Original Investigation

Long-Term 3-Dimensional Volume Assessment After Fat Repositioning Lower Blepharoplasty

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IMPORTANCE First reported 3-dimensional quantitative study of the lower periorbital area after lower blepharoplasty using the fat repositioning technique.

OBJECTIVE To determine the volumetric effects lower blepharoplasty with fat repositioning provides to the tear trough and deep fat compartments of the upper cheek.

DESIGN, SETTING, AND PARTICIPANTS A retrospective electronic medical chart review (16-month study with a minimum of 10-month postoperative evaluation) was performed on 12 initial patients recruited to a private practice; 2 patients were lost to long-term follow-up. Patients were recruited between May 2014 and November 2014. To fulfill recruitment criteria, patients must have undergone a lower blepharoplasty performed using the fat repositioning technique with a minimum of 10 months follow-up. Patients who had undergone additional procedures or had a history of filler to the tear trough or cheek area before or during the study period were excluded.

MAIN OUTCOMES AND MEASURES Volume (mL) measurement of a defined anatomical area in postoperative patients.

RESULTS Overall, 10 patients (mean [range] age, 56 [37-66] years) who had undergone a lower blepharoplasty performed using the fat repositioning technique had volume gain in the areas evaluated. The mean (range) follow-up time was 12 (10-16) months. The average volume gain was 0.64 mL (left side, 0.61 mL; right side, 0.67 mL). There was no statistical difference when the 2 sides were compared (P = .49).

CONCLUSIONS AND RELEVANCE The fat repositioning technique in lower blepharoplasty improves pseudofat herniation while simultaneously adding volume to the lower periorbital and cheek areas. The results are reproducible with long-term aesthetic improvement in the tear trough and upper cheek areas.

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Lower eyelid blepharoplasty is a commonly requested aesthetic procedure.[1] The primary reason is pseudofat herniation in the lower eyelid area that can impart an unwanted tired or sad appearance. Surgical techniques that are commonly used to correct pseudofat herniation can typically be categorized as fat preservation or fat subtractive. Fat repositioning lower blepharoplasty is a fat preservation technique that offers distinct advantages, namely effacing the tear trough by releasing the tethering orbicularis retaining ligament with the subsequent addition of volume to the tear trough and upper malar area (**Figure 1**).[2-5]

Prior to 3-dimensional (3D) imaging, evaluation of the effectiveness of the fat repositioning lower blepharoplasty technique was difficult to quantify. Specifically, standard photography relied on shadows and tight camera angles to illustrate qualitative results (Figure 1 and **Figure 2**). Moreover, patients would commonly have adjunctive procedures performed during or after the procedures, thereby confounding the results of the fat repositioning technique alone. The current study used a standardized 3D camera system and a cohort of patients having only fat repositioning lower blepharoplasty performed to quantify the long-term effectiveness of this fat preservation lower blepharoplasty technique.

Methods

A retrospective electronic medical record review was performed to identify patients who underwent primary lower

Figure 1. Results of the Fat Repositioning Lower Blepharoplasty Procedure

A, Preoperative photograph; B, 13-month postoperative result of the fat repositioning lower blepharoplasty procedure.

Figure 2. Results of the Fat Repositioning Lower Blepharoplasty Procedure

A, Preoperative photograph of a patient and (B) 12-month postoperative result of the fat repositioning lower blepharoplasty procedure. C, Black line outlining the preoperative facial contour and (D) black line emphasizing the postoperative contour change.

