Three-Dimensional Topographic Surface Changes in Response to Compartmental Volumization of the Medial Cheek: Defining a Malar Augmentation Zone

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Background: Given the widespread use of facial fillers and recent identification of distinct facial fat compartments, a better understanding of three-dimensional surface changes in response to volume augmentation is needed. Advances in three-dimensional imaging technology now afford an opportunity to elucidate these morphologic changes for the first time.

Methods: A cadaver study was undertaken in which volumization of the deep medial cheek compartment was performed at intervals up to 4 cc ($n = 4$). Three-dimensional photographs were taken after each injection to analyze the topographic surface changes, which the authors define as the "augmentation zone." Perimeter, diameter, and projection were studied. The arcus marginalis of the inferior orbit consistently represented a fixed boundary of the augmentation zone, and additional cadavers underwent similar volumization following surgical release of this portion of the arcus marginalis ($n = 4$). Repeated three-dimensional computer analysis was performed comparing the augmentation zone with and without arcus marginalis release.

Results: Volumization of the deep medial cheek led to unique topographic changes of the malar region defined by distinct boundaries. Interestingly, the cephalic border of the augmentation zone was consistently noted to be at the level of the arcus marginalis in all specimens. When surgical release of the arcus marginalis was performed, the cephalic border of the augmentation zone was no longer restricted.

Conclusions: Using advances in three-dimensional photography and computer analysis, the authors demonstrate characteristic surface anatomy changes in response to volume augmentation of facial compartments. This novel concept of the augmentation zone can be applied to volumization of other distinct facial regions. (*Plast. Reconstr. Surg.* 137: 00, 2016.)

CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, V.

Over the past several years, there has been growing evidence to support the presence of distinct fat compartments within the superficial and deep layers of the face.[1–3] This important discovery has changed the way surgeons approach aesthetic rejuvenation of the aging face. The role of facial volume loss as a natural aging process is now generating greater emphasis.[1,4,5] Increasing numbers of surgeons performing reconstructive

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and aesthetic procedures are incorporating facial volumization techniques as primary and adjunctive methods in the restoration of a more natural and youthful appearance.[3,6,7] Although many debate the benefits of autologous fat versus synthetic fillers, there is no doubt that facial volumization plays an important role in the current state-of-the-art approach toward facial rejuvenation.

Despite widespread use of autologous fat grafting as a technique in restorative surgery and identification of distinct facial fat compartments that can be volumized, understanding of the three-dimensional surface changes in response to compartmental volumization is unknown. It is unclear how fat grafting of known facial compartments alters the three-dimensional topography of the face. Objective three-dimensional analysis of the surface changes produced with facial compartmental volumization is imperative to the documentation of the effectiveness, longevity, and repeatability of these techniques.

This study builds on the senior author's AQ2 (O.M.T.) extensive experience with three-dimensional photography to develop practical methodology that can be used to relate controlled facial augmentation (injections) with the resultant topographic surface changes in facial anatomy. This study defines a new concept of the "augmentation zone." Using three-dimensional photography and computer analysis, we are able to objectively study how the surface topographic anatomy of the malar region responds to targeted fat grafting of the deep medial cheek.

MATERIALS AND METHODS

A cadaver study was performed in which volumization of the deep medial cheek compartment was performed ($n = 4$). A 1-cc syringe with an 18-gauge cannula was filled with fat analogue (applesauce) and used for injection. The physical properties of applesauce, including resistance, aspiration rate, and viscosity, has been shown to correlate with aspirated autologous fat in vivo.[8] The use of cadaveric studies with dyed Restylane (Galderma Laboratories, Ft. Worth, Texas) injected by AQ3 cannula into compartments by Surek et al. guided our injection techniques.[9] The site of needle entry was marked at the intersection between a vertical line dropped from the medial limbus and a horizontal line drawn at the level of the alar rim. The injection technique is consistent with the medial midface viaduct, as recently described by Surek et al.[9] Injections were then performed at the following volumes: 0.5, 1, 2, 3, and 4 cc.

Three-Dimensional Photography

Three-dimensional photographs were taken at baseline and after each injection. The Canfield VECTRA H1 system (Canfield Scientific, Inc., Fairfield, N.J.) was used to capture photographs, and included right oblique, frontal, and left oblique views. The three photographs were then uploaded to VECTRA to stitch the images into a single three-dimensional model. This process is performed by manual selection of key facial landmarks, including the pupil, radix, and nasal tip, followed by automated stitching of the three individual captures that combine to form a single three-dimensional photograph.

Three-Dimensional Computer Analysis and Defining the Augmentation Zone

Using Canfield VECTRA Analysis Module software, augmented three-dimensional surfaces were overlaid with the baseline surface image. Overlays were performed by manually selecting facial regions unchanged by injection (forehead and nose), followed by computer recognition and alignment of the selected identical surfaces. Color maps were then generated using a 1-mm change as the lower limit and the maximum projection value (calculated by the computer) as the upper limit. A color scale is then produced that shows a spectrum of changes for each injection. We call this new surface change the augmentation zone. Measurements of the augmentation zone included perimeter, maximum horizontal and vertical diameter (vector distance), and projection. Mean values were calculated with a two-tailed paired t test relating values to the previous injection value, and a value of $p < 0.05$ was considered statistically significant.

