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The eyebrows and eyebrow fat pads are key landmarks in the aesthetic configuration of the upper face. They are important for conveying emotive expressions and, acting in continuum with the upper eyelid, they significantly affect the three-dimensional (3D) contours of the upper face.1-3 An understanding of the mechanisms underlying the aging process in this area is of paramount importance in allowing the surgeon to appropriately address age-related changes.

Gravity has long been considered the major source of facial aging, and lifting surgeries have been designed to address this issue with inconsistent results.4,5 More recently, surgeons have begun to recognize the complex

Abstract
Background: The eyebrows and eyebrow fat pads, key structures in upper facial aesthetics, are particularly vulnerable to age-related changes.
Objectives: In this study, the authors compare the impact of aging on the eyebrows and eyebrow fat pad volume in men and women through three-dimensional (3D) volumetric analysis.
Methods: Electronic medical records of patients seen at the Jules Stein Eye Institute in the Division of Orbital and Ophthalmic Plastic Surgery between 2005 and 2010 were reviewed. Patients were included if they had undergone investigative imaging of the orbit for unilateral pathology. Computed tomography (CT) scans of patients with Graves disease diagnosis, extensive orbital trauma, and/or previous eyebrow surgery were excluded. A total of 52 CT scans (24 men and 28 women) were retained for analysis. A 3D reconstruction software was used to analyze the scans and calculate volumes of the retroorbicularis oculi fat (ROOF), galeal fat (ROOF and subcutaneous fat), and soft tissue muscles.
Results: Galeal and brow fat volumes showed a significant positive trend toward enlargement in women (P values of .01 and .05, respectively). Although men showed a tendency toward fat enlargement with age, this was not statistically significant. Soft tissue–muscle volume decreased significantly in aging women (9.32 mm³/y) (P = .02). Data indicated that soft tissue volume in men tended to increase with age (3.92 mm³/y) but not significantly (P = .36). Neither total volume nor brow thickness appeared to change significantly in women (P = .56, P = .73). In men, total volume and brow thickness showed weak evidence of increasing with age (P = .12, P = .22). Linear regressions of Hertel measurements with and without sex interaction showed no statistically significant trend between the amount of proptosis and the galeal or brow fat.
Conclusions: Although overall eyebrow volume does not change with age, the relative contribution of fat and soft tissue to the total volume does seem to change. This pattern also differs between men and women. As women age, the fat volume increases and the soft tissue volume decreases. In men, the shift from soft tissue volume to fat volume is less pronounced. Although many clinicians have been drawn to the concept of fat volume deflation as a key element of facial aging, this study does not support this perspective in the eyebrow fat pad. An increasingly refined understanding of the dynamics of facial aging is mandatory for clinical diagnosis and will likely provide the framework from which to develop more innovative treatment options.

Keywords
aging, eyebrow, facial rejuvenation, fat

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synergy of laxity, fat dimorphism, soft tissue deflation, muscle readaptation, and bony skeleton remodeling with coarsening of the supraorbital ridge—all of which play a role in the aging of the eyebrow region.6,12 Understanding the specific morphologic effects of aging is critical for successful facial rejuvenation. To that end, we utilized 3D volumetric analysis of computed tomography (CT) scans in order to characterize volumetric changes of the eyebrow complex across different age groups, in both men and women.

**METHODS**

**Patients**

This study was approved by the Institutional Review Board at the University of California, Los Angeles. Electronic Medical Records of patients seen at the Jules Stein Eye Institute in the Division of Orbital and Ophthalmic Plastic Surgery between 2005 and 2010 were retrospectively reviewed. Patients were included if they had undergone investigative imaging of the orbit for unilateral pathology. Patients with Graves disease diagnosis, extensive orbital trauma, and/or previous eyebrow surgery were excluded. A total of 52 CT scans (24 men and 28 women) were retained for analysis. The sample population consisted of 52 patients seen between 2001 and 2009 for unilateral pathology (neoplastic, vascular, muscular, neurological, lacrimal, trauma). CT scans (0.5- to 3-mm slice increments), demographic information (age, sex, and ethnicity), ocular pathology at presentation, surgical history of the orbit and eyebrow, and Hertel exophthalmometry were retrieved from the medical records. Supraorbital volumetric analysis was performed unilaterally on the unaffected side, or, in cases in which no specific orbital pathology was identified, the analyzed side was randomly selected.