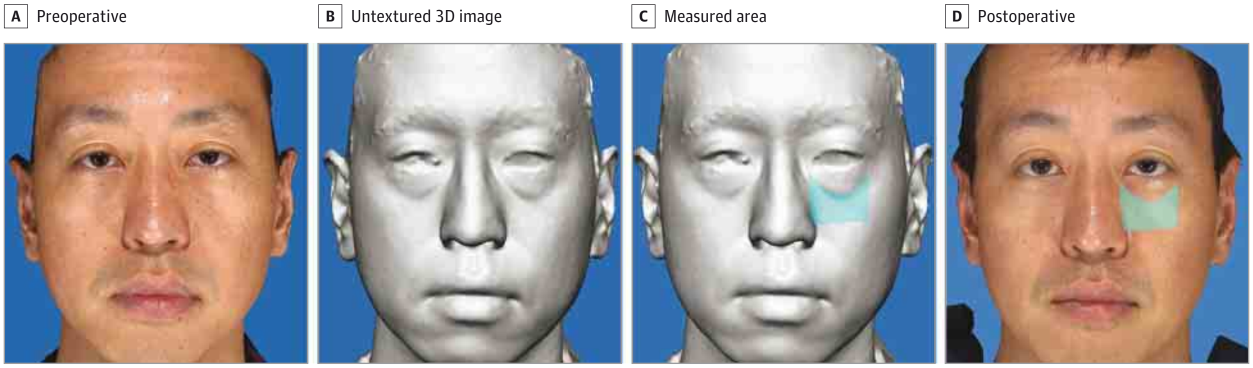
blepharoplasty with fat repositioning. In the author's aging face practice, patients commonly have additional procedures performed simultaneously. Consequently, patients having additional procedures such as canthopexy, fat transfer, rhytidectomy, brow-lift, rhinoplasty, and implants in the periorbital or cheek areas were excluded to avoid confounding the results. Additionally, patients with a history of lower blepharoplasty or a history of filler to the tear trough or cheek areas before or during the study period were also excluded.

Twelve patients were identified that matched the strict criteria; 2 patients were lost to long-term follow-up. All patients provided written informed consent. Their preoperative and postoperative (≥ 10 months) 3-dimensional (3D) images (VECTRA M3 Imaging System, Canfield Scientific, Inc) were used to obtain data for this study. All 3D images were performed in the author's dedicated photography area where the lighting, 3D camera system, and patient's relative positon to the camera are securely fixed. The photographs were taken per manufacturer protocol, where the results have been shown to be reproducible.[6,7]

All preoperative photographs were taken the day of surgery, and the preoperative 3D images were used as the baseline image for registering subsequent postoperative 3D photos. The computer registering process is important to correctly align and identically overlay subsequent postoperative photographs so analysis of volume differences can be accurately calculated. The registering process relies on landmarks. At least 12 landmarks were used: medial and lateral canthi, oral commissures, nasal tip, and nasal sill, as well as 6 or more unique facial landmarks not in the operative area (eg, nevus, lentigo, and scar).

The area selected for volume analysis was based on the areas typically affected by fat repositioning and by a recent cadaver study confirming reproducible target zones for augmentation in the malar area.[8] The area of evaluation for each patient included the tear trough (and eyelid-cheek junction) as

Figure 3. Volume Analysis After Fat Repositioning



A, Preoperative photograph of a patient; B, corresponding preoperative untextured 3D image; C, illustrated measured area; D, postoperative photograph with measured area transposed. 3D indicates three-dimensional.

the superior border; the medial and lateral borders were based on perpendicular lines originating from the medial and lateral canthi that intersect a horizontal line originating from the alar crease that served as the inferior border. The area was selected on the preoperative 3D photograph using the untextured view, which offers more precise recognition and inclusion of the entire tear trough (and eyelid cheek junction). The area selected was then identically duplicated on the patient's 3D postoperative (registered) image (**Figure 3**). This merging process and the subsequent calculations of volume differences between the preoperative and postoperative 3D images were performed by the VECTRA 3D Analysis Module (Canfield Scientific, Inc). The process of area selection to volume calculation was performed 3 times per side for each patient, and the average value per side was used in the calculations.

Statistical Analysis

Statistical analysis was performed within Microsoft Excel 2013 (Microsoft) using a paired 2-tailed *t* test, assuming unequal variances.

Surgical Technique

The patient is provided anesthesia through conscious intravenous sedation or general anesthesia. Local anesthesia is provided and lubricated eye shields are placed. A transconjunctival incision is followed by superior retraction of the incised conjunctiva and lower eyelid retractors. Blunt dissection is performed to the orbital rim in the (preseptal) plane located between the orbital septum and orbicularis oculi muscle. Although the arcus marginalis is identified it is not used as a definitive landmark for the orbital rim because this structure can be located within the orbital cavity secondary to aging.[9-11] The orbicularis retaining ligament (ORL) and its medial extension (tear trough ligament) are fully released in the subperiosteal plane.[12] Dissection (blunt) proceeds laterally and inferiorly. The lateral limit is the fascial extension of the orbital septum that extends to the ORL, while inferiorly the dissection extends into the premaxillary and prezygomatic spaces far enough to receive the repositioned fat pedicles.[5,10,13] As a result, during the inferior dissection the plane transitions from a subperiosteal plane to become anterior to the levator labii superioris muscle. To preserve volume no muscle is resected or detached from its bony origins.