Relationship of the Deep Medial Cheek and Nasojugal Groove

Having noted that the superior border of the augmentation zone was consistently at the level of the arcus marginalis of the inferior orbit (nasojugal groove or tear trough), additional cadaver studies were performed to better understand the anatomical relationship between the arcus marginalis and deep medial cheek compartment. Although the anatomical basis of the nasojugal groove or tear trough remains controversial, many experts believe the arcus marginalis plays a critical role.[10–16] The arcus marginalis is defined as the fused region of the periorbital orbicularis oculi retaining ligament, orbital septum, and periosteum that originates on the inferior bony orbital rim.[17] Release of the arcus marginalis is performed in concert with

fat repositioning to correct the tear trough deformity, which softens the transition between the
AQ4 cheek and lower lid.[10–12,18,19] Four additional fresh cadavers underwent surgical release of the arcus marginalis on the right side by means of a retroseptal approach, whereas the contralateral side was left intact. Arcus marginalis release was performed with a horizontal conjunctival incision 8 mm from the lower eyelid margin to access the retroseptal space. Orbital fat was retracted and the arcus marginalis was visualized and incised from the medial canthus to the midpupillary line from the internal orbital space. This maintains the continuity of the orbital system and the maxillary periosteum components of the arcus marginalis. This maneuver also elevates the origins of the orbital portion the orbicularis oculi muscle and orbital retaining ligament.[20] The orbital portion of the orbicularis oculi muscle was elevated and redraped over the medial infraorbital rim, whereas the palpebral portion was undisturbed. The transconjunctival incision was then closed with a running 5-0 nylon suture. Bilateral deep medial cheek injections of fat analogue were then performed as described. Three-dimensional computer analysis of the augmentation zone was performed in a similar fashion.

RESULTS

Volumization of the Deep Medial Cheek Creates an Augmentation Zone with a Unique Shape

Volumization of the deep medial cheek led to unique topographic changes of the malar region. Rather than the augmentation zone being a discoid pattern from spherical growth equal in all directions, the topographic changes showed a characteristic trapezoid shape across all specimens, with the base of the trapezoid at the nasal-cheek junction (Fig. 1). The perimeter of the F1
augmentation zone increased steadily over our injection range (Fig. 2). Early changes showed an F2
expansion in perimeter that approaches a threshold once the compartment boundaries reach capacity (Table 1). Perimeter increased as follows: T1
73.8 ± 21.1 mm at 0.5 cc, 101.7 ± 12.7 mm ($p < 0.05$) at 1 cc, 138.7 ± 6.7 mm ($p < 0.01$) at 2 cc, 160.6 ± 5.9 mm ($p < 0.01$) at 3 cc, and 171.0 ± 3.5 mm ($p < 0.05$) at 4 cc. Vertical and horizontal diameter of the augmentation zone showed similar changes throughout volumization (Fig. 3). Vertical diam- F3
eter increased to 17.9 ± 1.8 mm at 0.5 cc, 24.8 ± 3.0 mm (not significant) at 1 cc, 29.1 ± 2.1 mm ($p < 0.05$) at 2 cc, 33.1 ± 1.5 mm ($p < 0.05$) at 3 cc, and 36.1 ± 1.0 mm ($p < 0.05$) at 4 cc. Horizontal diameter increased from 18.2 ± 4.1 mm to 21.1 ± 4.0 mm (not significant), 31.0 ± 2.7 mm ($p < 0.05$), 36.5 ± 5.0 mm ($p < 0.05$), and 39.0 ± 4.6 mm (not significant), respectively.

Volumization of the Deep Medial Cheek Leads to Increased Projection of the Augmentation Zone

In addition to defining the shape of the augmentation zone, we analyzed projection to understand the three-dimensional contour achieved by incremental augmentation to the deep medial cheek. Projection increased throughout our