**CT Imaging**

Mimics (Version 9.12; Materialise, Leuven, Belgium) is an image-processing software with a 3D visualization function. Research conducted by Regensburg et al13,14 showed it to be a reliable tool validated for biomedical research. Reference CT images were imported into the software, processed, analyzed, and reconstructed. Volumetric calculations of the studied tissues (bone, muscle, fat) were then performed.

Our methodology of tissue analysis and segmentation was adapted from the approach described by Mourits.14,15 Following the creation of a bony mask (226-2165 Hounsfield units [HU]; Figure 1A-C), the 3D reconstruction of the facial skeleton was performed (Figure 1D-G). On the bony framework, the superolateral orbital target area was defined from the supraorbital notch (2.5 cm lateral from the frontal midline) to the lateral orbital rim. The inferior limit was defined as the zygomaticofrontal suture, whereas the superior extension was drawn horizontally 0.5 cm from the level of the supraorbital notch (Figure 1A-C).

These specific landmarks were selected based on the anatomic distribution of the eyebrow fat pad or retroorbicularis oculi fat (ROOF), described as an anatomic and functional unit by Charpy in 1909.16,17 This structure, which contributes significantly to eyebrow volume and definition, extends from the midsupraorbital rim to beyond the lateral orbital rim. It lies over the superolateral bone and orbital septum across the upper lateral and middle eyelid region and is considered part of the overall galeal fat pad, which is responsible for the easy motility of the lower 2 cm of the forehead.18-21 The vertical height of the eyebrow fibroadipose tissue is 1 to 1.5 cm superior to the orbital rim—approximately one-third of the vertical orbital dimension.22 In our study, we defined the cephalad extension as a horizontal plane 0.5 cm from the supraorbital notch, with its lateral projection at an adequately higher level from the rim to contain the entire ROOF structure. This compartment included the orbital component of the orbicularis oculi, frontalis, and the lateral corrugator muscles embedded in the multiple galeal layers.

The initial mask was created within the range of −200 to +100 HU. This range included fat (−200 to −30 HU) and soft tissue with muscle (−30 to 100 HU). The 3D software tissue analysis and specific range of Hounsfield units (fat vs soft tissue) allowed for the distinction between fat and soft tissue. Any anatomical structure in the eyebrow and eyebrow fat pad that was not fat (including muscles, nerves, and vessels) was considered soft tissue. Using the 3D cropping tool, the target area was isolated from the surrounding facial structures. This cropped mask was manually segmented on serial axial slices. The editing involved removing orbital structures that were included in the cropped 3D quadrant but that did not relate directly to the bony superolateral orbital rim (Figure 2). The final mask outlines the area of interest.

The next step involved the creation of fat (−200 to −30 HU) and soft tissue–muscle (−30 to 10 HU) masks. These were intersected with the edited mask of the supraorbital construct (Boolean operation). The resulting mask defined the total fat tissue in the eyebrow area. This mask was duplicated and manually edited to isolate the brow fat or ROOF overlying the bony rim. In a similar fashion, the soft tissue–muscle mask of the eyebrow was created by intersecting the soft tissue–muscle mask of the face with the edited mask of the supraorbital construct (Boolean operation). Following “region growing” (computer-assisted separation of nonconnected tissues), the software three-dimensionally reconstructed the three masks of interest: soft tissue–muscle (or any structure that was not fat) (Figure 1D), total galeal fat (Figure 1E), and brow fat or ROOF (Figure 1F).

Volumetric calculations were obtained and expressed in cubic millimeters (mm³).

