Continuing Medical Education Article—Facial Aesthetic Surgery

Why Do We Age in Our Cheeks?

Elsa Raskin, MD; and Gregory S. LaTrenta, MD

Dr. Raskin is Attending Surgeon in the Division of Plastic and Reconstructive Surgery, Department of Surgery, Greenwich Hospital, Greenwich, CT. Dr. LaTrenta is a Clinical Associate Professor of Surgery, Weill College of Medicine, Cornell University, and Attending Surgeon, Department of Surgery, Division of Plastic and Reconstructive Surgery, New York–Presbyterian Hospital, New York, NY.

Learning Objectives:
The reader is presumed to have a broad understanding of facial anatomy and plastic surgical procedures and concepts. After studying this article, the participant should be able to:
1. Describe the location of subcutaneous fat in the cheeks.
2. Contrast the distribution of fat in the superficial compartments to that in the deep compartments.
3. Explain the role of the retaining ligaments with respect to the clinical manifestations of aging in the cheeks.

Physicians may earn 1 AMA PRA Category 1 credit by successfully completing the examination based on material covered in this article. The examination begins on page 29. ASAPS members can also complete this CME examination online by logging onto the ASAPS Members-Only Web site (http://www.surgery.org/members) and clicking on “Online Clinical Education” in the menu bar.

Background: The cheeks are one of the first regions of the face in which changes relating to age occur and are the facial area most prone to ultimately display the ravages of time.

Objective: The purpose of this study was to determine (1) the subcutaneous fat mass in the cheeks both above and below the superficial musculoaponeurotic system (SMAS) relative to the facial and neck aesthetic subunits, and (2) the type and distribution of retaining ligament support of this subcutaneous fat mass within the cheeks relative to other aesthetic subunits.

Methods: Anatomic dissections in 10 fresh hemi-cadavers with a mean age of 65.6 years (range 42-86 years) were performed. The face and neck were divided into 8 aesthetic subunits: (1) glabella, (2) forehead, (3) temporal, (4) anterior upper cheek, (5) middle cheek, (6) posterolateral cheek, (7) mental, and (8) anterior neck. The dermis was discarded, and fat superficial to the SMAS in each aesthetic subunit was dissected, measured in grams, and analyzed. Superficial mimetic musculature was discarded, and fat deep to the SMAS in each subunit was dissected, measured in grams, and analyzed. The retaining ligament types and distribution were dissected and analyzed within each aesthetic subunit. Histologic cross-sectional analysis of fat and fascia was performed in each aesthetic subunit by hematoxylin and eosin staining and Mason Trichrome Sections.

Results: Overall, 80% of total subcutaneous fat mass was found in the face and 20% in the neck. In the face, 57% of the fat mass was found above the SMAS, and 43% was found below the SMAS, whereas in the neck 65% of the fat mass was found above the platysma and 35% below the platysma. One half of the total face and neck fat mass was found in the cheeks, with one third of the total fat mass located in the anterior and middle cheeks alone. Of special note, 75% of the total deep facial fat mass was found in the anterior and middle cheeks. Two types of retaining ligaments were found. Primary supporting ligaments were found in 4 locations approximating the zygomatic and mandibular sutureal interfaces. These ligaments only resided along borders between cheek aesthetic subunits and were observed to be mildly affected by cadaver age. Secondary supporting ligaments were found in 3 locations within the anterior, middle, and posterior cheek subunits. They were found only within borders of the cheek aesthetic subunits and were observed to be significantly affected by cadaver age.

Conclusions: The anterior, middle, and posterior cheeks were noted to be laden with fat, containing roughly half of the total facial and neck fat mass in fresh human cadavers dissected according to aesthetic subunit principles. Slightly greater than half of the subcutaneous fat in the cheeks (57%) is above the SMAS, whereas slightly less than half (43%) is below the SMAS.

The
fat-laden cheek aesthetic subunits were found to have secondary supporting retaining ligaments located within their borders that provided poor support and primary supporting retaining ligaments along their borders, which provided strong support. These anatomic arrangements, along with the fact that the anterior and middle cheek subunits serve as lining and cover for the bollow intraoral cavity, account for the characteristic and reproducible saggy appearance of the midface and cheeks when subjected to the forces of gravity, motion, time, and the elements. (Aesthetic Surg J 2007;27:19–28.)