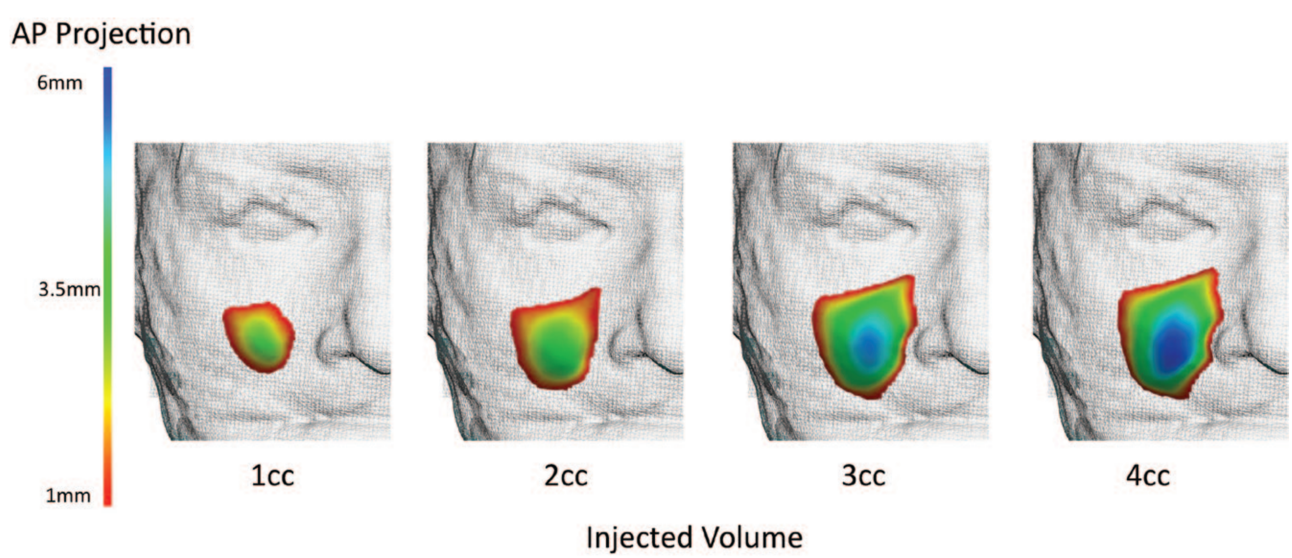

Fig. 1. Augmentation zone for deep medial cheek compartment. Surface change resulting from deep medial cheek augmentation from 1- to 4-cc injection of fat analogue. Color scale demonstrates range of surface change from 1 mm (*red*) to a maximum of 6 mm (*blue*). Note the superior boundary of the augmentation zone at the nasojugal groove. *AP*, anteroposterior.

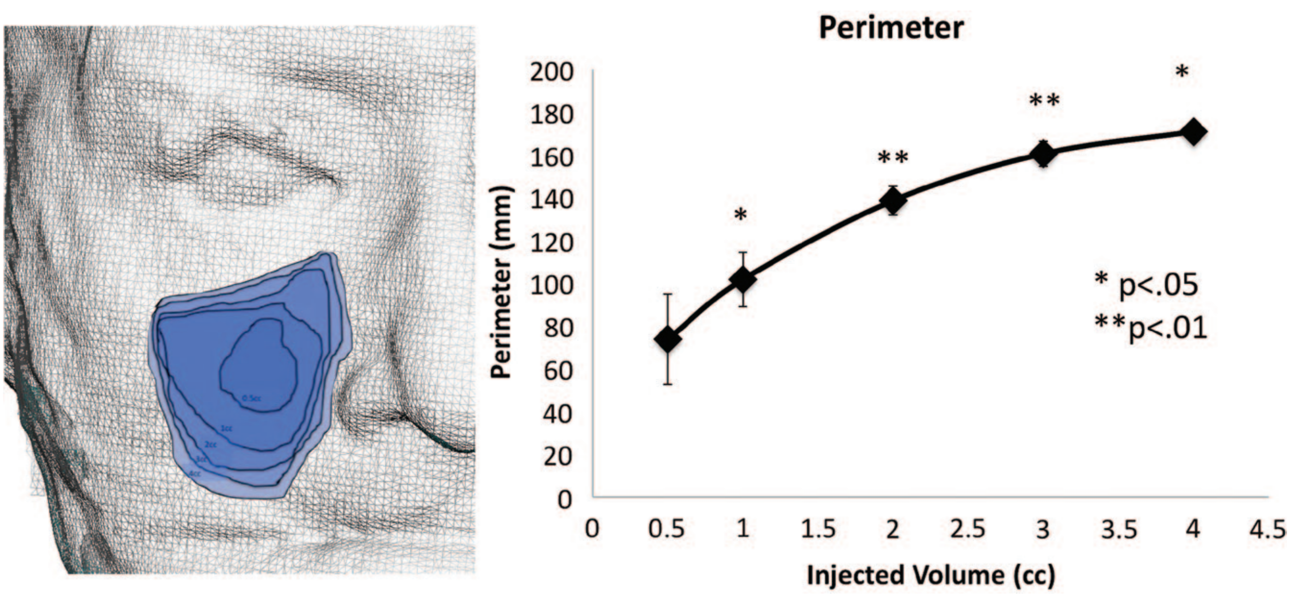

Fig. 2. (*Left*) Deep medial cheek augmentation zone perimeter tracings for 0.5-, 1-, 2-, 3-, and 4-cc injection volumes. (*Right*) Graph showing mean augmentation zone perimeter values, respectively.