Imaging analysis was performed by a single investigator who had substantial experience with the software (KIP). Segmentation was performed exclusively on the axial CT cuts. In addition, we evaluated the thickness of the lateral third of the eyebrow on the axial CT, as a linear measurement projected at a right angle from the supraorbital ridge.
Figure 1. Creation of a bony mask (226-2165 Hounsfield units [HU]) and three-dimensional (3D) reconstruction of the facial skeleton with Mimics (Version 9.12; Materialise, Leuven, Belgium) image-processing software. The superolateral orbital target area extends from the supraorbital notch (2.5 cm lateral from the frontal midline) to the lateral orbital rim. The inferior limit is the zygomaticofrontal suture. The superior extension is drawn horizontally 0.5 cm from the level of the supraorbital notch. (A) The green vertical line represents the midsagittal computed tomography (CT) plane. The horizontal red plane intersects the zygomaticofrontal suture and corresponds to the axial CT plane. (B, C) Projection of the supraorbital target area on the 3D fat (yellow) and soft tissue–muscle (red) masks of the face. (D) The 3D reconstruction of the soft tissue–muscle projected on the bony orbital rim. (E) The 3D reconstruction of the galeal fat projected on the semitransparent soft tissue–muscle mask (red) of the face. (F) The 3D reconstruction of the retroorbicularis oculi fat (ROOF) or brow fat pad projected on the semitransparent soft tissue–muscle mask (red) of the face. Total eyebrow volume consists of soft tissue–muscle (red) and galeal fat pad (yellow). (G, H) Anterior to the frontalis, we noticed a rather thickened galeal fat layer that blended with the ROOF.
Figure 2. The initial mask was created with Mimics (Version 9.12; Materialise, Leuven, Belgium) image-processing software within the range of –200 to +100 Hounsfield units (HU). This range represented the fat (–200 to –30 HU) and the soft tissue with muscle (–30 to 100 HU). Using the three-dimensional (3D) cropping tool option, the target area was isolated from the surrounding facial structures. This cropped mask was manually segmented on serial axial slices. The editing involved erasing all the orbital structures that were included in the cropped 3D quadrant but that did not relate directly to the bony superolateral orbital rim. (A-F) The final edited mask defined the target area of interest. Fat (–200 to –30 HU) and soft tissue–muscle (–30 to 10 HU, red) masks were created and intersected with the edited mask of the supraorbital construct (Boolean operation). As a result of this intersection, a galeal fat mask was created. (G-J) Subsequently, this mask was duplicated and manually edited to isolate the brow fat that overlies the bony rim. (K-M) In a similar fashion, the soft tissue–muscle mask of the eyebrow was created by intersecting the soft tissue–muscle mask of the face with the edited mask of the supraorbital construct (Boolean operation). (N, O) The accurate definition of the final masks of interest is shown. (P) The linear measurement of the lateral eyebrow thickness was projected at a right angle from the supraorbital ridge. (continued)
Figure 2. (continued) The initial mask was created with Mimics (Version 9.12; Materialise, Leuven, Belgium) image-processing software within the range of –200 to +100 Hounsfield units (HU). This range represented the fat (–200 to –30 HU) and the soft tissue with muscle (–30 to 100 HU). Using the three-dimensional (3D) cropping tool option, the target area was isolated from the surrounding facial structures. This cropped mask was manually segmented on serial axial slices. The editing involved erasing all the orbital structures that were included in the cropped 3D quadrant but that did not relate directly to the bony superolateral orbital rim. (A-F) The final edited mask defined the target area of interest. Fat (–200 to –30 HU) and soft tissue–muscle (–30 to 10 HU, red) masks were created and intersected with the edited mask of the supraorbital construct (Boolean operation). As a result of this intersection, a galeal fat mask was created. (G-J) Subsequently, this mask was duplicated and manually edited to isolate the brow fat that overlies the bony rim. (K-M) In a similar fashion, the soft tissue–muscle mask of the eyebrow was created by intersecting the soft tissue–muscle mask of the face with the edited mask of the supraorbital construct (Boolean operation). (N, O) The accurate definition of the final masks of interest is shown. (P) The linear measurement of the lateral eyebrow thickness was projected at a right angle from the supraorbital ridge.
Results

Fifty-two CT scans (24 men and 28 women) were analyzed in this study. The mean patient age was 49.3 years (range, 17-81). Fourteen patients (27%) had undergone CT imaging for unilateral orbital fracture-trauma and eight (15%) for orbital malignancy. CT slice thickness varied between 0.5 and 3 mm, and image pixel size ranged from 0.252 to 0.488.

Table 1 summarizes the univariate statistics of all five continuous parameters. Linear regression analysis of continuous variables in relation to age (as a continuous variable) was performed and summarized in Table 2. Age was measured in years, and we automatically controlled for sex with a sex-interaction model. Point estimates of the age slopes often diverged substantially between men and women; therefore, we used a regression model that allowed separate slopes to be estimated for each. With this model of analysis, we allowed age trends to differ between men and women and more accurately reflected the aging constructs actually taking place. In addition, we analyzed the difference between the age trends in men and women.

