The Retaining System of the Face: Histologic Evaluation of the Septal Boundaries of the Subcutaneous Fat Compartments

Rod J. Rohrich, M.D.
Joel E. Pessa, M.D.
Dallas, Texas

Background: Because the concept of subcutaneous fat compartments has many significant implications for cosmetic and reconstructive surgery, it is important to verify the original findings and validate the concept. The authors studied the histology of the septal boundaries between several adjacent fat compartments.
Methods: Eighteen hemifacial cadaver specimens were used (five male and four female cadavers; age range, 39 to 87 years). Tissue marking dye was injected into the central forehead and the medial, middle, and lateral temporal cheek compartments. Dye was allowed to diffuse for 4 hours until a skin blush was noted, at which point dye-setting solution was injected to fix the dye. En bloc transverse specimens were harvested and stored in formalin overnight. Standard histologic processing was performed.
Results: Each compartment partitioned dye in a consistent and reproducible manner. A fibrous condensation of connective tissue formed the diffusion barriers. These septa originated from underlying fascia and inserted into the dermis of the skin. A septal barrier originated from the fascia of the frontalis muscle, so these septal barriers are not necessarily related to the superficial musculoaponeurotic system but can occur anywhere between superficial fascia and skin.
Conclusions: These findings support the concept that subcutaneous fat is compartmentalized, specifically by fascial condensations that travel from superficial fascia to dermis. These septa form an interconnecting framework that limits shearing forces on the face. This framework provides a "retaining system" for the human face. Implicit in this concept is the suggestion that the face ages three dimensionally, with separate compartments changing relative to one another by both position and volume. (*Plast. Reconstr. Surg.* 121: 1804, 2008.)

It has been described that the subcutaneous fat of the human body is partitioned into discrete anatomical units or "compartments."[1] For many years, the subcutaneous fat of the face and human body has been considered to be a confluent mass, and rejuvenation techniques of both the face and trunk have been structured around the concept of lifting and repositioning ptotic soft tissue. The finding that fat is compartmentalized adds a different perspective to the concept of facial aging, one that suggests differential changes of various compartments.

For example, fat may be lost in the submental compartment and deposited in the jowl area.[2] These are both superficial fat compartments. Deep fat loss, known to occur in the temporal region, may also occur in the sub–orbicularis oculi fat and in the more recently described deep medial cheek fat.[3,4] Loss or deposition of fat creates a change in the surface topography of the face associated with the perception of facial aging.

Both Lambros and Little have suggested a volumetric approach to facial rejuvenation.[2,5]

From the Department of Plastic Surgery, University of Texas Southwestern Medical School.
Received for publication March 13, 2007; accepted June 19, 2007.
Presented in part at the 24th Annual Aesthetic Surgery and Rhinoplasty Symposium, in Dallas, Texas, March 1, 2007.

DOI: 10.1097/PRS.0b013e31816c3c1a

Disclosure: *Neither of the authors has an interest in any products, medical devices, instruments, or contracts that are related to this research.*

Lambros evolved the concept of "deflation" as an important mechanism by which the face ages. The finding that fat is compartmentalized, not simply in the face but throughout the entire human body including the trunk and extremities, supports these authors' concept.

Why fat is compartmentalized is unknown. It has been noted that numerous dyes stain very discrete anatomical fat regions. Fascial condensations could be visualized with loupe magnification in the initial study.[1] It was hypothesized that these fascial septa inserted into the dermis, thereby acting as partitioning barriers. Because the concept of fat compartmentalization has so many important implications for plastic surgery, for the study of obesity, and for the science of aging, the following study was performed to evaluate the histologic barriers between several adjacent compartments.

MATERIALS AND METHODS

Eighteen hemifacial cadaver dissections were performed. Five male and four female faces were used, ranging in age from 39 to 87 years. No previous surgical scars were present in the specimens used for dissection, as this could affect dye diffusion. All specimens were fresh; none had been frozen before dissection and harvesting of samples for histology.

Cancer Therapeutics dyes were found to diffuse well at a diluted concentration of 1:3 (one part dye to three parts normal saline). Two to 3 cc of this blue dye were injected into a compartment, and adequate time was allowed for diffusion. Four hours has been found to be adequate time for diffusion of the facial compartments. A skin blush was used as a clinical indicator of proper dye diffusion.