Table 1. Deep Medial Cheek Augmentation Zone Metrics for Injection Volumes of 0.5 to 4 cc

Injected Volume (cc)	Perimeter (mm)	Vertical Diameter (mm)	Horizontal Diameter (mm)	Anterior Projection (mm)
0.5	73.8 ± 21.1	17.9 ± 1.8	18.2 ± 4.1	1.9 ± 0.6
1.0	101.7 ± 12.7*	24.8 ± 3.0	21.1 ± 4.0	2.6 ± 0.6*
2.0	138.7 ± 6.7†	29.1 ± 2.1*	31.0 ± 2.7*	3.4 ± 0.5*
3.0	160.6 ± 5.9†	33.1 ± 1.5*	36.5 ± 5.0*	4.6 ± 0.7*
4.0	171.0 ± 3.5*	36.1 ± 1.0*	39.0 ± 4.6	5.2 ± 0.9

*$p < 0.05$; determined by comparison to prior injection volume.
†$p < 0.01$; determined by comparison to prior injection volume.

injection range, and was characterized by an initial slow increase at low injection volumes followed by a steep increase once the perimeter was restricted
F4 by compartment boundaries (Fig. 4). Projection for 0.5-, 1-, 2-, 3-, and 4-cc injection were as follows: 1.9 ± 0.6, 2.6 ± 0.6 ($p < 0.05$), 3.4 ± 0.5 ($p < 0.05$), 4.6 ± 0.7 ($p < 0.01$), and 5.2 ± 0.9 mm (not significant), respectively.

Anatomical Relationship of the Deep Medial Cheek and Arcus Marginalis Release

One interesting finding in all of our cadaver specimens was that the arcus marginalis (nasojugal groove) consistently represented the superior boundary of the augmentation zone. To better define the anatomical basis of the arcus marginalis (nasojugal groove) and deep medial cheek, we performed additional studies in cadavers that underwent arcus marginalis release on
F5 one side (Fig. 5). Bilateral volumization of the deep medial cheek was then performed, and the topographic changes were compared between the side of arcus marginalis release versus no release ($n = 4$).

Surgical release of the arcus marginalis led to an augmentation zone with unique shape and boundaries relative to the contralateral side. With arcus marginalis release, the augmentation zone resembled a shield shape, as the nasojugal groove no longer restricted the augmentation zone superiorly, and volume change was observed extending beyond this interface to now augment the nasojugal groove (Fig. 6). Despite a different overall
shape of the augmentation zone, surface measure- F6
ments did not change significantly. Perimeter did not differ between released versus nonreleased sides: 145 ± 5.8 mm versus 139.3 ± 12.2 mm (not significant) at 2 cc, and 178.8 ± 13.5 mm versus 169.6 ± 8.4 mm (not significant) at 4 cc. This was true for vertical and horizontal diameter as well. For vertical diameter, the values were as follows: 31.1 ± 2.6 mm for the released side versus 30.9 ± 4.2 mm for the nonreleased side (not significant) at 2 cc, and 38.3 ± 1.1 mm versus 34.4 ± 3.6 mm (not significant) at 4 cc. For horizontal diameter, the values were as follows: 29.0 ± 3.2 mm versus 27.7 ± 4.7 mm (not significant) at 2 cc, and 39.1 ± 1.9 mm versus 35.1 ± 5.7 mm (not significant) at 4 cc. Maximum projection on each side was similar as well: 5.5 ± 1.0 mm for the released side versus 5.3 ± 1.0 mm for the nonreleased side (not significant) at 2 cc, and 7.2 ± 0.4 mm versus 7.4 ± 0.8 mm (not significant) at 4 cc.

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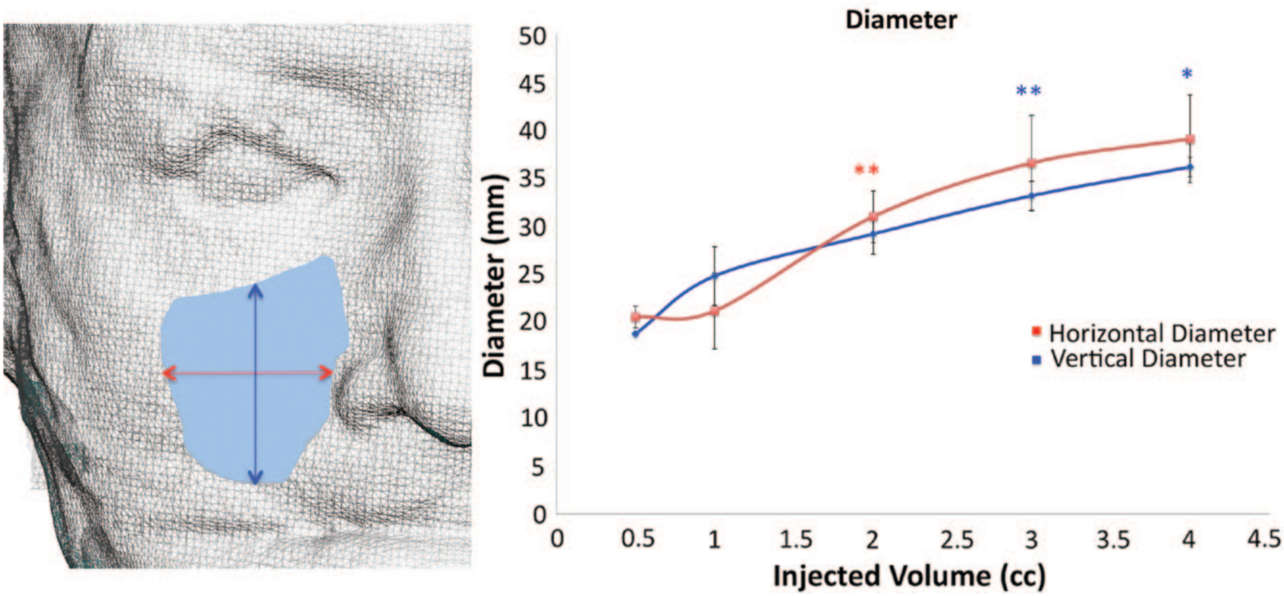