Table 1. Univariate Summary Statistics of the Fat and Muscle Measurements

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>25th</th>
<th>50th</th>
<th>75th</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>49.3</td>
<td>19.6</td>
<td>17</td>
<td>32</td>
<td>47</td>
<td>66</td>
<td>81</td>
</tr>
<tr>
<td>Brow fat (ROOF), mm³³</td>
<td>306</td>
<td>307</td>
<td>0</td>
<td>67</td>
<td>265</td>
<td>469</td>
<td>1250</td>
</tr>
<tr>
<td>Galeal fat, mm³</td>
<td>714</td>
<td>620</td>
<td>12</td>
<td>212</td>
<td>577</td>
<td>1102</td>
<td>2398</td>
</tr>
<tr>
<td>Soft tissue–muscle, mm³²</td>
<td>1157</td>
<td>678</td>
<td>218</td>
<td>534</td>
<td>1053</td>
<td>1660</td>
<td>2986</td>
</tr>
<tr>
<td>Total volume, mm³</td>
<td>1871</td>
<td>685</td>
<td>807</td>
<td>1397</td>
<td>1812</td>
<td>2261</td>
<td>4058</td>
</tr>
<tr>
<td>Brow thickness, mm</td>
<td>6.19</td>
<td>1.56</td>
<td>3</td>
<td>4.9</td>
<td>6.5</td>
<td>7.3</td>
<td>9.2</td>
</tr>
</tbody>
</table>

ROOF, retroorbicularis oculi fat.

Table 2. Regression Analysis of Continuous Variables in Relation to Age

<table>
<thead>
<tr>
<th>Variable</th>
<th>Age Effecta</th>
<th>Point Estimate</th>
<th>SE</th>
<th>P Value</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brow fat (ROOF), mm³³</td>
<td>Female</td>
<td>5.46</td>
<td>2.72</td>
<td>.05</td>
<td>(–0.01, 10.93)</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>3.97</td>
<td>3.02</td>
<td>.19</td>
<td>(–2.1, 10.04)</td>
</tr>
<tr>
<td></td>
<td>M-F effect difference</td>
<td>–1.49</td>
<td>4.06</td>
<td>.72</td>
<td>(–9.66, 6.68)</td>
</tr>
<tr>
<td>Galeal fat, mm³</td>
<td>Female</td>
<td>13.07</td>
<td>4.9</td>
<td>.01</td>
<td>(3.21, 22.93)</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>7.39</td>
<td>5.45</td>
<td>.18</td>
<td>(–3.56, 18.34)</td>
</tr>
<tr>
<td></td>
<td>M-F effect difference</td>
<td>–5.68</td>
<td>7.33</td>
<td>.44</td>
<td>(–20.41, 9.06)</td>
</tr>
<tr>
<td>Soft tissue–muscle, mm³²</td>
<td>Female</td>
<td>–9.32</td>
<td>3.78</td>
<td>.02</td>
<td>(–16.93, –1.72)</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>3.92</td>
<td>4.2</td>
<td>.35</td>
<td>(–4.52, 12.36)</td>
</tr>
<tr>
<td></td>
<td>M-F effect difference</td>
<td>13.24</td>
<td>5.65</td>
<td>.02</td>
<td>(1.88, 24.6)</td>
</tr>
<tr>
<td>Total volume, mm³</td>
<td>Female</td>
<td>3.75</td>
<td>6.36</td>
<td>.56</td>
<td>(–9.05, 16.54)</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>11.31</td>
<td>7.67</td>
<td>.12</td>
<td>(–2.90, 25.51)</td>
</tr>
<tr>
<td></td>
<td>M-F effect difference</td>
<td>7.56</td>
<td>9.51</td>
<td>.43</td>
<td>(–11.56, 26.68)</td>
</tr>
<tr>
<td>Brow thickness, mm</td>
<td>Female</td>
<td>0.0054</td>
<td>0.0154</td>
<td>.73</td>
<td>(–0.026, 0.036)</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>0.0214</td>
<td>0.0171</td>
<td>.22</td>
<td>(–0.013, 0.056)</td>
</tr>
<tr>
<td></td>
<td>M-F effect difference</td>
<td>0.0160</td>
<td>0.0231</td>
<td>.49</td>
<td>(–0.03, 0.06)</td>
</tr>
</tbody>
</table>

CI, confidence interval; ROOF, retroorbicularis oculi fat.

