Does a Superficial Musculoaponeurotic System Exist in the Face and Neck? An Anatomical Study by the Tissue Plastination Technique

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An exact knowledge of the subcutaneous layers in the different regions of the face and neck is important in several surgical disciplines. In the parotid region, a superficial musculoaponeurotic system (SMAS) has been described. The existence of a SMAS as a guiding structure for the surgeon in the other regions of the face and neck has been discussed but is controversial. Therefore, the authors investigated the development of the subcutaneous connective-tissue layers in the different facial regions and in the neck. They studied these regions in 22 human fetuses using the technique of plastination histology and in three newborn and three adult specimens using sheet plastination. In addition, they dissected the neck and face in 10 fresh adult cadavers to identify the SMAS as in the surgical situation. The results show that no SMAS could be detected in any facial regions other than the parotid region. In the parotid region, it is thick and attached to the parotid sheath. However, it becomes very thin, discontinuous, and undissectable in the cheek area. No SMAS can be found in the neck, in which the authors are the first to describe a fascia covering both sides of the platysma. This fascia has close topographical connections to the subcutaneous layers of the adjoining regions. On the basis of these findings, the surgical pathways have to be defined regionally in the face. A "platysma fascia" can be considered as a surgical landmark in the neck. Therefore, the authors conclude that it is not justified to generalize a SMAS as a surgical guiding structure. (*Plast. Reconstr. Surg.* 111: 664, 2003.)

For several surgical disciplines, it is important to know the exact subcutaneous layers of the face and neck. Especially in plastic and reconstructive surgery, a superficial musculoaponeurotic system (SMAS) is generally considered a landmark for subdividing the superficial from the deep region. There are many descriptions of the anatomical situation in these regions, but they are controversial.

The first description of the so-called SMAS was published in 1974 by Mitz and Peyronie,[1] who gave a detailed explanation of it within the parotid and cheek area. Consequently, plastic surgeons have supposed that the skin of the cheeks and the anterior neck region is an interconnected three-layer unit that is composed of the superficial epidermal–dermal layer, the underlying subcutaneous adipose tissue, and a fascial layer beneath. The latter is considered to be composed of connective tissue and skeletal muscle and is generally accepted as a SMAS. This SMAS is thought to have multiple fibrous extensions through the different subcutaneous layers to the skin, allowing them to move together as a unit.[2,3] Conversely, some surgeons do not believe that the subcutaneous layering can be generalized for all the face and neck.[4]

The specific purpose of our study was to investigate the development of the subcutaneous layers in the sternocleidomastoid, buccal, oral, and nasal regions and the region surrounding the platysma. For our study, we used the plastination technique to achieve a preparation with undisturbed topography. Our hypothesis was that the architecture of the subcutaneous connective tissue is typical for each region in the face and neck.

Materials and Methods

We studied the macroscopic and microscopic anatomy of regions in the face and neck

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in 22 fetuses (9 to 24 weeks old; crown-to-rump length, 40 to 229 mm), in three newborn babies, and in three adults. All full-thickness cross sections, inclusive of all tissue from skin to bone, are summarized in line drawings in Figure 1.

The fetal and adult specimens were impregnated and processed with a modified plastination technique according to Fritsch[5,6] and Fritsch and Hegemann.[7] The impregnated specimens were then sectioned with a diamond-wire saw (Well; Mannheim, Germany) in the transverse, coronal, and sagittal planes. The thickness of the sections ranged between 300 and 700 μm. After mounting and polishing, the sections were stained with azure II/methylene blue and counterstained with basic fuchsin.[6] The stained sections were examined and photographed with a microscope (Wild; Heerbrugg, Switzerland).

The three head and neck preparations of the newborns were stored in a 4% formaldehyde solution for at least 3 months. For the sheet plastination procedure, the specimens were frozen at −80°C. They were serially cut with a band saw into sections 3 to 5 mm thick in the transverse plane. The sawdust was carefully removed from the sheets, which were then dehydrated with acetone at −25°C for 5 weeks, defatted in methylene chloride at room temperature for at least 2 weeks, and impregnated with an epoxy resin mixture of Biodur E 12 (G. von Hagens, Heidelberg, Germany).[8] Finally, the sheets were put into a chamber composed of glass plates, filled with epoxy resin, and cured at 50°C.