Fig. 3. (*Left*) Deep medial cheek augmentation zone vertical and horizontal diameter. (*Right*) Graph showing mean augmentation zone vertical (*blue*) and horizontal (*red*) diameter for 0.5-, 1-, 2-, 3-, and 4-cc injection volumes.

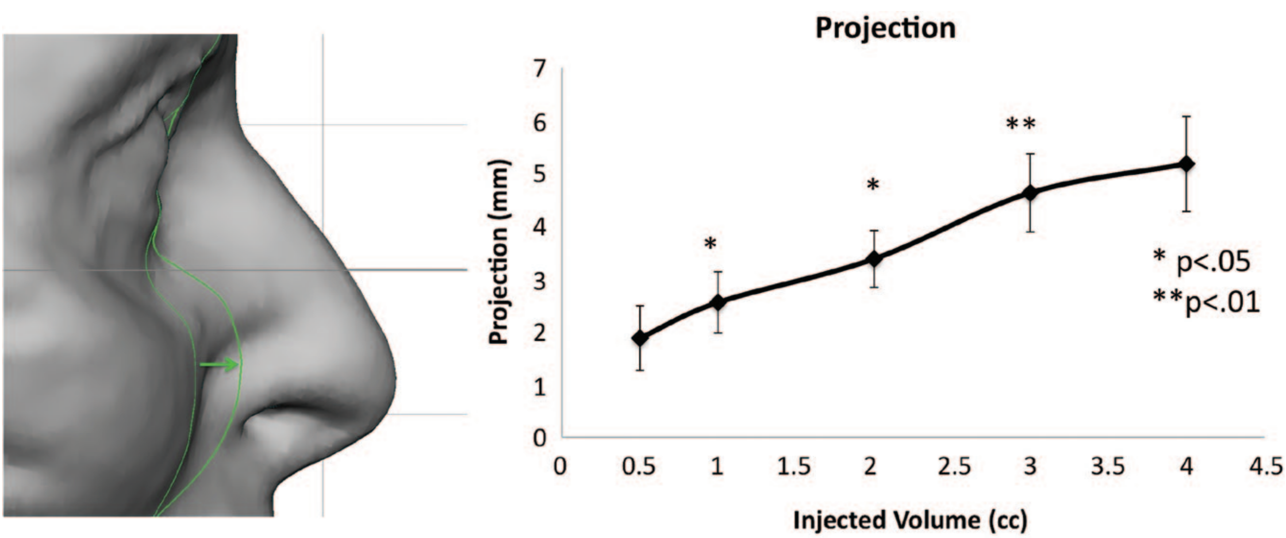

Fig. 4. (*Left*) Deep medial cheek augmentation zone projection from baseline surface. (*Right*) Graph showing mean augmentation zone projection for 0.5-, 1-, 2-, 3-, and 4-cc injection volumes

DISCUSSION

This study documents that controlled volumization (injection) into specific facial fat compartment can produce a pattern of change in the topographic surface anatomy in the malar region. We introduce a new term, "augmentation zone," which defines the topographic surface changes that occur in response to controlled volumization of a facial compartment. Contour and support are also provided; however, these parameters are not effectively measured from these cadaveric studies.

Evidence that superficial and deep fat depositions exist in the face suggests that alterations in the volume and positions of this compartmentalized fat may play a significant role in aging. In this study, we focused on volumization of the deep medial cheek compartment. Pessa et al. first described this compartment in 2007.[21] The compartment resides deep in the premaxillary space nestled on the maxillary periosteum and deep to the muscles of facial expression: levator labii superioris, levator anguli oris, zygomaticus major, zygomaticus minor, and portions of levator alaeque nasi. More recent