It is axiomatic to state that the human face ages. We recognize the signs of facial aging when we see them, whether on our patients, our friends, our families, or in our own mirror. It is also axiomatic to state that we age in a consistent and reproducible pattern. The cheeks are the region of the face in which we see first these changes occurring and are the most prone to ultimately display the ravages of time. The smile and marionette creases deepen, the folds behind them thicken, the cheekbones bare themselves, the jowls begin to pool and swell, and the surface of the face begins to sag like a heavy swathe of drapery. Although the swiftness of these changes can be as unpredictable as the wind, they are as inevitable as the passage of the seasons.

In this study, we sought to characterize the unique relationship in the cheek between the fat content and the retaining ligament system. The purpose of this study was to determine (1) the subcutaneous fat mass in the cheeks both above and below the superficial musculoaponeurotic system (SMAS) relative to the other facial and neck aesthetic subunits and (2) the type and distribution of retaining ligament support of this subcutaneous fat mass within the cheeks relative to other aesthetic subunits.

Methods

Subcutaneous fat and retaining ligament distribution for 8 facial aesthetic compartments in 5 fresh cadavers were studied by type, weight, and histologic condition. A total of 10 fresh hemifacial cadaver dissections were performed. The cadavers, 3 males and 2 females, had died within 2 weeks of the dissections and ranged in age from 42 to 86 years (mean 65.6 years).

Each cadaver head was dissected in layers. The skin alone was dissected off, leaving all subcutaneous fat intact. The following subunits were marked (Figure 1) according to the aesthetic facial and neck subunit principle of Gonzales-Ulloa et al:

1. Forehead: from hairline to eyebrows, from the midline to the deep temporal line, excluding the glabella
2. Glabella: the area overlying the corrugator supercilii, the procerus, and the medial head of the orbicularis oculi muscles, down to the root of the nose and between the eyebrows
3. Temporal: from the zygomatic arch to the deep temporal line to the anterior edge of the hairline
4. Anterior upper cheek: the triangle formed by 3 points, the junction of the zygomatic arch and body, the lateral commissure of the mouth, and the nasoorbital valley at the level of the orbital rim

Figure 1. Arbitrarily divided anatomic units of the face after the dermis has been dissected off the cadaver’s face and neck include the following: (1) glabella, (2) forehead, (3) temporal, (4) anterior upper cheek, (5) middle cheek, (6) posterolateral cheek, (7) mental, and (8) anterior neck. (From LaTrenta,13 with permission.)
5. Middle cheek: the quadrangle formed by the junction of the zygomatic arch and body, the lateral commissure of the mouth, the mandibular ligamentous attachment on the anterior third of the mandibular body, and the most anterior point of the masseter muscles attachment on the posterior third of the mandibular border.

6. Posterolateral cheek: the quadrangle formed by the anterior cartilage of the ear, the lateral border of the middle cheek compartment (which roughly corresponds to the anterior border of the masseter muscle), the zygomatic arch, and the border of the mandible.

7. Mental: the quadrangle formed by the midline, the vermilion of the lower lip, the lower border of the anterior third of the mandibular body, and the medial border of the middle cheek compartment.

8. Anterior neck: the triangle formed by the lower border of the mandible, the midline, and the posterior border of the sternocleidomastoid muscle. Because negligible amounts of fat were found during early dissections in the orbital, nasal, and posterior neck regions, measurements of these areas were not included in the study.

The superficial fat portion of each aesthetic subunit was dissected, making certain to stay above the level of the SMAS and mimetic musculature. Special emphasis was given to the location, type, and density of retaining ligaments for each superficial fat compartment. Weights were then measured in grams with a calibrated medical scale (Model Y50; Pelouze, Bridgeview, IL).

The SMAS and mimetic musculature were dissected off of the face and neck and discarded. The aesthetic subunits were redrawn on each cadaver hemisection (Figure 2). The deep fat compartment was then dissected off the face and neck within each aesthetic subunit, with special emphasis given to the type and density of the retaining ligaments within each deep fat compartment. This resulted in a cadaver dissection virtually bereft of fat (Figure 3).

Two cadaver hemidissections were transversely sectioned for histologic analysis in each of the 8 aesthetic subunits. These sections were harvested horizontally from each studied area. Specimens were fixed in 10% formalin for 48 h at room temperature and processed with hematoxylin and eosin (H & E) stain for fat delineation and Masson trichrome stain for delineation of fascia layers. Histologic specimens were examined and photographed at original magnification ×10 and ×40 for study.