Next, the nasal (medial) and middle fat pads are released through the excision of a small strip of septum and ("suborbicularis fascia"), and vascularized fat pedicles are then fashioned using blunt dissection only. All fat is preserved during the creation of the pedicles. Moreover, the author does not use electrocautery or laser in this endeavor or during the dissection phase to reduce the potential for volume loss secondary to thermal injury. The inferior oblique muscle is always identified prior to this process and is a significant landmark to safely obtain full mobility of the pedicles.[14]

The fat pedicles are then transposed over the orbital rim and secured with 3 to 4 transcutaneous 5-0 polydioxanone sutures that are removed on postoperative day 3. The inferior extent of the fat repositioning is dependent on the size of the fat pad, but always to the previous attachments of the ORL and tear trough ligament and typically beyond. The lateral fat pad is reduced as needed. A gentle forced duction test is performed to assess restriction of the globe and the conjunctiva is closed with fast-absorbing plain gut sutures.

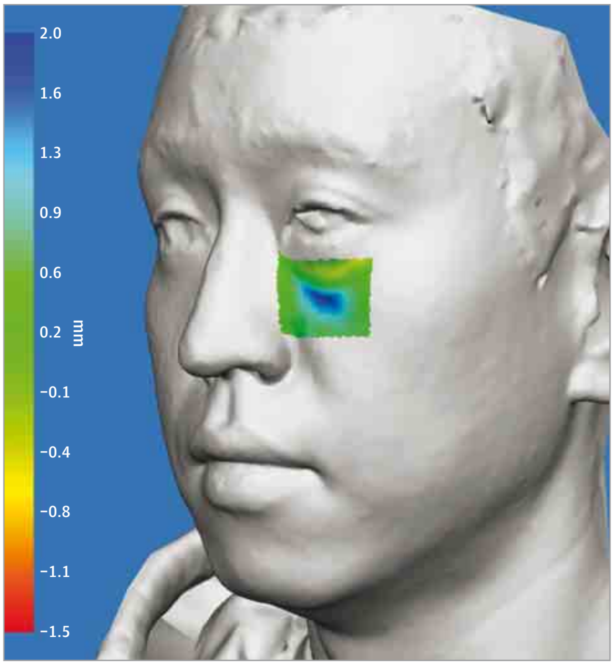
Results

Overall, 10 patients met the inclusion criteria. There were no complications. The mean (range) age was 56 (37-66) years. The mean (range) follow-up period was 12 (10-16) months. All patients had volume gain in the areas evaluated (**Figure 4** and **Figure 5**A and B). The mean (range) volume gain was 0.64 mL (left side, 0.61 [0.33-1.07] mL; right side, 0.67 [0.31-0.92] mL) (**Table**). There was no statistical difference when the 2 sides were compared ($P = .49$).