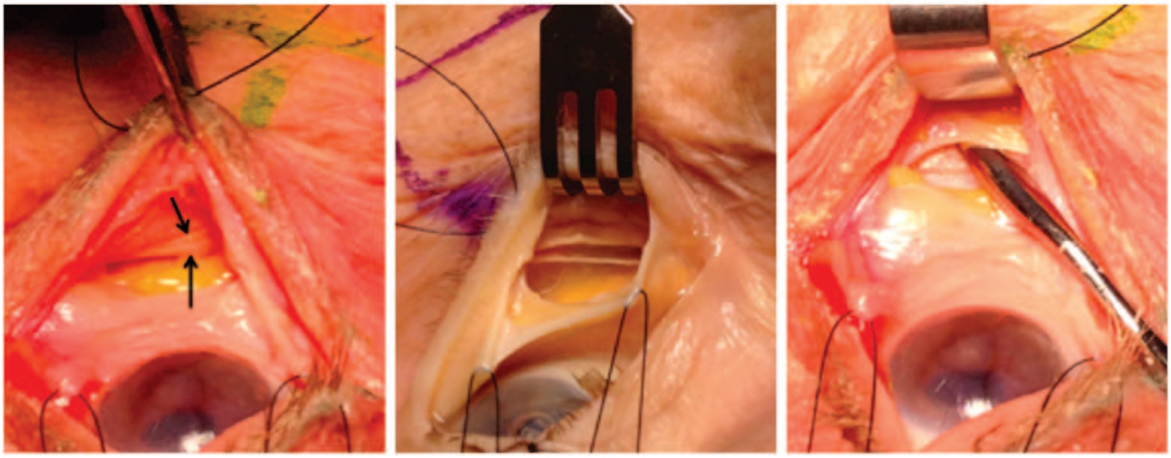

Fig. 5. Surgical release of the arcus marginalis. (*Left*) Transconjunctival retroseptal approach and visualization of the arcus marginalis. (*Center*) Incision through the arcus marginalis, extending from the level of the medial canthus laterally to the level of the pupil. (*Right*) A probe demonstrating a communication between the retroseptal space and the deep medial cheek compartment after arcus marginalis release

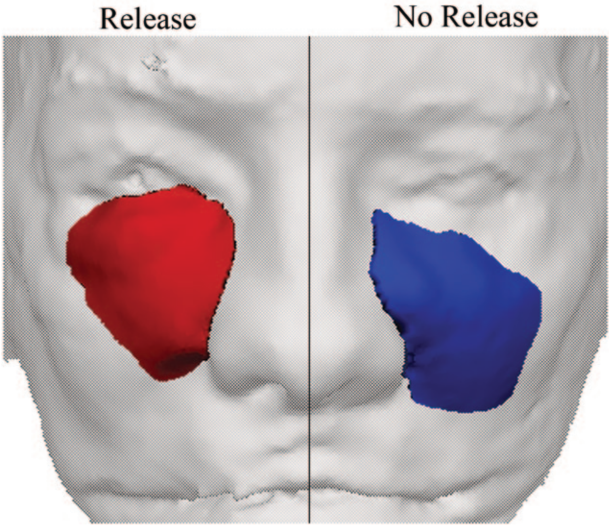

Fig. 6. Augmentation zone for bilateral deep medial cheek volumization when the arcus marginalis is surgically released (*red*) and when it is not released (*blue*).

studies demonstrate the presence of deep lateral suborbicularis oculi fat, deep medial suborbicularis oculi fat, and deep medial cheek components to the deep medial cheek compartment.[9] There are intimate anatomical relationships with the prezygomatic space, orbital retaining ligaments, origins of the orbicularis oculi muscles, arcus marginalis, and lateral canthal retinaculum.

This study demonstrates that incremental deep medial cheek injections of a substance similar to clinically harvested autogenous fat (applesauce) can lead to reproducible incremental augmentation of the deep medial cheek. The use of three-dimensional photography and computer analysis demonstrates a distinct pattern of incremental augmentation for the deep medial cheek. This characteristic augmentation zone is apparent when the deep medial cheek topographic boundaries are reached. These boundaries appear to be consistent with the orbital retaining ligaments, prezygomatic space, deep medial suborbicularis oculi fat, and deep lateral suborbicularis oculi fat determining the horizontal and vertical diameters, perimeter, and anterior projections of the injected material. The topographic three-dimensional changes in diameter and perimeter approach a maximum value with 2 to 3 cc of augmentation.

This could be explained by the boundaries restricting the perimeter spread of the deep medial cheek compartment. It was demonstrated at this phase of the cadaver specimen augmentation that there was an accelerated phase of anterior projection in the three-dimensional topographic analysis. This suggests that there may be an ideal volume of augmentation at which time the deep medial cheek compartment borders are reached and further augmentation will result in a predictable amount of projection. (We refer to this phenomenon as the “sweet spot” for the deep medial cheek.)

The Ristow space has also been described as a component of the deep medial cheek. The Ristow space lies beneath the caudal aspect of the deep medial cheek and abuts the pyriform aperture.[22] As this space ascends to its cephalic boundary, it remains in a suborbicularis plane, deep to the superficial nasolabial compartment and premaxillary space. Understanding this layered deep relationship is clinically relevant during volume augmentation in this region. It highlights the importance of using the deep and medial viaduct to access the deep medial cheek. Our three-dimensional analysis supports this and shows that the depth and longitudinal positioning of injections are vital to avoid inadvertent augmentation outside of compartments causing nonanatomical appearing facial changes, jowling, or cheek incongruence.