Results

Gross dissections

Superficial compartments. The superficial fat was found to be uniform, finely lobulated, and intensely yellow. The superficial fat was compact and held in a tightly patterned arrangement by many firm dense vertical septa, which held the fat tightly between the dermis and the superficial fascia. This weave of superficial fat within the superficial fascia was found to be tightest in the forehead, temporal, and mental regions, with progressive loosening as the midface, cheek, and neck regions were entered. In the anterior and middle cheek regions, fat superficial to the fascia was loosely contained within the fibrous tissue.

The superficial fat was found to be distributed as follows: forehead, 15.25 g (17% of the total superficial...
facial fat); glabella, 7.89 g (9%); temporal region, 9.75 g (11%); anterior upper cheek, 14 g (16%); middle cheek, 21.62 g (25%); posterolateral cheek, 10.5 g (12%). The highest concentration of facial fat above the superficial fascia was found in the middle cheek compartment 21.62 g (25%), with the anterior and the middle cheek together accounting for 41% of the entire subcutaneous facial fat. The total superficial fat distribution was found to be 88.12 g (78%) in the face and 24.12 g (22%) in the neck. The distribution and measurements of superficial fat are found in Table 1.

**Deep compartments.** Unlike the superficial fat compartments, the deep fat compartment lacked uniformity. The deep fat varied from pale yellow to straw color. Most of the deep fat compartment was arranged in a loose latticework, consisting of thin wisps of cross-hatched fascia stretching from the deep investing layer to the superficial fascia. The deep fat was densest in the temporal, periorcular, cheek, and submental regions. In the temporal region, the deep fat pad consisted of the superficial temporal fat pad and the temporal extension of the deep fat pad of Bichat. The deep fat was connected through longitudinal oriented fibrous septa to a very dense layer of deep fascia. Cheek fat deep to the superficial fascia was arranged in very large globules sparsely contained within a block-like arrangement of fascia. In the neck, fat deep to the platysma was lacking fibrous investing tissue.

The deep fat distribution was found to be as follows: brow (forehead and glabella), 11 g (15% of the total deep facial fat); anterior upper cheek (suborbicularis oculi fat pad or SOOF), 11.75 g (16%); temporal fat pad, 8.87 g (12%); middle cheek, 14.62 g (20%); posterolateral cheek 10.62 g (14%); buccal fat pad, 14.62 g (20%). The total deep fat distribution was found to be 71.5 g (85%) in the face and 12.75 g (15%) in the neck. The distribution and measurements of deep fat are found in Table 2.

**Figure 3.** The skin, SMAS, and superficial and deep layers of fat, including the fat pad of Bichat, have been dissected off the cadaver’s face and neck, demonstrating the near complete loss of contour in faces bereft of fat and SMAS. (From LaTrenta,13 with permission.)
Overall, 80% of total subcutaneous fat mass was found in the face and 20% in the neck (Table 3). In the face, 57% of the fat mass was found above the SMAS, and 43% was found below the SMAS, whereas in the neck 65% of the fat mass was found above the platysma and 35% below the platysma. One half of the total face and neck fat mass was found in the cheeks, with one third of total fat mass located in the anterior and middle cheeks alone. Of special note, 75% of the total deep facial fat mass was found in the anterior and middle cheeks. The distribution of cheek fat alone is illustrated in Table 4.

### H & E and Masson trichrome

Both H & E and Masson trichrome sections were performed within the anterior, mid-cheek, and posterior cheek compartments. A representative full-thickness middle cheek Masson trichrome section is illustrated in Figure 4.

#### Retaining ligaments

The retaining ligament distribution is illustrated in Figure 5. In general, as also noted by other investigators, two types of retaining ligaments were found, which we characterize as dermal-periosteal ligaments that provide primary support along the borders of the cheek aesthetic units and intrafascial coalescences that provide secondary support within the borders of the cheek aesthetic units. The dermal-periosteal ligaments were found in 4 key locations overlying both zygomatic and mandibular sutureal interfaces: (1) overlying the zygomatico-frontal suture, (2) overlying the zygomatico-temporal suture, (3) overlying the junction of the anterior to the middle third of the mandibular body, and (4) overlying the zygomatico-maxillary suture. Empirically, these ligaments were found to be only mildly affected by the cadaver's age.