The technique of plastination histology was chosen to demonstrate all layers from the skin to the bone without shrinkage of the artifacts, which cannot be achieved by any other technique. Collagen fibers stain blue-violet, in contrast to skeletal and smooth muscle fibers, which appear in shades of bluish-green.[6] Because of the thickness of the sections, both small amounts of collagen fibers and large amounts of collagen fibers such as fasciae are easy to distinguish with our technique (azure II/methylene blue, counterstained with basic fuchsin).

In addition, 10 head and neck preparations (20 hemiheads) of fresh adult specimens (mean age, 65 years) were dissected. To identify the SMAS as in the surgical situation, the preparation was performed in the classic way with a temple and preauricular incision. The dissection was performed under loupe magnification (×3.5).

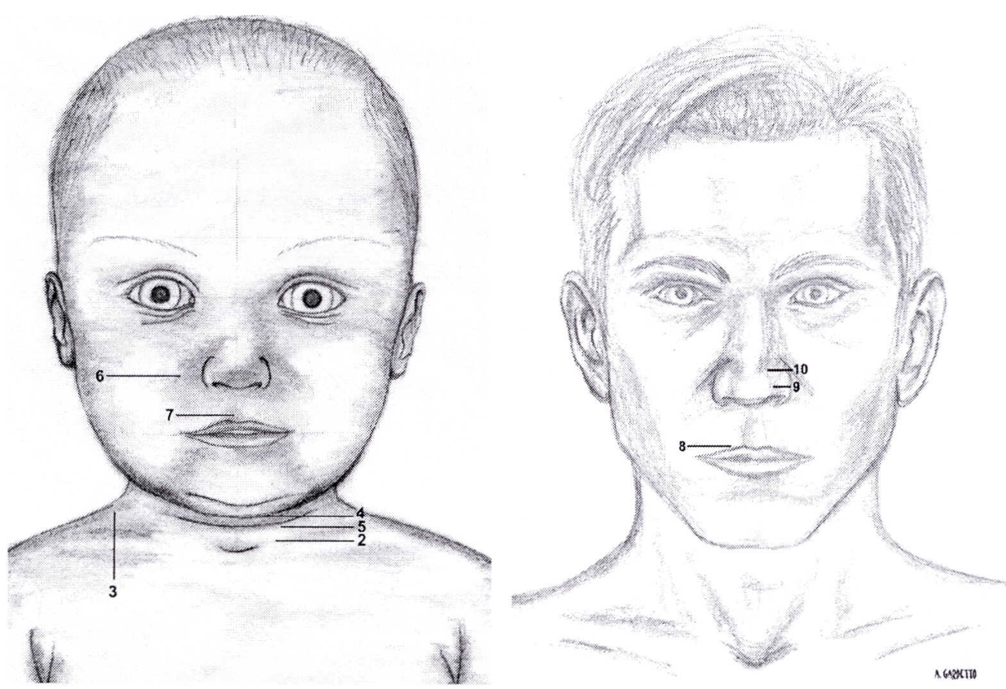

FIG. 1. Orientation of the histologic section taken in the neck and the face of fetuses and newborns (*left*) and adults (*right*). The numbers *2* through *10* correspond to Figures 2 through 10, in which the different numbered sections are exactly described.

Results

Topographic Relationships of the Muscles and Connective Tissue to the Subcutaneous Tissue and Skin

The facial muscles and the platysma are defined as mimic or skin muscles,[9] and their close relations to the subcutaneous tissue and to the skin can be better understood with a detailed knowledge of their development. Therefore, we studied this in the sternocleidomastoid, buccal, oral, and nasal regions.

Sternocleidomastoid Region

In fetuses at 9 to 10 weeks of age, the platysma consists of myoblasts. Around these myoblasts, we recognized an accumulation of mesenchymal cells that we consider to be the precursor cells of the so-called platysma fascia (Fig. 2). Between the platysma and sternocleidomastoid muscle, an additional layer of mesenchyma can be found that is not connected to the platysma fascia.