Dye-setting solution (Cancer Therapeutics) was then injected to "set" the previously injected dye. This is a critical step to prevent washout during processing. Transverse sections of skin through the underlying fascia were then harvested across the stained boundaries. The septal barriers of four compartments were evaluated: the region between the nasolabial and medial cheek fat, medial cheek and middle fat, middle fat and lateral temporal cheek fat, and the central temporal septum lying between the central forehead compartment and the middle forehead compartment (Fig. 1).

Sections were placed in specimen carriers, immersed in formalin, and stored overnight. Processing was performed in the usual fashion, and both hematoxylin and eosin and trichrome stains were used to demonstrate the microanatomy.

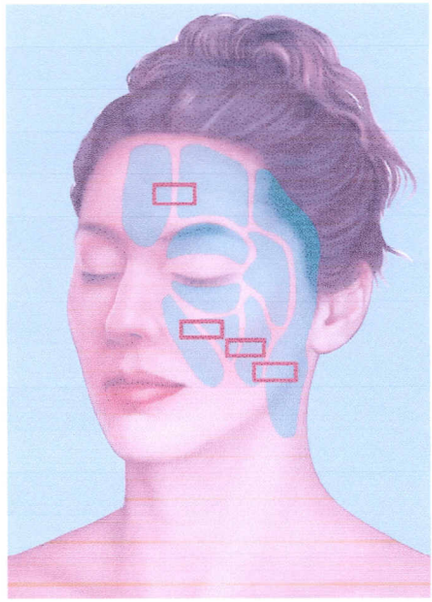

Fig. 1. Sections were taken from the transition zones between fat compartments to verify the presence of septal barriers. Four regions were studied: the central compartment and the medial, middle, and lateral temporal cheek compartments (areas of histologic sampling are shown in *red*).

Trichrome stain, in general, was found to be superior to hematoxylin and eosin for demonstrating the connective tissue barriers.

RESULTS

The central temporal septum illustrates highly regionalized dye partitioning (Figs. 2 and 3). Fibrous septa arise from the underlying fascia of the frontalis muscle (Fig. 2), and can be clearly noted as they insert into the skin of the dermis. Trichrome stain is highly accurate for localizing connective tissue and intensively stains this septal boundary.

The central temporal septum can be dissected on a macroscopic level as well. A firm condensation of fascia is noted lateral to the stained central forehead compartment (Fig. 4, *above*), and the fibrous nature of this structure is clearly evident (Fig. 4, *below*). The subcutaneous boundaries of the central temporal septum coincide very precisely with the known clinical boundaries of the median forehead flap. This is likely attributable to the vascular anatomy, as the boundaries are fascial conduits for perforators from the supratrochlear vessels.

The medial cheek septum separates the nasolabial fat from the medial cheek fat (Fig. 5). This fat compartment has been noted to vary in size

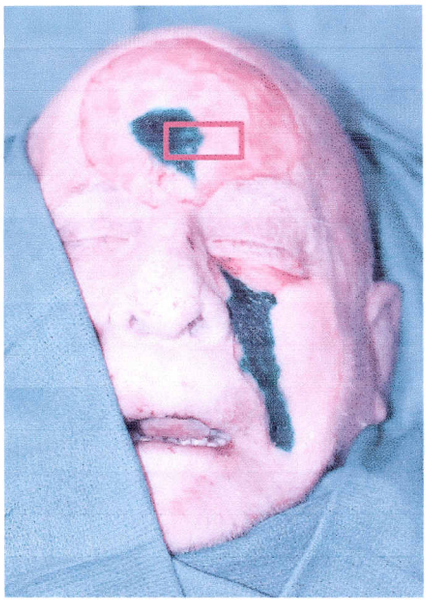

Fig. 2. A section was taken from the boundary between the middle forehead compartment (undyed) and the central forehead compartment (stained with Cancer Therapeutics dye).

