inject Ck3 using a 27G needle onto the periosteum level and deposit a bolus of 0.2-0.3 mL of VYC-20L HA per side.

2. Support and projection

In addition to injection on the periosteum level, the Ck3 area could warrant further injections at different levels, depending on

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**TABLE 2** Injection recommendations for treating tear troughs complicated with eye bags in Asian patients

<table>
<thead>
<tr>
<th>#</th>
<th>Goal</th>
<th>Product</th>
<th>Point</th>
<th>Depth</th>
<th>Tool</th>
<th>Volume (mL), Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lifting</td>
<td>VYC-20L</td>
<td>Ck1</td>
<td>Periosteum</td>
<td>27G needle</td>
<td>0.1/point × 3 points, 0.3/side</td>
</tr>
<tr>
<td>2</td>
<td>Lifting</td>
<td>VYC-20L</td>
<td>Ck2</td>
<td>Periosteum</td>
<td>27G needle</td>
<td>0.2/side; bolus deposit</td>
</tr>
<tr>
<td>3</td>
<td>Lifting projection</td>
<td>VYC-20L</td>
<td>Ck3</td>
<td>Periosteum</td>
<td>27G needle</td>
<td>0.2-0.3/side; bolus deposit</td>
</tr>
<tr>
<td>4</td>
<td>Supporting projection</td>
<td>VYC-20L</td>
<td>Ck3</td>
<td>DMCF</td>
<td>≥25G cannula</td>
<td>0.5/side; fanning</td>
</tr>
<tr>
<td>5</td>
<td>Supporting projection</td>
<td>VYC-17.5L</td>
<td>Ck3</td>
<td>SOOF</td>
<td>≥25G cannula</td>
<td>0.3-0.5/side; fanning</td>
</tr>
<tr>
<td>6</td>
<td>Volumizing</td>
<td>VYC-15L</td>
<td>Tt2</td>
<td>Periosteum subdermal</td>
<td>25G cannula</td>
<td>0.1-0.2/pooint × 2 points, 0.3/side; microaliquot</td>
</tr>
<tr>
<td>7</td>
<td>Volumizing</td>
<td>VYC-15L</td>
<td>Tt1/3</td>
<td>Periosteum subdermal</td>
<td>25G cannula</td>
<td>0.1-0.2/pooint × 2 points, 0.3/side; microaliquot</td>
</tr>
</tbody>
</table>

Abbreviations: DMCF, deep medial cheek fat; SOOF, suborbicularis oculi fat; VYC, vycross hyaluronic acid.
patient characteristics and evaluation (Figure 1B). In general, further injections at Ck3 aim to bolster the soft tissue components at this location to better support the overlying structures and grooves formed by facial retaining ligaments.

In patients with DMCF atrophy, which manifests as an easily noticeable AMC concavity or nonprojection in the profile view, injection at Ck3 at the level of the DMCF is indicated. Inject Ck3 using a cannula of 25G or greater, into the DMCF level, and deposit 0.5 mL of VYC-20L HA per side. This should be done using the “fanning” technique to achieve uniform spread of product throughout the entire fat pad. To ensure the correct level of injection, insert the cannula at a 30-40 degree angle from the skin, and slowly advance until mild resistance from the superficial muscular aponeurotic system (SMAS) is encountered; after pushing through the SMAS layer, the cannula should be at the DMCF level.

Similar to patients with DMCF loss, patients with large eye bags or SOOF atrophy (which also manifest in a similar manner as DMCF atrophy) should be considered for injection at the SOOF level. The procedure is very similar to that of DMCF injections, though with a different product; using a cannula of 25G or greater, inject into the SOOF level, and deposit multiple microaliquots with a total volume of 0.1-0.2 mL of Vycross 17.5 mg/mL HA (VYC-17.5L HA; Juvéderm® Volift™, Allergan) per side. As with DMCF injections, this should be done with the “fanning” technique in order to maximize uniformity. The SOOF can be reached by inserting the cannula in a superior direction, through the ZCL, until it reaches the area just inferior to the OOM.

3. Volumization

The last steps to the injection algorithm should be directly over the deformities themselves. Injections in these locations serve to provide local, concentrated volumization for the targeted smoothing of the tear trough or PMG. In order to achieve a smooth, natural-looking result, injections should be done in a “bottom-up” manner from the periosteum, with a less viscous product to facilitate gentler volumization.

The first target of direct volumization is the PMG (Tt2), if present. In order to volumize patients who exhibit PMGs, the most lateral location of the tear trough (Tt) codes should be injected. Inject Tt2 using a 25G cannula onto the periosteum level and deposit multiple microaliquots with a total volume of 0.1-0.2 mL of Vycross 15 mg/mL HA (VYC-15L HA; Juvéderm® Volbella™, Allergan) per side.