*Age was measured in years and sex was controlled for using a sex-interaction model.
of .01 and .05, respectively. Although men showed a tendency toward fat volume increase with age, this was not statistically significant ($P = .18$ and .19). Men showed a 7.39-mm$^3$ increase in galeal fat per year versus 13.07 mm$^3$ in women. The increase trend for brow fat in men was 3.97 mm$^3$ versus 5.46 mm$^3$ in women. The sex-age effect difference had negative point estimates for fat volumes in women, reflecting the positive slope of the age trend in women’s galeal and ROOF volumes.

Soft tissue–muscle volume (or anything nonfat) showed a highly significant negative trend in the aging female population ($P = .02$), with a 9.32-mm$^3$ decrease per year (Figures 7-9). Data for men indicated that soft tissue volume might increase with age, as reflected in the 3.92-mm$^3$ annual increase trend), although this trend was not significant ($P = .36$). Neither total volume nor brow thickness (Figures 10 and 11) appeared to change significantly in women ($P = .56$, $P = .73$). This effect may be due to a combination of an increase in fat and a decrease in soft tissue with no net change. For men, in contrast, these two variables showed weak evidence of increase with age ($P = .12$, $P = .22$).

Linear regressions of Hertel measurements without sex interaction (Table 3) showed no statistically significant correlation between the amount of proptosis and the galeal or brow fat, although for every millimeter of proptosis, there was a 98-mm$^3$ point increase in total volume ($P = .015$) and a 0.2-mm increase in brow thickness ($P = .025$). We did not adjust for any additional variables in any of the regressions.

**DISCUSSION**

Defining eyebrow position and shape is an essential goal of upper facial rejuvenation. Traditionally, gravity has been considered the main contributor to upper facial aging, leading to eyebrow ptosis. Therefore, techniques to rejuvenate the upper face have focused on lifting either the forehead or the brow directly. However, these procedures provide less-than-ideal results in many patients.4,5 Studies have been published showing that volume loss, particularly fat deflation, may be a primary driving force in the aging face.10,11 As a result, instead of lifting procedures, there has been a trend toward facial rejuvenation focusing on volume restoration.5-7 However, there is a paucity of data assessing 3D aging changes and much of the evidence for volume loss as a basis of facial aging remains anecdotal.

In our study group, the total eyebrow volume showed no evidence of decline in the older population. On the contrary, there was a weak trend toward increased volume, especially in aging men. Eyebrow thickness also showed no decrease with age. In fact, fat volume may increase with age; we noted a considerable increase in the fat constituent of the eyebrow complex in aging women. A weaker trend for increased fat volume was observed in men. For the galeal fat pad, the annual increase in men was half the value observed in aging women (point estimate of 7.39 mm$^3$ vs 13.07 mm$^3$).

These trends appear to contradict clinical observations of apparent volume loss but were previously described in a cadaveric study by Aghai and Caix in 2004.17,25-29 These
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authors demonstrated an age-related increase in the ROOF (or Charpy’s fat pad) and suggested this trend might explain the “masculinization” of the eyebrows in aging women. There is good clinical evidence that individual fat compartments age independently. The eyebrow fat pad may exhibit distinct behavior with age when compared to the rest of the face. Additionally, lower eyelid magnetic resonance imaging (MRI) has shown similar infraorbital fat expansion with age, and others described the orbital fat as resistant to lipolysis.26,27

In our study, there was no statistically significant correlation between the amount of proptosis and the galeal or brow fat, although for every millimeter of proptosis, there was a 98-mm³ point increase in total volume. Although galeal facial planes are less discernable with age, galeal compartmentalization could minimize proptotic anterosuperior redistribution of preseptal fat across the supraorbital rim. Also, although fat volume increased, the soft tissue–muscle volume decreased with age in women. Menopause might account for the lack of total volume change in the aging female eyebrow, as increasing fat volume balances decreased soft tissue volume. In women, declining estrogen levels are associated with a variety of cutaneous changes, many of which can be improved with estrogen supplementation. Postmenopausal estrogen deprivation is related to epidermal atrophy and thinning, as well as declining dermal collagen content.28-31 Hormonal changes in women could explain the difference in observed distributional shifts compared to men, who may have slightly increased total eyebrow volume with age.