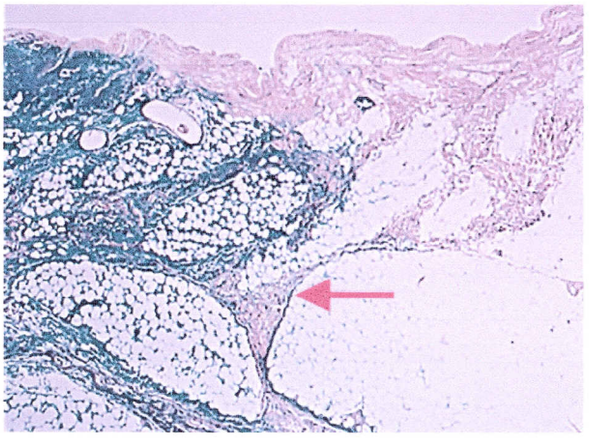

Fig. 3. Histologic examination of the central temporal septum (*red arrow*) shows that this is a condensation of connective tissue, evidenced by the intense staining. The septum originates from the underlying fascia of the frontalis muscle. It is important to note that this is a subcutaneous septum rather than a submuscular membrane.

depending on the particular individual. However, it is always located superior to jowl fat and inferior to the infraorbital fat (Fig. 5). A transverse section obtained from the transition between nasolabial and medial cheek fat shows a dense fascial condensation separating these two compartments (Fig. 6). High-power magnification shows that this membrane inserts into the dermis of the skin.

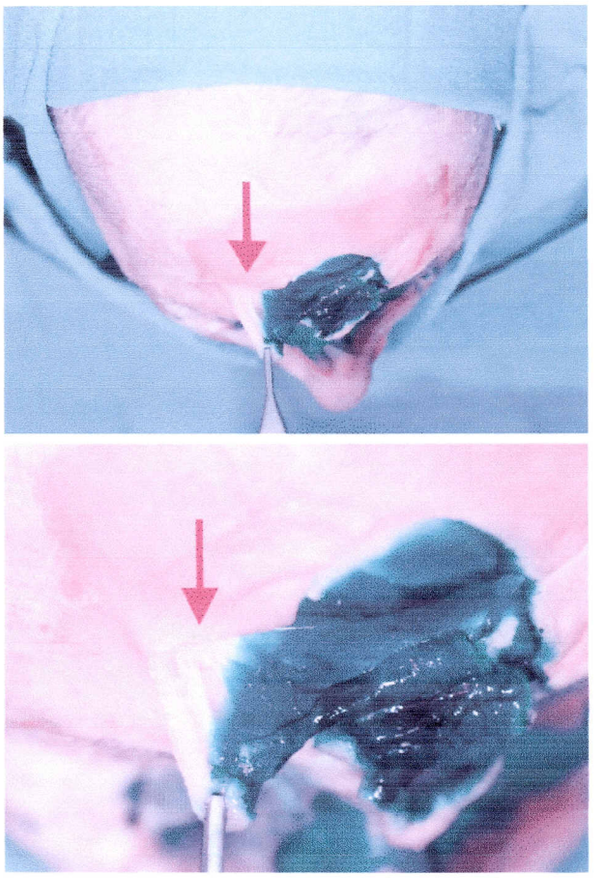

Fig. 4. (*Above*) Macroanatomical dissection confirms the presence of the central temporal septum as a subcutaneous structure. (*Below*) Macroanatomical photography of the central temporal septum shows this to be a dense, fibrous band. The functional characteristics of all of these septa enable their localization with dye injection and histologic evaluation.

Although many subcutaneous fat septa are noted throughout this slide, it is important to recognize that only one region—this fascial condensation—partitions dye, highlighting its difference functionally from the surrounding random septa. Hematoxylin and eosin staining likewise verifies the presence of this barrier.

The middle cheek compartment is separated from its medial counterpart by the middle cheek septum. An en bloc specimen harvested from the transition zone between these two regions reveals a dense fibrous barrier (Fig. 7). The microanatomy is shown to consist of connective tissue, as evidenced by the intense staining with trichrome. A dermal insertion is again noted as this septum courses from superficial fascia to skin.

The lateral cheek septum represents the transition zone from middle cheek fat to lateral tem-

Fig. 5. A section is harvested from the transition between the nasolabial compartment (undyed) and the superficial medial cheek fat (dyed with Cancer Therapeutics dye).