In 14-week-old fetuses, the platysma is situated directly under layers of the skin; muscle fibers have now differentiated, and they build up a clearly discernible muscle plate. The platysma is separated from the corium by a narrow space filled with loose connective tissue. Within this space, a proliferation of primitive vessels has begun. This is the first sign of the development of the subcutaneous adipose tissue. Furthermore, in this stage of development, a clear morphologic differentiation of the skin, with segmentation into epidermis and corium with sprouting hair roots, can be recognized. The mesenchyma has already been replaced by different sorts of connective tissue (Fig. 3). Connective-tissue septa originating from the platysma fascia, which consists of bundles of collagen fibers, run through the developing subcutis and are connected to the corium (Fig. 3, *right*). The sternocleidomastoid muscle is situated beneath the platysma and is enclosed by the superficial layer of the cervical fascia, which has differentiated at this stage. The fasciae of the platysma and the sternocleidomastoid muscle glide on a small layer of loose connective tissue.

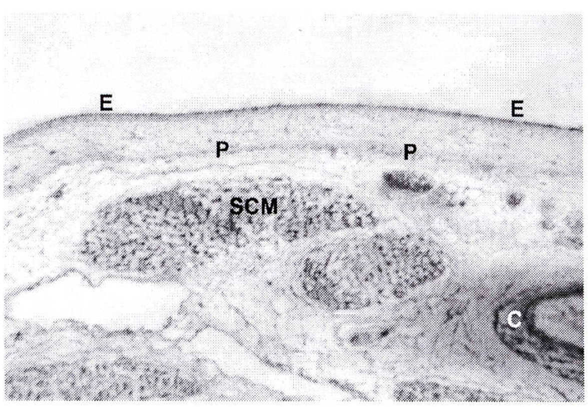

FIG. 2. Transverse section (300-μm) through the sternocleidomastoid region of a 9- to 10-week old fetus cranial to the sternoclavicular joint (×80). *E*, epidermis; *P*, platysma; *SCM*, sternocleidomastoid muscle; *C*, clavicle.

In 20-week-old fetuses, preadipose tissue can be found beneath the corium. The connective-tissue fibers from the platysma fascia present a more septal character and divide the subcutaneous adipose tissue into lobules (Fig. 4).

In the newborn, the layering is identical to that of the 20-week-old fetus. The thickness of the subcutaneous tissue has increased, and the latter has differentiated to adipose lobules (Fig. 5).

The differences between the neck and the facial regions are pointed out in those developmental stages in which they are best discernible, i.e., in the late fetal period and in the newborn.

Buccal Region

In the buccal region, the buccinator muscle represents the base of the cheek and runs to the angle of the mouth. Here, the muscle fibers intermingle with the orbicularis oris muscle. A thick fat pad is situated between buccinator muscle and corium, which has completely differentiated in the newborn. The adipose lobules are separated by strong connective-tissue septa, the fibers of which arise from a thick fascia unsheathing the buccinator muscle. Thus, the two structures are connected (Fig. 6). Some muscle fibers of the platysma irradiate into the buccal region. The platysma itself is accompanied by its fascia, which is rather thin in this region.

Oral Region

This region is characterized by the underlying orbicularis oris muscle. The deep fibers of this muscle insert into the maxilla and mandible and into the skin of the nasal septum. Adjacent to these deep muscle fibers, a broad layer consisting of muscle fibers and connective-tissue fibers can be found. Both are intermingled and directly connected to the corium.