This is followed lastly by volumization procedures for patients who exhibit the tear trough, which is almost identical to that for the PMG. Inject Tt1 and Tt3 using a 25G cannula onto the periosteum level, and deposit multiple microaliquots with a total volume of 0.1-0.2 mL of VYC-15L HA per point. A volume of 0.2 mL for Tt1 and 0.1 mL for Tt3 is typically recommended, for a total of roughly 0.3 mL per side.

5 | CLINICAL CASE STUDIES

Two clinical cases, both with a significant display of eye bags, were treated according to the ABL method and selected as demonstration of the method’s technical efficacy.

Case 1 is a 60-year-old Asian female with laxity over the cheek and lower eyelids, very large and prominent eye bags, and prominent tear troughs and PMGs. Her ABL classification score was A3B1L3, but she refused surgical intervention. Injection was done according to protocol, at Ck1, Ck3 (at the DMCF and SOOF layers), and Tt1-3 points. A total of 2.0 mL VYC-20L HA, 1.0 mL VYC-17.5 HA, and 1.0 mL VYC-15L HA were used. Good results were noted immediately and 1-month post-treatment (Figure 6).

Case 2 is a 68-year-old Asian female, presenting with very similar deformities as Case 1 and an identical ABL score of A3B1L3. Note
also the very large and prominent eye bags. She also refused surgical intervention. Injection was done according to protocol, and injection points were identical to Case 1 injection points. A total of 1.0 mL VYC-20L HA, 1.0 mL VYC-17.5 HA, and 1.0 mL VYC-15L HA were used. Good results were noted 3- and 28-month post-treatment (Figure 7). Note the retention of efficacy even 2 years after treatment.

6 | DISCUSSIONS

Filler injection for tear trough combined with eye bags is a relatively new practice, and especially so for patients with complicated deformities. One very recent report has demonstrated the efficacy of filler injections,22 though surgical interventions such as lower eyelid blepharoplasty remain popular and viable.23 This report affirms the efficacy of filler injections, even in complex and severe cases, and provides a systematic, logical algorithm that builds on and expands from the original ABL system.

In the early years of tear trough treatment with fillers, the prevailing method calls for a direct injection at the tear trough to simply correct for any volume deficiency. While this produced great results for patients who only have tear troughs, it proved insufficient for patients who were complicated with multiple aging signs. The MD Codes™ system, developed by Dr de Maio,24 took a more holistic approach, opting to inject the cheek, temple, and lateral orbital regions before the tear trough itself. However, the author prefers to tackle temporal injections after tear trough injections, for two main reasons. Firstly, in contrast with volumization at the AMC and “Lifting” injections at the zygoma, volumization at the temporal and lateral orbital positions have less anatomical impact on the tear trough region and mainly serve a supporting function for the lateral canthus and lateral eyebrows. Secondly, some patients may have budgetary restraints, which can force the physician to preclude areas of lesser impact. It is therefore recommended to postpone temporal and lateral orbital injections if needed.

As with any injection, serious complications involving vascular occlusion (such as vision loss or necrosis), can occur, making safety a critical issue. Numerous arteries and arterioles overly the tear trough area, which create additional challenges; based on a cadaver study, the safest injection level for the tear trough is over the perios- teum, with less than 6.7% of injections encountering blood vessels, compared with up to 70% in the submuscular level, and up to 90% in the supramuscular level.24 Using a cannula can further reduce the risk of intravascular events. One report suggests that using a cannula to inject the preseptal level could potentially lower risks and achieve satisfactory results.25 Overall, injection at the periosseous level, routine aspiration before deposition of product (if using a needle), and knowledge of local anatomy should be sufficient in preventing the majority of vascular occlusion accidents.

7 | CONCLUSIONS

The etiologies of eye bags include bone loss, fat atrophy, muscle laxity and structural degradation, and natural anatomical features. Three major characteristics—lower eyelid quantity, lower eyelid quality, and eye bag severity—can be used to determine whether or not a patient should undergo surgery. Two tests, the snap test and the push test, were provided for the accurate evaluation of patients and for the simulation of treatment outcomes. An injection sequence was then tailored and proposed to counteract the various eye bag etiologies, which can be summarized as “Creating lift,” “Creating support,” and “Volumization.” Through the use of this system, good results have been obtained for patients with tear troughs complicated with eye bags.

ORCID

Hsien-Li Peter Peng  https://orcid.org/0000-0002-5381-7167
Jui-Hui Peng  https://orcid.org/0000-0001-5976-2809

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