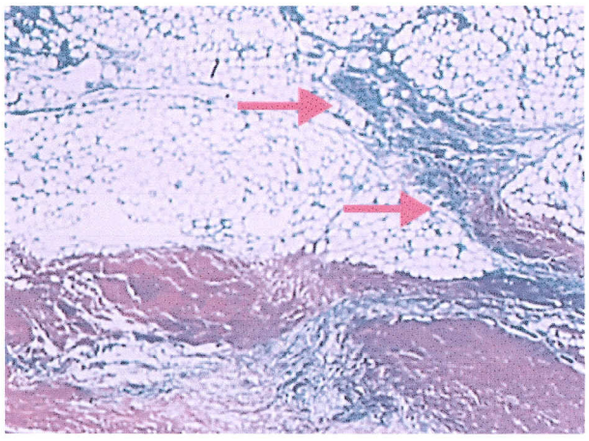

Fig. 6. Histologic examination of the septum between nasolabial fat and medial cheek fat shows a fibrous structure (*red arrows*) that inserts into the dermis of the skin. Note that there is no epidermal marker (e.g., dimpling or diminished thickness) at the dermocutaneous insertion. The medial cheek septum represents the fascial boundary between the two compartments described above.

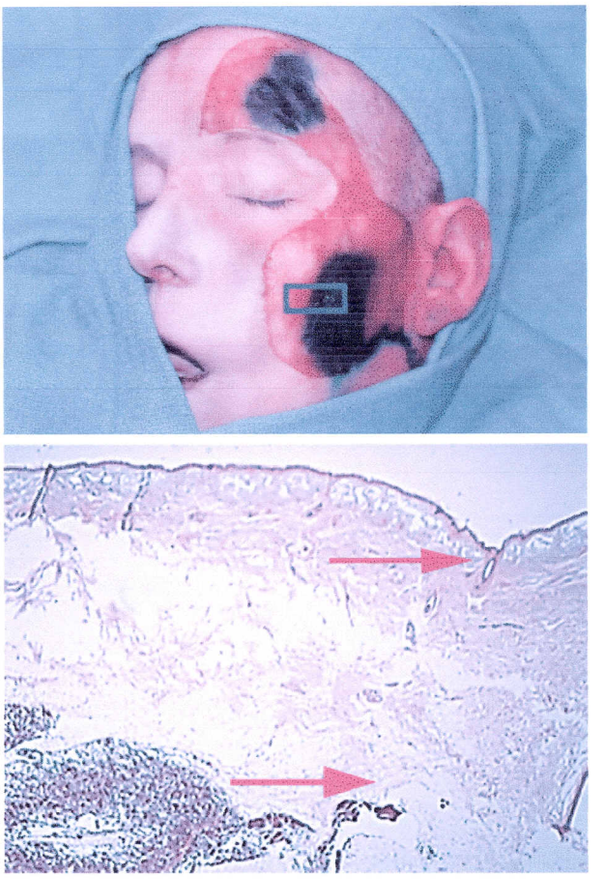

Fig. 7. (*Above*) The boundary between the middle cheek fat (dyed) and medial cheek fat (undyed) is termed the middle cheek septum. A tissue sample has been harvested from this area (*blue section*). (*Below*) The fibrous nature of the barrier between these two regions can be seen (*red arrows*). Dye washout has occurred with this particular specimen. This is not as firm a membrane as that noted in the forehead (Fig. 4, *below*).

poral cheek fat. This compartment is of interest in that it is the only one that traverses the forehead and the neck. Dye staining of this particular compartment has been very specific in every cadaver studied to date. A full-thickness specimen was harvested (Fig. 8, *above*). The dye resists washout during histologic processing and clearly demarcates the boundary between these two compartments. The lateral cheek septum is seen as a thickened region that partitions dye from the unstained middle cheek fat (Fig. 8, *below*). It is noted that there is overlap between these compartments on a microanatomical level (Fig. 8, *below*), in keeping with what has been observed during macroanatomical dissection. Other septal boundaries, including the lower eyelid and the boundary to the jowl fat, have been studied and confirm the presence of fascial condensations as the mechanism of fat compartmentalization.