Discussion

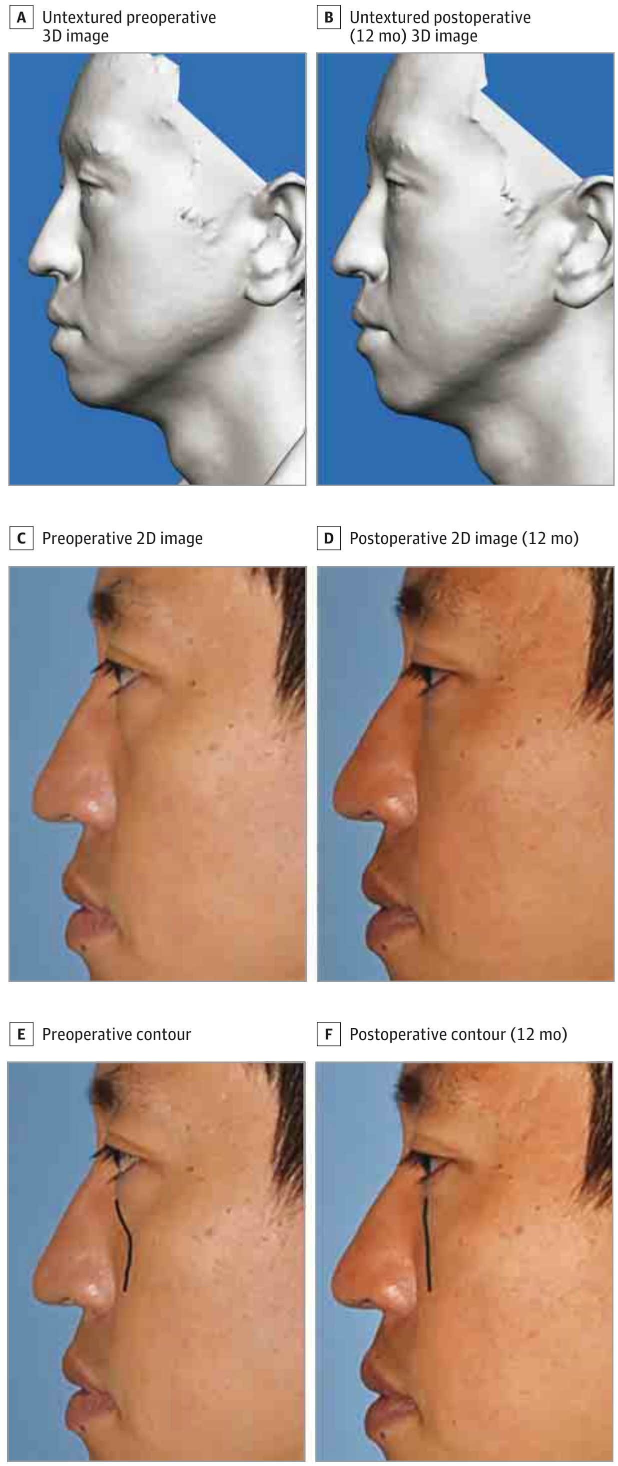
Rejuvenation of the periorbital area for patients with pseudoherniated fat is a common request.[1] Techniques vary but most

Figure 4. Colorimetric Analysis 12 Months After Fat Repositioning



According to the corresponding scale on the left of the image, blue represents increased volume.

Figure 5. Results of the Fat Repositioning Lower Blepharoplasty Procedure



A, Image shows an untextured preoperative 3D image; B, untextured 3D results of the fat repositioning lower blepharoplasty procedure at 12 months. C, Preoperative 2D photograph of the same patient; D, postoperative 2D results at 12 months. E, Black line outlining the preoperative facial contour of the patient; F, black line emphasizing the postoperative contour change. Results illustrate long-term volume augmentation of the tear trough and anterior cheek. 2D indicates two-dimensional; 3D, three-dimensional.

surgical procedures can be categorized as fat preservation or fat subtractive. Based on a review of the literature, Loeb[2,3] was the first to publish a fat preservation technique that emphasized effacing the tear trough, or using his terminology, "leveling" of the nasojugal fold (tear trough) by "sliding" the "inner" (medial or nasal) and "mesial" (middle) orbital fat pads over and inferior to the orbital rim. Descriptions by Hamra,[4] who popularized the term fat repositioning, were followed by modifications of the technique by Goldberg,[5] who emphasized a transconjunctival approach, thereby sparing the potential issues with a skin-muscle flap approach. The current study used a transconjunctival approach.

Fat repositioning offers distinct advantages, especially when recognizing the interrelationship between periorbital aging and midface anatomy. Specifically, Pessi, Rohrich, and others[10,15] have defined the deep fat compartments of the periorbital and midface areas as those being the deep medial fat and the medial and lateral suborbicularis orbital fat. Their descriptions offer clarity to the importance of these fat compartments for providing, maintaining, and reestablishing youthful contours. Prior to fat "sliding," Loeb frequently used free fat grafts to rejuvenate the tear trough and lower eyelid-cheek junction. Loeb reasoned that successful augmentation and "leveling" of the tear trough (and lower eyelid-cheek junction) with fat grafts required an excellent blood supply and for the grafts to be continuous with the fat already existing there. Moreover, the volume of fat required for this "leveling" was minimal, theorizing a maximum of 1 g based on his extensive experience with free fat grafts (fat density = 0.9 g/mL).[2]

The fat repositioning technique fulfills Loeb's criteria because the technique involves the use of vascularized pedicles of orbital fat and positions the fat pedicles anatomically adjacent to the recently defined deep fat compartments, or more precisely, within the overlying prezygomatic and premaxillary spaces that have been theorized to offer the best plane for augmenting and rejuvenating the periorbital and malar areas.[8,10,13] Techniques based on removing orbital fat during lower blepharoplasty do not provide this benefit.