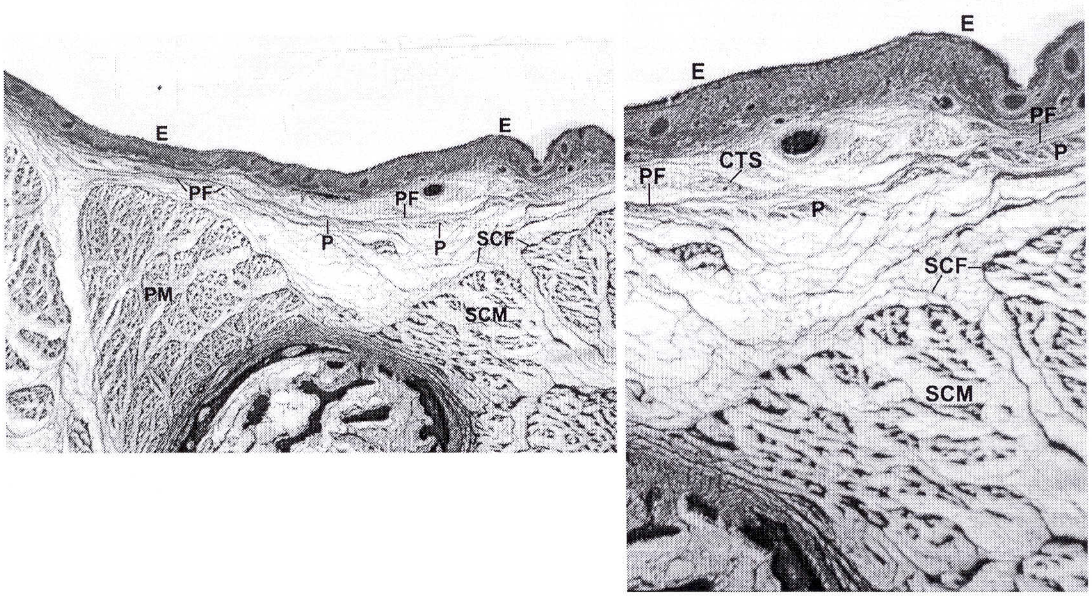

FIG. 3. Sagittal sections (400-μm) through the neck and the upper chest region of a 14-week-old fetus. *Left*, ×50 and *right*, ×80. *E*, epidermis; *PF*, platysma fascia; *P*, platysma; *CTS*, connective-tissue septa; *SCF*, superficial cervical fascia; *SCM*, sternocleidomastoid muscle; *PM*, pectoral muscle.

This strong connection between the muscle and the skin increases with advancing years.

In 24-week-old fetuses, a subcutaneous layer of adipose tissue does not exist. Although in the newborn, no subcutaneous adipose tissue can be demonstrated in the medial area of the oral region, in the lateral area a preadipose tissue is situated in a network that includes muscle fibers and connective-tissue fibers beneath the corium (Fig. 7).

In the adult, subcutaneous adipose tissue can be found in the entire oral region, but it differs in structure from that of other facial regions. No lobules of adipose tissue can be recognized. However, groups of adipose tissue cells are embedded in a crisscross network of muscle fibers and corial connective tissue (Fig. 8). A unique structure is missing in the oral region.

Nasal Region

The skin facial muscle fibers of this region are directly fixed in the corium and in the epidermis. Because of this direct insertion, a unique structuring of the layers does not exist in the nasal region (Fig. 9). The fibers of the nasalis muscle, the levator labii superioris alaeque nasi muscle, and the procerus muscle and several connective-tissue septa separate the subcutaneous adipose tissue in a superficial and a deep layer in the area in which the muscles originate (Fig. 10).

Comparative Cadaver Dissection

After a face-lift type of incision had been performed in the preauricular region, the skin and subcutaneous tissue were totally dissected free. A SMAS could be clearly identified in the parotid–masseterica area, where it is thick and distinct from the fascia of the parotid gland. It is attached to the parotid sheath for approximately 2 or 3 cm and then becomes separated from the parotid sheet. Toward the lower eyelid, a few fine fibers are in continuity with the lateral portion of the orbicularis oculi muscle. In the temporal region and in the cheek area and in all of the other facial regions, it was impossible to identify or to dissect a SMAS. In the upper neck, the SMAS can be elevated in continuity with the platysma muscle, in which it is noted to be muscular, in contrast to the fibromuscular composition in the parotid region. At the medial and caudal border of the parotid gland, branches of the facial nerve are present deep to the SMAS, lying on the surface of the masseter muscle.