DISCUSSION

Subcutaneous fat compartments are determined by fascial membranes that arise from the

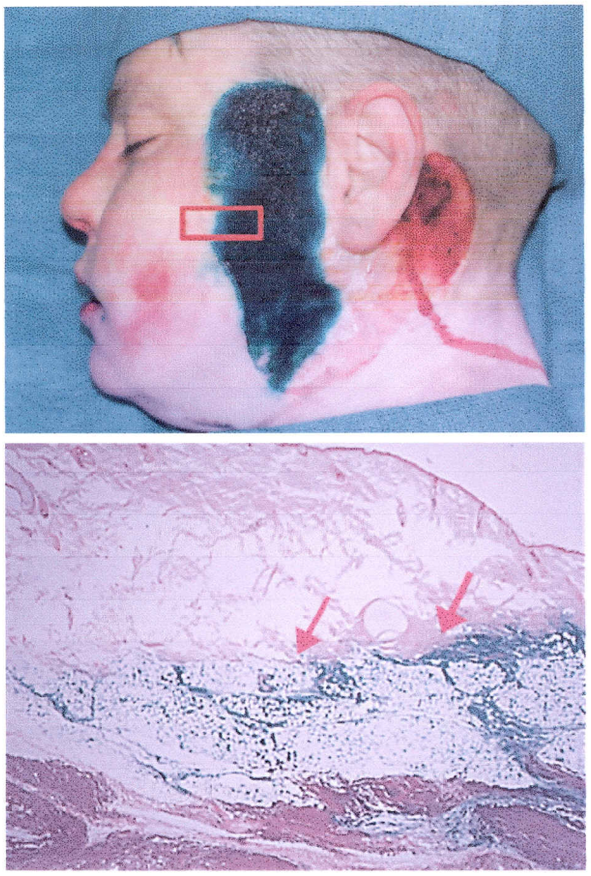

Fig. 8. (*Above*) This cadaver has been stained to show the anatomical limits of the lateral temporal cheek septum. This compartment is unique in that it is the only one that spans the forehead with the neck. A section was harvested from the midportion of this compartment, between it and the adjacent middle cheek fat (*red section*). (*Below*) Dye staining is seen in the lateral temporal cheek region (*blue dye*). Note that the lateral cheek septum (*red arrows*) runs along an oblique course. This is characteristic of this particular compartment: the septal boundary between the nasolabial fat and medial cheek fat runs almost always along a more perpendicular course. Overlap of fat between subcutaneous fat is observed in many situations.

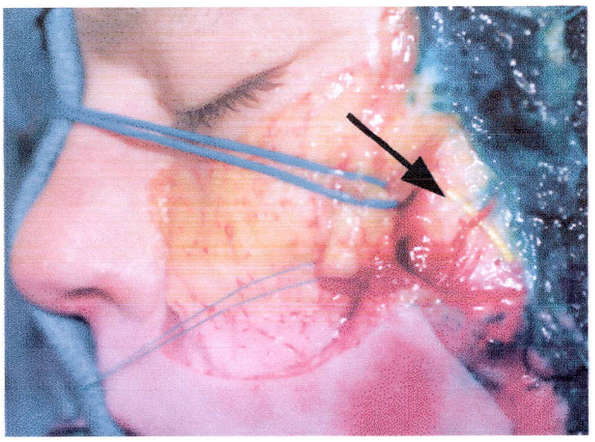

Fig. 9. Septal membranes between adjacent subcutaneous compartments represent potential sites of injury to the facial nerve. The facial nerve (*arrow*) is tethered between the lateral cheek compartment (dyed) and the middle cheek compartment.

superficial fascia and insert into the dermis of the skin. These membranes are impermeable to dye, a finding that has enabled the study of compartments throughout the human body. It is this fascial system that dictates the location and shape of each anatomical subcutaneous compartment.

During the face-lift procedure, septae between compartments must be divided as dissection proceeds. It is important to recognize the fact that transition zones between compartments are regions of potential injury to deeper structures, including branches of the facial nerve (Fig. 9). During the early part of the face-lift procedure, one dissects from the lateral cheek compartment through a septal barrier into the middle cheek fat. The facial nerve can be injured, as can branches of the facial artery, if transitioning is performed in too deep a plane (Fig. 9). This is also true of the greater auricular nerve and the buccal branch of the facial nerve—McKinney's point and MacGregor's patch—which are simply regions where three or more septal membranes fuse.