In 2007, Le Louarn et al32 introduced the “facial recurve concept,” stating that the increased resting tone and repeated contractions of facial mimetic muscles change the shape and 3D morphology of the overlying and underlying fat distribution. The lack of frontalis and corrugator muscles at the lateral third of the eyebrow might be an additional factor affecting the volumetric increase of eyebrow fat with aging. These findings may appear counterintuitive at first. If eyebrow volume does not decrease with age, what accounts for the appearance of the aging eyebrow, and why does adding volume to the lateral eyebrow seem to rejuvenate the periorbital complex? Gunter and Antrobus’s two-part study2 on eyebrow aesthetics showed that most surgeons preferred recontouring of the brow–eyelid continuum rather than frank elevation, and Donath et al11 highlighted lipoaugmentation of the superior orbital rim and conservative upper blepharoplasty as the means to achieve more youthful aesthetics. Perhaps qualitative replacement of soft tissue–muscle with fat lacks the inherent colloidal components, proteins, hyaluronan, fluidics, or osmotic aspects essential for the youthful texture and appearance of the eyebrow. Additionally, age-related skin changes play a role in a dynamic aesthetic, leading some authors to suggest that thinning and loss of skin elasticity can create a false impression of soft tissue deflation and brow ptosis.1,11 Therefore, the addition of volume in the aging eyebrow can restore a youthful skin texture.
As the supraorbital rim widens and deepens with age, more volume is required to maintain the 3D projection of the eyebrow. The increased orbital width and superomedial height of the orbit lead to an accordion-like spreading of overlying tissues. This might explain the relative maintenance of eyebrow volume on 3D analysis and the clinical appearance of a deflated supraorbital region. This concept represents a twisting of the “concertina” effect described by Pessa et al for the relationship between soft tissue changes and reduced height of the aging maxilla.

There are inherent flaws in our study. Due to its retrospective nature, it was not possible to obtain longitudinal measurements for our sample. This would have been valuable to assess changes in volume over time. Furthermore, it is also virtually impossible to select patients at the same point in their aging process because there is a great variation in the aging process between individuals. Therefore, to overcome these obstacles, we analyzed age as a linear rather than as a categorical parameter. Sex was controlled for the whole analysis. It is also possible that the dynamic effect of gravity on brow position was underestimated, as CT imaging was acquired while the patients were supine. Perhaps in the supine position, the relationship between brow ptosis and volume is distorted, resulting in erroneous calculations. If this were the case, however, the analysis would likely show an increase in volume with age. Furthermore, it is not clear whether the eyebrow descends with age. Matros et al described paradoxical elevation of the eyebrow with age, especially in women, and Lambros showed that 71% of eyebrows were either stable or visibly elevated with age. Body mass index (BMI) scores were also not available for correlation, since in the clinical setting of an oculoplastic service, the BMI is not routinely assessed. A potential correlation between BMI and eyebrow volume might have been interesting, although it would have been a challenge to define, assess, or grade facial weight and its impact on eyebrow volume. An increased BMI does not necessarily equate to a “heavy” face. In addition, the study group of 52 patients should offer a balanced distribution of anthropometric-biometric indexes in both younger and older patients.

If volume loss, particularly fat deflation, does not fully explain aging of the supraorbital complex, what are the clinical implications for designing and implementing...
rejuvenating therapeutic approaches? Preservation of eyebrow volume with age, combined with the apparent orbital hollowing, accentuates the impact of light reflections and shadows on the eye and creates a false impression of eyebrow ptosis. Adding volume to the orbital sulcus and eyebrow-eyelid continuum can minimize the impact of eyebrow shadowing and camouflage the physiologic orbital hollowing. Rejuvenation should ideally be based on analysis of the specific anatomic changes involved in aging. These dynamics are secondary to complex interactions of endocrine changes, skin laxity alterations, bony skeletal remodeling, and fat/soft tissue compartment redistribution, especially in aging women.

**CONCLUSIONS**

Our pilot study suggests that eyebrow volume may not decrease with age and furthermore that the fat component may actually increase with age. Specifically, our results
suggest that the relative contribution of fat and soft tissue to the total volume does seem to change and that this pattern also differs between men and women. As women age, the fat volume increases and the soft tissue volume decreases. In men, the shift from soft tissue volume to fat volume is less pronounced. Although many clinicians have been drawn to the concept of fat volume deflation as a key element of facial aging, our study does not support this perspective in the eyebrow fat pad. Better understanding of these phenomena may come from more robust studies, particularly studies that follow individual patients over time. An increasingly refined understanding of the underlying anatomic basis of facial aging will likely provide the framework from which to develop more innovative treatment options.

**Disclosures**

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