Is Intraorbital Fat Extraorbital? Results of Cross-Sectional Anatomy of the Lower Eyelid Fat Pads

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Preliminary Report

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Results of Cross-Sectional Anatomy of the Lower Eyelid Fat Pads

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BACKGROUND: Prominent fat pads of the lower eyelids are a frequent complaint prompting patients to seek cosmetic surgery. Previous studies have stated that these fat pads exist as three compartments in the lower eyelids. An accepted anatomic concept is that these lower eyelid fat pads are intraorbital.

OBJECTIVE: This study evaluates the possibility of distinct compartments of lower eyelid fat pads not being different from each other, but rather being separate from posterior intraorbital fat.

METHODS: This study used eight hemifacial cadaver dissections. Methylene blue injections were used to stain the middle and medial fat pads on each side. Sagittal cross-sections were obtained to visualize the area of fat staining. An axial cross-section of one additional specimen was obtained as confirmatory evidence.

RESULTS: Each specimen showed that lower eyelid fat pads stain as discrete fat compartments that are not in continuity with the posterior intraorbital fat. Their anterior boundary is the orbital retaining ligament at the anterior aspect of the inferior orbital rim. Their posterior boundary is an insertion point on the floor of the orbit in line with the midpoint of the globe, called the circumferential intraorbital retaining ligament.

CONCLUSIONS: Lower eyelid fat pads are not in continuity with posterior intraorbital fat. They can accurately be described as partially intraorbital and partially extraorbital in location. This information augments our previous understanding of the anatomy of the lower eyelid fat pads and is important for studies that attempt to determine their etiology. (Aesthetic Surg J 2009;29:189–193.)

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Prominent fat pads of the lower eyelids are a frequent complaint prompting patients to seek cosmetic surgery. Fat pads exist as three compartments in the lower eyelids. Previous studies have defined the position of these fat pads in relation to periorbital structures. The orbicularis retaining ligament fusion point on the orbital rim is the anterior and inferior limit of these fat compartments. The superior limit is the lower portion of the globe. The orbital septum fuses at the arcus marginalis, which is a fusion point of several fascias located just posterior to the superior-most part of the inferior orbital rim.

Several theories have been offered as explanation for the increased prominence of fat pads with aging. One of the oldest theories is that the orbital septum becomes lax and enables pseudoherniation of the fat pads with age. This is related to other theories that suggest weakening of other facial septal barriers over time. A second theory is that the ocular globe descends with age as a result of elongation and descent of the lateral canthus and the attached Lockwood ligament, leading to anterior displacement of the lower eyelid fat pads as a compensatory measure. A more recent idea is that the volume of intraorbital fat increases with age. In this study, volume measurements obtained from magnetic resonance imaging (MRI) scans suggest that the entire intraorbital fat volume increases with age, along with the amount of fat anterior to the inferior orbital rim.

Recent anatomic studies suggest that intraorbital fat exists as separate fat compartments. This observation is important because different fat compartments are known to behave differently with respect to their volume as a patient ages. Some of the best evidence supporting the theory of differential fat volume loss or gain with age comes from observing patients who are taking antiretroviral medications. These patients tend to lose both superficial and deep facial fat. At the same time, they will deposit fat in the posterior cervical area.
Enophthalmos in scleroderma patients may be secondary to fat loss in the posterior orbit. Another example is the altered body fat distribution in patients with Cushing syndrome.

To investigate further, the following study evaluates the possibility of distinct compartments of lower eyelid fat pads not being different from one another, but rather being separate from posterior intraorbital fat. This distinction becomes important for the study of disease processes that affect the orbital and periorbital structures, as well as for future research on orbital fat volume changes with age.

**METHODS**

The Willed Body Program at the University of Texas Southwestern Medical Center at Dallas provided all specimens for this research. Eight hemifaces from two males and two females were included in this study. All of these nonembalmed, frozen specimens were thawed for 48 hours before dissection. One additional fresh specimen was included in this study to offer confirmatory evidence for the findings.

Irrigation of each specimen was accomplished with saline washout of the common carotid arteries. Methylene blue was used as the dye because of its consistent ability for diffusion throughout fat. Injections consisted of 1 mL of methylene blue placed directly into the middle or medial fat pads after dissecting down through the orbicularis oculi muscle to the orbital septum. Only the middle and medial fat pads were studied because the position of these structures allowed for accurate and reproducible sagittal sections to be produced with our laboratory equipment, whereas the position of the lateral fat pads made obtaining cross-sections technically difficult and unreliable. Loupe magnification was used to assist with careful placement of dye. Four hours were allowed to elapse for dye diffusion. After this time period, the specimens were again frozen overnight. Sagittal sectioning through the orbit was outlined by the senior author (RJR) and performed using laboratory equipment to allow visualization of the pattern of lower eyelid fat pad staining. Axial sectioning through the orbits of the fresh specimen was performed to provide confirmatory evidence for the observations made from examining the sagittal sections.

Documentation included digital photography and macrophotography. Adobe Photoshop (Adobe, San Jose, CA) was used to resize and crop the digital images. No other modifications of the digital images were performed.