An intriguing finding from our initial cadaver studies was that the cephalic boundary of the deep medial cheek compartment was at the fixed position of the nasojugal region, consistent with the anatomical position of the arcus marginalis and the origin of the orbicularis oculi and levator alaeque nasi muscles (nasojugal groove) in all cases of deep medial cheek augmentation.[23] This finding defined the cephalic reach of the deep medial cheek and its potential role in medial lid-cheek support. When additional studies were performed with arcus marginalis release, injection of the deep medial cheek led to effacement of the palpebral malar interface that had not occurred if this structure was left intact. This suggests that our injected volume was distributed into the prezygomatic space, suborbicularis fat, and possibly preseptal orbital space. Anatomically, this carries relevance to the concept that the described suborbicularis fat (suborbicularis oculi fat) is primarily a laterally based structure bound on its medial edge by the arcus marginalis, orbicular retaining ligament, and the prezygomatic space deep to it.

Although this study focused on the deep medial cheek compartment, the concept of change in surface topography as an augmentation zone is relevant to the other facial compartments. The study of surface topographic change after injection augmentation of the other key facial compartments is the next logical extension of this study. Three-dimensional technology offers novel metrics not available with traditional two-dimensional methods. Measurements of the complex facial contour—including, diameter, perimeter, and projection—can be determined with reliable precision using three-dimensional technology. Of note, other authors have reported the use of three-dimensional technology to describe facial changes following augmentation with fat or fillers. For instance, Donath et al. was the first to report the use of three-dimensional photography to evaluate volume augmentation and the effect of hyaluronic acid–based fillers in the nasojugal groove.[24] Meier et al. looked at the long-term efficacy of fat grafting in midface rejuvenation using three-dimensional color analysis.[25] It is our belief that many more studies such as these are needed that use three-dimensional imaging to document objective changes.

A number of limitations exist in our study. One limitation is the small sample size of our study. There are many variables involved in surface response to volume augmentation, which include skin elasticity, overlying soft tissue, and individual compartment size. It can therefore be expected that the augmentation zone will be unique for any given compartment, and will differ among patients. A patient with excess overlying soft tissue and limited skin elasticity may experience restricted changes in perimeter and projection compared with a patient whose compartment does not have these opposing forces. Nevertheless, we found consistent patterns within the deep medial cheek compartment of our study cohort, and thus suspect that similar kinetics should be expected from other distinct compartments of the face. Future studies will look at topographic changes to volumization of multiple compartments. Studies are planned to further elucidate these changes and differences. The ultimate goal is to define an algorithm that will help guide the clinical practice of facial compartmental volumization.

Our study was limited to the use of cadaver specimens and the use of applesauce as a fat analogue. The limitations in cadavers relate to elasticity and dynamics of the overlying skin, which may differ from surgical patients. To fully address the dynamic changes that occur in both cadavers and clinical patients, it would be important to reproduce these methods with additional samples to fully address the diversity that exist between cadavers and live tissue but also between known variables such as skin elasticity, age, body mass index, and compartment size.

A 2005 study by Fodor et al. used applesauce as an analogue for autologous fat to evaluate the physics of the components of suction-assisted lipoplasty, including cannula diameter and tubing length. The study correlated its findings in the laboratory setting using applesauce to the clinical setting using autologous fat in vivo. Properties such as aspiration rate, resistance, and viscosity were found to be similar between applesauce and autologous fat.[8] Our group is currently performing related clinical studies to define these changes in surgical patients, with the use of autologous fat rather than an analogue.

This project is looking at how deep compartments behave following a discrete volume of injection. This study looks at how deep compartments AQ5 behave following a discrete volume of injection in cadavers, rather than longevity or survivability of fat grafts and thus the method of injection (i.e., bolus versus small-volume passes) is less significant). In addition, the most volume injected at once was 0.5 cc directly into the deep compartment, and not the superficial compartment. Injections of superficial compartments are more likely to be affected by bolus injections versus small-volume passes. This will be addressed in our ongoing studies where technique is of great importance.

CONCLUSIONS

Although many plastic surgeons have added fat grafting to the techniques they use for aesthetic and reconstructive procedures, there is no literature to date describing how fat grafting to a localized compartment specifically alters the overlying soft tissue in targeted regions. Combining previous work in fat grafting and three-dimensional soft-tissue analysis, we describe a new concept of augmentation zone and topographic surface change. Although this project focused on the deep medial cheek, ongoing work will help to elucidate how other fat compartments behave in response to volumization.