### Table 3. Superficial versus deep fat distribution

<table>
<thead>
<tr>
<th>Location</th>
<th>Weight</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facial superficial fat</td>
<td>88.125 g</td>
<td>56</td>
</tr>
<tr>
<td>Facial deep fat</td>
<td>71.5 g</td>
<td>44</td>
</tr>
<tr>
<td>Total facial fat</td>
<td>159.69 g</td>
<td></td>
</tr>
<tr>
<td>Neck superficial fat</td>
<td>24.125 g</td>
<td>65.4</td>
</tr>
<tr>
<td>Neck deep fat</td>
<td>12.75 g</td>
<td>34.6</td>
</tr>
<tr>
<td>Total neck fat</td>
<td>36.875 g</td>
<td></td>
</tr>
<tr>
<td>Total facial and neck superf.</td>
<td>132.25 g</td>
<td>61.1</td>
</tr>
<tr>
<td>Total facial and neck deep</td>
<td>84.25 g</td>
<td>39.9</td>
</tr>
<tr>
<td>Total facial and neck fat</td>
<td>216.5 g</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4. Cheek fat distribution

<table>
<thead>
<tr>
<th>Location</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior cheek superficial fat</td>
<td>14 g</td>
</tr>
<tr>
<td>Anterior cheek deep fat</td>
<td>11.75 g</td>
</tr>
<tr>
<td>Total anterior cheek fat</td>
<td>25.75 g</td>
</tr>
<tr>
<td>Middle cheek superficial fat</td>
<td>21.62 g</td>
</tr>
<tr>
<td>Middle cheek deep fat</td>
<td>14.62 g</td>
</tr>
<tr>
<td>Total middle cheek fat</td>
<td>36.24 g</td>
</tr>
<tr>
<td>Posterior cheek superficial fat</td>
<td>10.5 g</td>
</tr>
<tr>
<td>Posterior cheek deep fat</td>
<td>10.62 g</td>
</tr>
<tr>
<td>Total posterior cheek fat</td>
<td>21.12 g</td>
</tr>
<tr>
<td>Fat pad of Bichat</td>
<td>14.62 g</td>
</tr>
</tbody>
</table>

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Figure 4. Histologic Masson trichrome composite section at the middle cheek level demonstrating that fat superficial to the fascia is contained within a clear latticework of fibrous tissue (fine arrow), whereas fat deep to the fascia is arranged in very large globules sparsely contained within a thin block-like arrangement of fascia (thick arrow). (From LaTrenta,13 with permission.)
The intrafascial ligaments were found to be located at 3 key locations: (1) in the anterior cheek—lateral and parallel to the nasolabial fold, (2) in the middle cheek—parallel to the anterior border of the masseter muscle, and (3) in the posterior cheek—parallel to the angle of the mandible and below the lobule of the ear. Empirically, these ligaments were found to be greatly affected by the cadaver’s age.

Discussion

Much of the beauty of the human face, as well as the uniqueness of human facial identity, is much better understood and appreciated through a thorough understanding of the role that fat plays in defining facial and neck contour. Previous research in the area of facial and neck fat distribution have included magnetic resonance imaging, which has accurately mapped the soft tissues for preoperative and postoperative evaluation of aesthetic facial contouring; and various cadaveric anatomic dissections that have described the individual facial fat pads. Numerous individual facial fat pads have been described and named, including the temporal fat pad and the buccal fat pad. This research has increased our understanding of the intricate role fat plays in the anatomy of the face and neck and also of what is actually accomplished by our surgical attempts at rejuvenation of the facial subcutaneous layers. None of these studies, however, has quantified the differential volume of fat in the human face and neck or adequately described the relationship facial and neck fat has to the superficial and deep fascial layers and its retaining ligament system.

In our cadaver dissections, we found that 80% of total subcutaneous fat mass was found in the face and only 20% in the neck. In the face, 57% of the fat mass was found above the SMAS, and 43% was found below the SMAS, whereas in the neck 65% of the fat mass was found above the platysma and 35% below the platysma. Overall, one half of the total face and neck fat mass was found in the cheeks, with a full one third of the total fat mass located in the anterior and middle cheeks alone. Of special note, 75% of the total deep facial fat mass was found in the anterior and middle cheeks.