**RESULTS**

Eight hemifaces clearly showed that lower eyelid fat pads stain as discrete fat compartments that are not in continuity with posterior intraorbital fat (Figure 1, A). Higher-power views showed that the anterior boundary of the lower eyelid fat pads is the insertion of the orbicularis retaining ligament at the anterior aspect of the inferior orbital rim. The posterior boundary was an unexpected finding: it occurred at the insertion point on the floor of the orbit in line with the midpoint of the globe, which we will refer to as the circumferential intraorbital retaining ligament (Figure 1, B). This structure was easily identified in all specimens and staining did not occur posterior to this structure in any specimen. In the upper orbit, dissection revealed a posterior fascial membrane that separated supravelar fat from the upper posterior intraorbital fat. The circumferential intraorbital retaining ligament appeared to extend to upper eyelid fat compartments.

The methylene blue partitioned in a highly specific manner to the middle and medial fat pads. There was no instance in which dye stained intraconal fat (Figure 2). A similar result occurred on the contralateral side of the face of one particular specimen (Figure 3). In addition, extraconal fat above the floor of the orbit, along the maxillary periosteum, did not absorb dye (Figure 4, A). This, too, was a consistent finding. This extraconal fat was noted to be different in color from intraconal fat. 
Higher magnification further illustrated this anatomic difference (Figure 4, B).

An axial section confirmed these findings (Figure 5). The limit of dye penetration was again the circumferential intraorbital retaining ligament. The dye traversed from the middle to the lateral fat compartments in this specimen; however, the dye did not transgress into the posterior intraorbital fat.

**DISCUSSION**

These results suggest that lower eyelid fat pads are separate compartments from posterior intraorbital fat. The circumferential intraorbital retaining ligament was identified in all specimens; it partitions the lower eyelid fat pads from the posterior intraorbital fat. This structure is closely related to the extraocular muscles and their associated connective tissue pulleys, which have been previously described. In addition, this retaining ligament likely provides circumferential fixation and support of the intraorbital soft tissues, including the globe. Clinical evidence of the circumferential intraorbital retaining ligament can be observed in the setting of facial trauma when an anterior orbital floor fracture allows air originating from the maxillary sinus to transgress into the posterior intraorbital fat.
lower eyelid fat pads, but not further into the posterior intraorbital fat (Figure 6).

Studies have attempted to assess the intraorbital fat volume changes that may occur with age. One of the limitations of these studies was that they assessed total fat volume. The results of this study further distinguish the lower eyelid fat pads from the posterior intraorbital fat. Since lower eyelid fat pads are distinct from other intraorbital fat, including extraconal and intraconal fat, each fat compartment requires separate analysis. To better understand the etiology of lower eyelid aging and the role that both lower eyelid fat pads and intraorbital fat volume changes play, future studies should focus on examining changes in each of these fat compartments. They may contribute variably to changes in total orbital fat volume and related morphologic changes of the aging eyelids.

Fat compartmentalization occurs in the face and other regions of the body. This leads to a discussion of how different fat compartments behave with respect to fat volume loss and/or gain as a patient ages. These volume changes occur in both healthy patients and those with a defined medical illness. An example of this is scleroderma. Some scleroderma patients develop fat loss in highly specific locations, including loss of intraorbital fat, which may in turn lead to enophthalmos. Other examples of volume changes occur in patients with known genetic syndromes. Progeria, a disease first defined by Hutchinson and later by Gilford, also illustrates how fat behaves differently in various regions of the body. Affected individuals preferentially deposit fat in their truncal region, while they almost completely lack subcutaneous fat in their extremities, especially their upper extremities. In addition, they experience remarkable lipodystrophy in the face and a significant loss of intraorbital fat.

Recent reports that fat grafts may survive to a greater or lesser degree based on the donor site also suggest that fat differs. Fat grafting from certain areas—one example being the posterior cervical region—may lead to fat volume increase as the patient gains weight. This suggests that there are different types of fat, which differ either based on their metabolic demands or possibly their endocrine receptors.

The fact that lower eyelid fat pads are separate from more posterior intraorbital fat raises the question of how retrobulbar hemorrhage, a known possible complication of surgery for fat pad removal, may occur. Although lower eyelid fat pads are distinct from posterior intraorbital fat, blood vessels run through these fat pads into the more deeply-situated intraorbital fat. This is clinically most apparent in the upper eyelid, where an artery is frequently associated with the medial upper eyelid fat pad. Latex studies have suggested this same mechanism in the lower eyelid.

Future studies will involve evaluation of differences in the biology of fat in these various compartments. In addition, volume changes will have to be assessed in light of these findings because different fat compartments may behave differently with age. As such, this research represents findings along a continuum of work evaluating mechanisms of aging of the intraorbital and periorbital regions.

CONCLUSIONS

Lower eyelid fat pads are not in continuity with posterior intraorbital fat. Their location can accurately be described as partially intraorbital and partially extraorbital. This information augments our previous understanding of the anatomy of the lower eyelid fat pads and is important for studies that attempt to determine their etiology.

DISCLOSURES

The authors have no disclosures with respect to the contents of this article.

REFERENCES


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