Although the fat repositioning technique requires a more thorough grasp of anatomic knowledge, surgical proficiency, and operating time, the results have been shown in the current study to be aesthetically beneficial and the results long lasting. The study results reveal an average benefit of 0.64 mL to the areas studied. The range of volumes calculated per patient (and per side) in this study correlates to differences seen clinically. It is common to see differences in the size of pseudofat herniation between patients and even between the left and right sides in a patient. However, the current study calculated no significant difference between the sides in our patient population ($P = .49$) and a positive volume gain, both quantitative and qualitative, in all patients (**Figure 6**).

How the increased volume after fat repositioning mathematically correlates to the volume of injected free fat grafts or a hyaluronic acid filler is difficult to determine.[6,7] When free fat grafts or fillers are injected into the tear trough area, the dense tethering orbicularis retaining ligaments and tear trough ligaments are not released. As a result, the volume expansion by filler or fat transfer may not exhibit a 1:1 correlation to repositioned fat; that is, by releasing the tethering ligaments less volume may be required to elevate, "level," and maintain fullness to the area.

The current study attempted to evaluate the transposition of fat without confounding the results by additional procedures or previous fillers to the area that could affect the volume measurements in the areas studied. For instance, the author commonly uses fat transfer to the tear trough and deep fat compartments simultaneously with fat repositioning lower blepharoplasty and/or performs a deep-plane high-SMAS (superficial musculoaponeurotic system) rhytidectomy that technically enters the prezygomatic space during the ligament release portion. The deep-plane high-SMAS procedure and the following imbrication of the SMAS layer could change the contour of the area studied and confound the results. Consequently, the number of patients in the current study was small, and a larger population would be beneficial to confirm or extend the results.

The author uses a subperiosteal approach but transitions from this plane at the level of the levator labii superioris muscle. The main objectives before the creation of the fat pedicles, however, are the formation of adequate sized pockets for the repositioned fat pedicles and the release of the tethering effects of the ORL and tear trough ligaments that can be accomplished through either a subperiosteal or supraperiosteal approach.[11,12,15] Recent studies have shown no significant differences in aesthetic outcomes based on planes of dissection.[16] However, the current study used 3D imaging analysis to evaluate the volumetric effects using a subperiosteal plane, additional studies will need to be performed to assess if these objective long-term volumetric results are reproducible, reduced, or enhanced using other anatomical planes.

Table. Volume Increase After Fat Repositioning Lower Blepharoplasty

Patient	Age, y	Follow-up, mo	Volume Increase, mL Left Side	Volume Increase, mL Right Side
1	37	12	0.57	0.71
2	60	16	0.56	0.61
3	57	12	0.85	0.70
4	63	10	1.07	0.92
5	55	12	0.47	0.54
6	59	12	0.69	0.73
7	45	10	0.39	0.32
8	62	13	0.58	0.74
9	66	12	0.49	0.79
10	58	12	0.46	0.66

Figure 6. Results of the Fat Repositioning Lower Blepharoplasty Procedure

A Preoperative; B Preoperative untextured; C Postoperative (10 mo); D Postoperative (10 mo) untextured

A, Preoperative 3D image of a patient; B, corresponding untextured image; C, postoperative 3D image at 10 months; D, corresponding untextured image.

Three-dimensional imaging is increasing in popularity in plastic surgery. The study benefitted from a calibrated stationary 3D system that reduced the potential errors of reproducing patient-to-camera position, angles, and lighting issues often experienced with handheld 2D and 3D camera systems. Nevertheless, the areas studied required many phases; for instance, computer mathematical models and calculations to align the preoperative and postoperative images, extrapolating the exact area of study to the after photos, and calculating volume differences. Moreover, although the area studied on each individual patient was set by standardized landmarks, interpatient variability does exist based on the placement of the landmarks and each patient's unique anatomy. As a result, each step has the potential for measurement errors that may be further reduced with future advancements in the expanding field of 3D imaging and analysis.

Conclusions

The lower blepharoplasty fat repositioning technique is an effective procedure for improving the tear trough and lower eyelid-cheek areas. The aesthetic improvement is explained by the release of ligaments and volume augmentation of specific areas that have recently been defined by recent anatomical studies. Additionally, proper implementation of the technique offers patients long-lasting and reproducible results.

ARTICLE INFORMATION

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