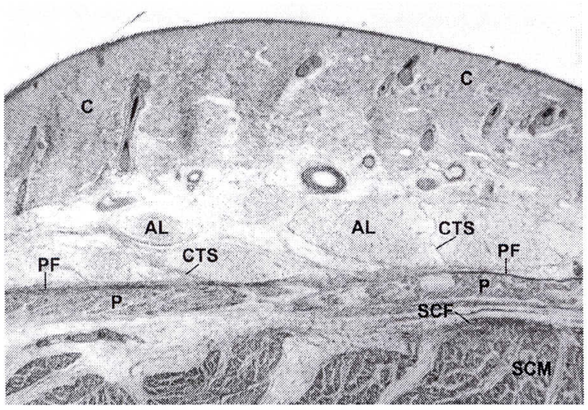

FIG. 4. Transverse section (500-μm) through the left part of the neck of a 20-week-old fetus at the level of the thyroid gland (×40). *C*, corium; *AL*, adipose lobule; *CTS*, connective-tissue septa; *PF*, platysma fascia; *P*, platysma; *SCF*, superficial cervical fascia; *SCM*, sternocleidomastoid muscle.

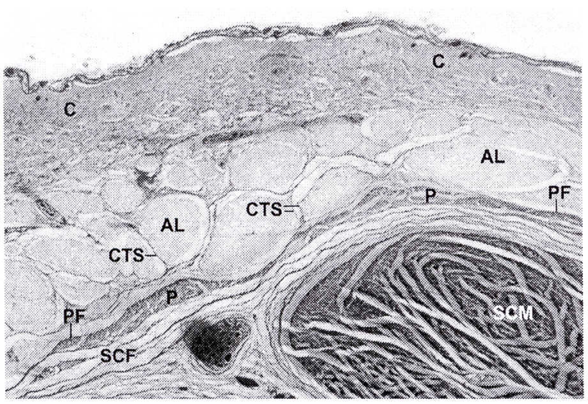

FIG. 5. Transverse section (700-μm) through the sternocleidomastoid region of a newborn (×15). *C*, corium; *AL*, adipose lobule; *CTS*, connective-tissue septa; *PF*, platysma fascia; *P*, platysma; *SCF*, superficial cervical fascia; *SCM*, sternocleidomastoid muscle.

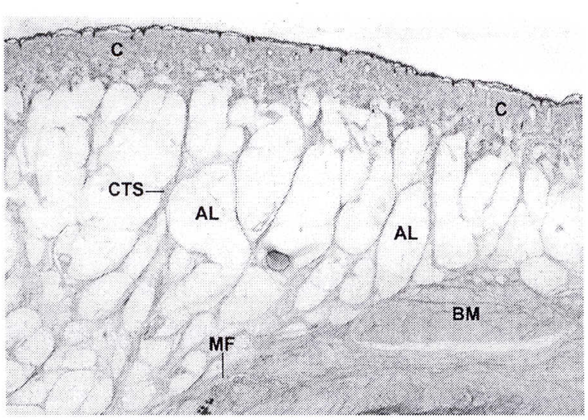

FIG. 6. Transverse section (700-μm) through the buccal region of a newborn (×13). *C*, corium; *AL*, adipose lobule; *CTS*, connective-tissue septa; *MF*, muscle fascia; *BM*, buccinator muscle.

DISCUSSION

In facial surgery, an exact knowledge of anatomical structures is necessary to ensure satisfying postoperative results. Especially in parotid surgery, in facial nerve reconstruction, and in rhytidectomy, a correct preparation of the facial tissue layers determines the success of the surgical intervention.[3,10–16] The SMAS as a guiding structure may be helpful in reconstructive surgery for facial palsy and during face-lifting operations whenever a retrofascial approach is used. Particularly during the dissection from the preauricular region, the SMAS prevents necrosis in the skin and subcutaneous tissue. In addition, a general view of the lateral facial region without the risk of damaging nerves and vessels is gained. Therefore, the SMAS has to be identified correctly in the parotid region.