Figure 5. The retaining ligament system found consisted of 2 types: true dermal-periosteal ligaments found only along the border of the cheek aesthetic unit and intrafascial coalesences found only within the borders of the cheek aesthetic unit. (From LaTrenta, with permission.)
The histologic sections demonstrated a finely compact honeycomb of fibrous septa in the superficial fat compartment densely connecting the superficial fat fascia to the dermis. Superficial to the SMAS the fat lobules were divided by well-defined fibrous septa. The superficial fat was finely lobulated and composed of small tightly compact arrays of homogeneous fat lobules. These superficial septations vary in density and quality depending on the location; a high density of short septation is found in the forehead, glabella, and periorbital and temporal regions, whereas a low density of long and loose septation is found in the cheek and neck regions. Progressive widening and loosening of this fine superficial weave was noted as we dissected inferiorly into the anterior, middle, and posterior cheek regions and into the neck. In contrast, the deep fat compartment was found to be bereft of septation and arranged with larger fat lobules placed in a more random pattern. As did other investigators, we found that the fibrous attachments retaining the SMAS layer and skin to the deep tissues had a constant and predictable location with varying density of fibrous tissue.2-4

The findings of this study allow for a more fundamental understanding of the role that the subcutaneous fat, periosteal, and fascial systems play in defining the facial soft tissue contours and mass. The facial subcutaneous tissue mass can be thought of as an extremely intricate netting, with primary supports through periosteal condensations at the zygomatic and mandibular suture interfaces that are not greatly affected by aging, and secondary supports at intrafascial condensations within the aesthetic subunits of the cheek that are greatly affected by aging. Three of the 4 primary supports of the face were found along the borders of the aesthetic subunit of the cheek, whereas all of the 3 secondary supports were found within the borders of the anterior, middle, and posterior cheek subunits. This leads to the fundamental question asked by this study; why do we age in our cheeks?

This study has demonstrated that the cheek region of the human face and neck has the highest concentration of fat. The cheek accounts for roughly half of the total facial and neck fat. Most of this fat, roughly a full third of the total fat, was found to be located in the anterior and middle cheek regions alone. The cheeks are essentially hollow, providing soft tissue cover for the oral cavity. This hollowness is necessary for the oral cavity to perform the vital functions of speech, mastication, respiration, and facial expression. Although securely fastened to the periosteum along its borders, the cheeks have intrafascial supports that exist only within their borders and with varying properties. The inherent weakness of the secondary supporting system within the cheeks and the inherent tautness of the primary support system along the borders of the cheeks are other factors, which account for the clinical manifestations of facial aging.

The posterior platysma-auricular ligaments within the posterior cheek subunit were found to be strong and broad, providing the posterior cheek subunit with a broad band of strong lateral fixation to the underlying parotid gland and mandible. This strong swathe of tissue fixation is the one encountered when one elevates the lateral portion of the platysma muscle during a lateral platysmaplasty. The masseteric-cutaneous ligaments within the midcheek subunit were found to be numerous, thin, and spiky, probably allowing the middle cheek subunit to be held to the masseter muscle during mastication. These masseteric-cutaneous ligaments are found to be evident during extended SMAS rhytidectomy when one encounters the parotid maseteric fascia anterior to the parotid gland. The anterior buccal-maxillary ligaments within the anterior cheek subunit were found to be long, loose, and elastic, probably allowing for the extensibility and subtle glide necessary for facial expression. These ligaments are evident during the intraoral portion of a subperiosteal rhytidectomy, especially if one dissects anteriorly into the subcutaneous tissues.13

In this study, this weaker intrafascial system of cheek suspension was found to be progressively weaker the more anteriorly in the cheek we dissected. Hence, not only was there more fat mass to suspend anteriorly, there was also a weaker system anteriorly for which to provide suspension. The combination of weak intra-cheek suspension and heavier anterior cheek mass ultimately results in the characteristic inferolateral descent of facial soft tissues (ie, deep nasolabial and marionette folds, jowls and facial folding) as we age.