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REFERENCES

1. Rohrich RJ, Pessa JE. The fat compartments of the face: Anatomy and clinical implications for cosmetic surgery. *Plast Reconstr Surg.* 2007;119:2219–2227.
2. Schaverien MV, Pessa JE, Rohrich RJ. Vascularized membranes determine the anatomical boundaries of the subcutaneous fat compartments. *Plast Reconstr Surg.* 2009;123:695–700.
3. Rohrich RJ, Pessa JE, Ristow B. The youthful cheek and the deep medial fat compartment. *Plast Reconstr Surg.* 2008;121:2107–2112.
4. Stuzin JM, Baker TJ, Gordon HL. The relationship of the superficial and deep facial fascias: Relevance to rhytidectomy and aging. *Plast Reconstr Surg.* 1992;89:441–449; discussion 450.
5. Little JW. Three-dimensional rejuvenation of the midface: Volumetric resculpture by malar imbrication. *Plast Reconstr Surg.* 2000;105:267–285; discussion 286.
6. Gierloff M, Stöhring C, Buder T, Gassling V, Açil Y, Wiltfang J. Aging changes of the midfacial fat compartments: A computed tomographic study. *Plast Reconstr Surg.* 2012;129:263–273.
7. Bucky LR, Kanchwala SK. The role of autologous fat and alternative fillers in the aging face. *Plast Reconstr Surg.* 2007;120(Suppl):89S–97S.
8. Fodor PB, Cimino WW, Watson JP, Tahernia A. Suction-assisted lipoplasty: Physics, optimization, and clinical verification. *Aesthet Surg J.* 2005;25:234–246.
9. Surek C, Beut J, Stephens R, Lamb J, Jelks G. Volumizing viaducts of the midface: Defining the Beut techniques. *Aesthet Surg J.* 2015;35:121–134.
10. Barton FE Jr, Ha R, Awada M. Fat extrusion and septal reset in patients with the tear trough triad: A critical appraisal. *Plast Reconstr Surg.* 2004;113:2115–2121; discussion 2122.
11. Hamra ST. Arcus marginalis release and orbital fat preservation in midface rejuvenation. *Plast Reconstr Surg.* 1995;96:354–362.
12. Schiller JD. Lysis of the orbicularis retaining ligament and orbicularis oculi insertion: A powerful modality for lower eyelid and cheek rejuvenation. *Plast Reconstr Surg.* 2012;129:692e–700e.
13. Stark GB, Iblher N, Penna V. Arcus marginalis release in blepharoplasty I: Technical facilitation. *Aesthetic Plast Surg.* 2008;32:785–789.
14. Hamra ST. The role of the septal reset in creating a youthful eyelid-cheek complex in facial rejuvenation. *Plast Reconstr Surg.* 2004;113:2124–2141; discussion 2142.
15. Goldberg RA. Transconjunctival orbital fat repositioning: Transposition of orbital fat pedicles into a subperiosteal pocket. *Plast Reconstr Surg.* 2000;105:743–748; discussion 749.
16. Loeb R. Naso-jugal groove leveling with fat tissue. *Clin Plast Surg.* 1993;20:393–400; discussion 401.
17. Ghavami A, Pessa JE, Janis J, Khosla R, Reece EM, Rohrich RJ. The orbicularis retaining ligament of the medial orbit: Closing the circle. *Plast Reconstr Surg.* 2008;121:994–1001.
18. Kawamoto HK, Bradley JP. The tear “TROUF” procedure: Transconjunctival repositioning of orbital unipedicled fat. *Plast Reconstr Surg.* 2003;112:1903–1907; discussion 1908.
19. Jelks GW, Jelks EB. No-touch lower blepharoplasty. In: de Castro CC, Boehm KA, eds. *Techniques in Aesthetic Plastic Surgery Series: Midface Surgery.* Philadelphia: Saunders Elsevier; 2009:59–75.
20. Wong CH, Mendelson B. Facial soft-tissue spaces and retaining ligaments of the midcheek: Defining the premaxillary space. *Plast Reconstr Surg.* 2013;132:49–56.
21. Rohrich RJ, Pessa JE. The fat compartments of the face: Anatomy and clinical implications for cosmetic surgery. *Plast Reconstr Surg.* 2007;119:2219–2227; discussion 2228–2231.
22. Wan D, Amirlak B, Rohrich R, Davis K. The clinical importance of the fat compartments in midfacial aging. *Plast Reconstr Surg Glob Open* 2013;1:e92.
23. Haddock NT, Saadeh PB, Boutros S, Thorne CH. The tear trough and lid/cheek junction: Anatomy and implications for surgical correction. *Plast Reconstr Surg.* 2009;123:1332–1340; discussion 1341.
24. Donath AS, Glasgold RA, Meier J, Glasgold MJ. Quantitative evaluation of volume augmentation in the tear trough with a hyaluronic acid-based filler: A three-dimensional analysis. *Plast Reconstr Surg.* 2010;125:1515–1522.
25. Meier JD, Glasgold RA, Glasgold MJ. Autologous fat grafting: Long-term evidence of its efficacy in midfacial rejuvenation. *Arch Facial Plast Surg.* 2009;11:24–28.

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