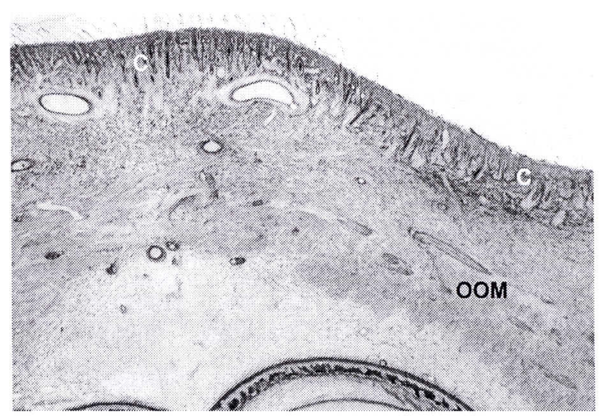

FIG. 7. Transverse section (600-μm) through the upper lip of a 24-week-old fetus (×17). *C*, corium; *OOM*, orbicularis oris muscle.

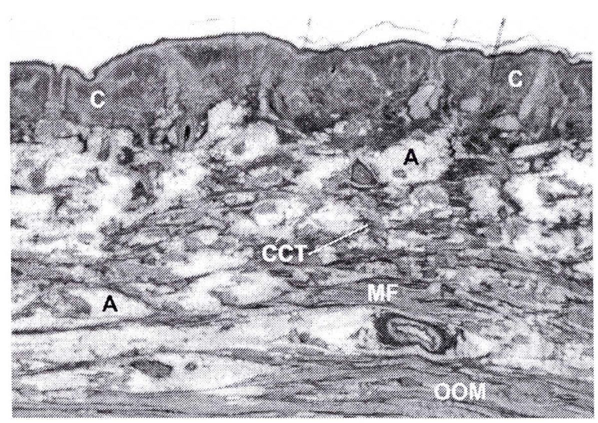

FIG. 8. Transverse section (700-μm) through oral region of an adult (×28). *C*, corium; *A*, adipocytes; *CCT*, corial connective tissue; *MF*, muscle fibers; *OOM*, orbicularis oris muscle.

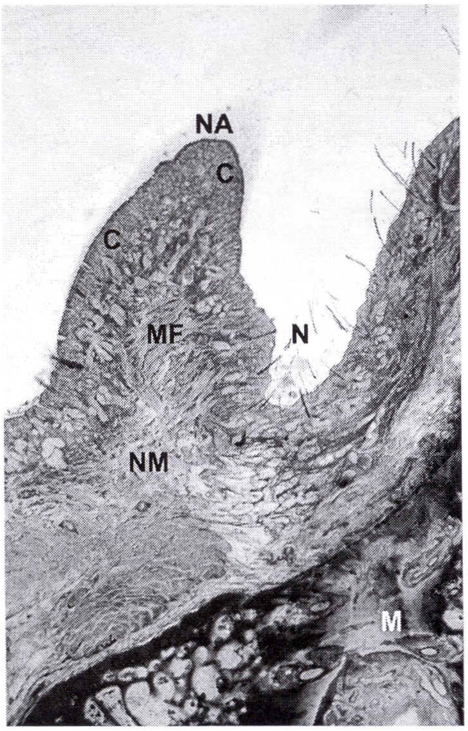

FIG. 9. Transverse section (500-μm) through the left nasal ala of an adult (×8). *NA*, nasal ala; *N*, nostril; *C*, corium; *MF*, muscle fibers; *NM*, nasal muscle; *M*, maxilla.

In plastic and reconstructive surgery of the face, the SMAS and, in the neck, the platysma, are considered landmarks for dividing the superficial from the deep subcutaneous region. In particular, the existence of the SMAS is not always clear. Even Mitz and Peyronie[1] knew that what is safe in the parotid area might be dangerous in the area anterior to the parotid gland. A number of anatomical discrepancies still exist, especially with respect to the terminology defining the subcutaneous layers in face and neck, and an exact topography of the fascial layers in the clinically relevant areas is still lacking.