The knowledge of where these septal partitions occur can be used during the face-lift procedure. For example, Aston advocates dissection of the preauricular flap, the postauricular flap, and then *parallel to the platysma cutaneous ligament.*[6] This technique is really a surgical principle: dissection of the subcutaneous plane is always facilitated if one dissects parallel to the known septal barriers. It is when dissection occurs perpendicular to a septum that improper transitioning may occur. One of the most significant regions where this can occur is anterior to the middle cheek compartment, where the area beneath the zygomaticus major muscle can be inadvertently dissected. Again, knowledge of where these membranes occur can facilitate the face-lift dissection.

An interesting concept arises from this histologic research. Because an interconnecting framework is constructed by these septal barriers, it may be that this constitutes a "retaining system" of the face. The retaining ligaments have been described by Furnas and further elucidated by Stuzin et al.[7,8] It is noteworthy that ligaments occur where several septal boundaries meet and, presumably, fuse. A

retaining system prevents migration of skin, a finding that can be observed by clinical examination.

Why these septal membranes exist is unknown. Scheverien et al. have suggested that these membranes stabilize the blood supply to the skin.[9] This correlates with the clinical finding that zones of vascularity are encountered alternating with zones of relative avascularity during the face-lift procedure. The vascular zones occur between anatomical compartments, where the septal membranes are located. This is particularly evident in the medial face, where perforators from the transverse facial artery and angular artery are found. This finding may be analogous to the zones of adherence described on the trunk and encountered during liposuction.

The question arises that if these compartments exist all over the surface of the human body, why have they only recently been brought to our attention? The answer is that fat compartmentalization has been recognized for years, ever since periorbital ecchymosis was first observed. Periorbital bruising is restricted to the inferior orbital fat compartment, and the only difference between the lower eyelid and the rest of the face is the thickness of the skin. The thin skin of the lid allows blood (or dye) partitioning to be recognized in a discrete region, *before the pigment has had time to diffuse to an adjacent compartment along the muscles, vessels, or nerves.* By the time a cheek hematoma stains the skin, it has had sufficient time to diffuse along these channels, so a discrete compartment was not observed. If one removes the epidermis and some of the dermis, time lapse photography can show complete diffusion of dye in some compartments in as little as 4 hours.

The current study lends additional evidence for the anatomical concept of subcutaneous fat compartments. This further refines our understanding of facial anatomy and will improve the results of facial aesthetic surgery.

Joel E. Pessa, M.D.
Department of Plastic Surgery
University of Texas Southwestern Medical School
5323 Harry Hines Boulevard
Dallas, Texas 75390
joel.pessa@utsouthwestern.edu

REFERENCES

1. Rohrich, R. J., and Pessa, J. E. The subcutaneous fat compartments of the face: Anatomy and clinical implications for cosmetic surgery. *Plast. Reconstr. Surg.* 119: 2219, 2007.
2. Lambros, V. Personal communication, November 2006.
3. Aiache, A. E., and Ramirez, O. M. The sub-orbicularis oculi fat pads: An anatomic and clinical study. *Plast. Reconstr. Surg.* 95: 37, 1995.
4. Rohrich, R. J., and Pessa, J. E. The deep medial cheek fat. Accepted.
5. Little, J. W. Volumetric perceptions in midfacial aging with altered priorities for rejuvenation. *Plast. Reconstr. Surg.* 105: 252, 2000.
6. Aston, S. J. Personal communication, 1990.
7. Furnas, D. W. The retaining ligaments of the cheek. *Plast. Reconstr. Surg.* 83: 11, 1989.
8. Stuzin, J. M., Baker, T. J., and Gordon, H. L. The relationship of the superficial and deep facial fascias: Relevance to rhytidectomy and aging. *Plast. Reconstr. Surg.* 89: 441, 1992.
9. Scheverian, M., Pessa, J. E., and Rohrich, R. J. The vascular basis of fat compartmentalization. Submitted for publication.