Anterior bunching of subcutaneous mass is held in place by the much tighter true retaining ligament system along the nasolabial and oromandibular grooves. This unique and ubiquitous distribution of the weaker secondary suspensory system within the confines of the cheek is another factor resulting in the reproducible “face of age” we encounter in our patients requesting midfacial rejuvenation. The suspensory system of the cheek has been found to resemble a trampoline, whose center sags significantly away from the supporting bars at the periphery (Figure 6). The greater the amount of musculofascial laxity within the cheeks, the worse the sagging; the greater the proportionate fat increase within the face and neck, the worse the sagging; the greater the
Figure 6. The “Trampoline Effect” of midfacial aging. The soft tissues of the midface and cheek can be thought of as the elastic netting of a trampoline that is suspended from the bones of the face by four supporting legs. The more the trampoline is subjected to the vectors of aging (ie, gravity, body fat, musculofascial laxity, solar elastosis), the more the trampoline sags. (From LaTrenta,13 with permission.)
Why Do We Age in Our Cheeks?

loss of elasticity within the skin envelope of the cheeks, the worse the sagging. And when this sagging soft tissue is subjected to the forces of gravity, time, motion, and the elements, the nagging signs of aging in the midface appear.

Finally, what are the clinical implications of this cadaveric investigation for the plastic surgeon performing rhytidectomy? The primary surgical goal of rhytidectomy is mobilization of the subcutaneous tissue layers of the face and neck to restore midfacial soft tissue volume and to re-contour and tighten the neck. This study has demonstrated that fat is the major component of the subcutaneous tissue layers of the face and neck and has clarified exactly where the fat resides within these subcutaneous layers. A wide variety of subcutaneous tissue undermining and transfer techniques are available for rhytidectomy.14–19 These include subcutaneous “minilifts,” skin lifts, supra-SMAS/platysma lifts, limited lateral SMAS plication/SMASectomy, extended SMAS flaps, “deep plane” and “composite” lifts, and subperiosteal lifts (Table 5).

This study has demonstrated that for those surgeons who primarily perform skin lifts, the vast majority of the available cheek and neck fat is not undermined or transposed. For those surgeons who perform subcutaneous “minilifts,” which either directly or indirectly undermine and transpose the superficial posterior cheek compartment, only 8.75% of the total available fat in the cheeks and neck is “lifted” by this technique. For those surgeons who routinely perform supra-SMAS/platysma dissections extending the full width of the neck, which either directly or indirectly undermines and transposes the superficial middle and posterior cheek and superficial neck compartment, then 46.8% of the total available fat in the cheeks and neck is “lifted” by this technique. If a limited lateral SMAS/platysma plication or SMAS-ectomy is performed up to or along the parotid border, thereby additionally either directly or indirectly undermining and transposing the posterior deep fat compartment as well, then 55.7% of the total available fat in the cheeks and neck region is “lifted” by this technique. If an extended SMAS is performed, which either directly or indirectly additionally transposes the deep middle cheek compartment, then 67.9% of the total available fat in the cheeks and neck is “lifted” by this technique. If a composite or deep plane lift is performed instead,16 whereby the attachments of the SMAS to the deep fat compartments are lysed, thereby elevating the entire superficial facial and neck fat mass, then 58.5% of the total available fat in the cheeks and neck is “lifted” by this technique. And finally, if the surgeon decides to perform a subperiosteal midface lift via either an intraoral or a lower eyelid approach, this procedure alone would undermine and transpose only the superficial and deep anterior cheek compartments, thereby “lifting” only 21.5% of the total available fat in the cheek and neck region.

Conclusion

This study has demonstrated that fat is the major component of the subcutaneous tissues of the face and neck, that the superficial and deep subcutaneous layers have differential fat density, and that the anterior and middle cheek compartments alone contain roughly half of total facial fat. The study also demonstrated that the deep anterior and middle cheek compartments, which are particularly difficult to mobilize with standard lateral rhytidectomy approaches, contained roughly three quarters of the deep subcutaneous fat in the face.

The results of facial rejuvenation are without doubt multifactorial, and a surgeon’s postoperative results will depend on the individual patient’s facial skeletal support and skin quality, as well as on the fat fixation method,
among other factors. Within this context, our study focused on the role of fat volume and location in the subcutaneous tissue layers and implies that the more subcutaneous facial and neck tissue that the rhytidectomy surgeon undermines and transposes, the far greater chance that surgeon has in restoring midfacial volume and recontouring the neck. Further, residual midfacial sagging after rhytidectomy may be primarily related to the fat-laden, elusive, and difficult to access deep anterior and middle cheek compartments.

References

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Reprint requests: Elsa Raskin, MD, 2½ Dearfield Drive, Suite 102, Greenwich, CT 06831.
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