Platysma Fascia

In the present study, we investigated the development of the subcutaneous layers in the neck and face and compared different regions. To the best of our knowledge, we are the first to demonstrate the development of a fascia surrounding the platysma, and we point out the topographic connections to the adjoining regions. The platysma has been described to be a skinlike muscle of the neck that does not possess its own fascia.[9,17,18] This muscle is proposed either to lie on the cervical fascia[9] or to come into relationship to it.[19] Grodinsky and Holyoke[20] and Poulsen[21] postulated that the platysma is settled in the superficial fascia. However, our results show that its muscular fascia develops around the platysma during prenatal life independently of the cervical fascia (Fig. 2). Histologic study of this fascia shows that the structure of this connective-tissue layer is comparable to the connective-tissue layer building up the cervical fascia. Therefore, the name platysma fascia seems to be justified.

Our results show that it is important to look at the early fetal development of this fascia, in which an individual layer of mesenchyma surrounds the platysma. Because there are no connections with the underlying superficial layer of the cervical fascia until week 20 of fetal development, it can be assumed that the platysma fascia undergoes an individual development. In later stages, topographical connections to the adjoining fasciae develop. As to the position of the platysma with regard to the subcutaneous tissue, our findings correspond to the literature.[20] The platysma, accompanied by its fascia, divides the subcutaneous tissue at the neck into two layers. However, the connective tissue surrounding the platysma can clearly be distinguished from the loose connective tis-

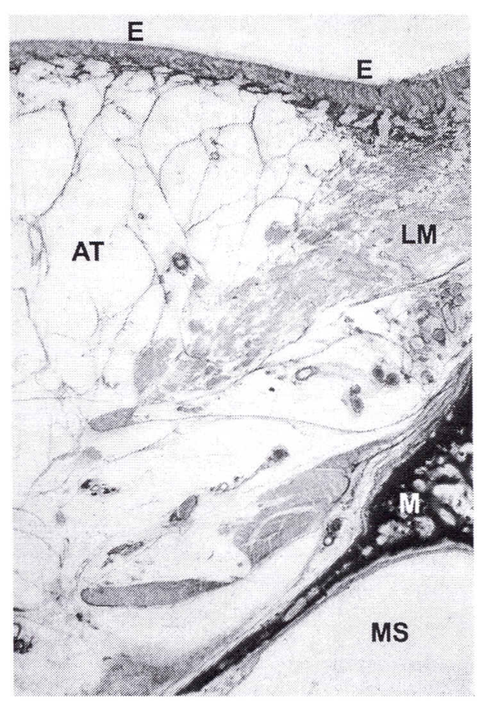

FIG. 10. Transverse section (500-μm) through the left inferior concha nasalis of an adult (×6). *E*, epidermis; *AT*, adipose tissue; *LM*, levator muscle (levator labii superioris alaeque nasi muscle); *M*, maxilla; *MS*, maxillary sinus.

sue and from the adipose tissue forming the subcutaneous layers. Thus, a description of platysma fascia is useful.

Subcutaneous Layer in the Face and Neck

According to Mitz and Peyronie,[1] the SMAS is intimately associated with the entire superficial fascia of the neck and head. It is considered to be a subdivider of the subcutaneous adipose tissue, and it acts as a distributor of all facial musculature contractions to the skin.[3] Furthermore, it is believed to be stretched by the platysma inferiorly and by the superficial temporal muscle, the external part of the frontal muscle, and the orbicularis oculi muscle superiorly[1,3,22] (Fig. 11). Thaller et al.[23] and Jost et al.[24] described the SMAS as a primitive platysma muscle, being a large muscle sheet that covers the neck and the lower part of the face. It degenerates during evolution and therefore is called fibrous platysma.

Thaller et al.[23] distinguished the SMAS from the superficial cervical fascia, whereas Rees and Aston[25] considered it a part of this fascia. Some authors, however, claimed the SMAS to be the superficial cervical fascia itself.[1,19,26] Apart from the existence of the SMAS within the lateral region of the face, a SMAS is described for the nose[27] and in the area of the upper lip.[28]

In the present study, we investigated the subcutaneous layers in the face and in the neck and compared the two. We have found regional differences that can be summarized as follows.

In the sternocleidomastoid region of the neck, connective-tissue fibers run from the platysma fascia through the subcutaneous tissue toward the corium (Fig. 12). In this region,

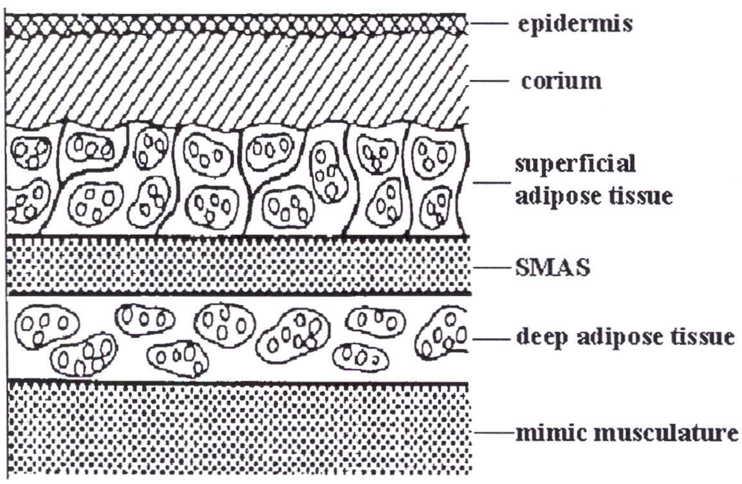

FIG. 11. The subcutaneous layers described by Mitz and Peyronie [The superficial musculo-aponeurotic system (SMAS) in the parotid and cheek area. *Plast. Reconstr. Surg.* 58: 80, 1976].

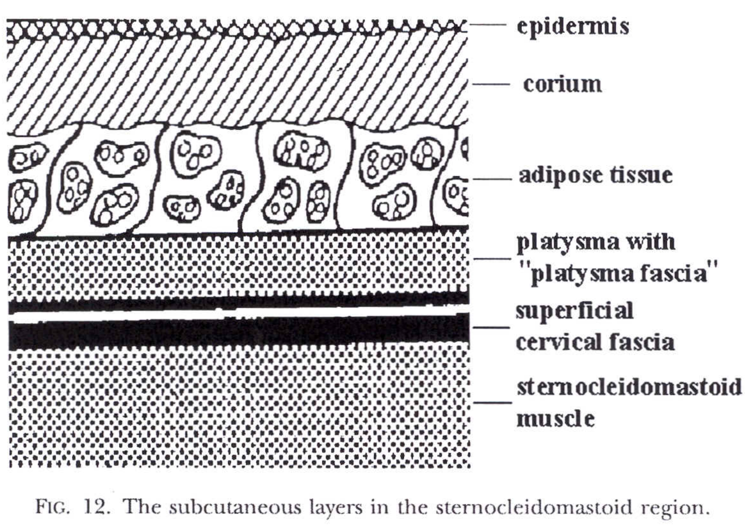

FIG. 12. The subcutaneous layers in the sternocleidomastoid region.

a deep adipose tissue layer is missing. Thus, the criteria of a SMAS, as described by Mitz and Peyronie,[1] are not fulfilled. In the buccal region of the face as well, connective-tissue fibers run from a strong fascia that overlies the buccinator muscle through the subcutaneous tissue toward the corium. A SMAS does not exist (Fig. 13). Furthermore, we have shown that in the region of the lip, the connection between the facial muscle and the corium is quite different from that in the lateral regions of the face. Whereas the deep muscle fibers of the orbicularis oris muscle run nearly parallel, the superficial muscle fibers insert directly into the corium. Thus, a differentiation of separate layers in the oral region is as impossible as a differentiation of a SMAS (Fig. 14). In the nasal region, the situation of the subcutaneous layers resembles the situation in the oral region.

Our results show that no SMAS exists in any of the described regions, which agrees with the basic criteria of Mitz and Peyronie. The comparative anatomy dissection on fresh cadavers, however, corroborates the contention that a SMAS exists in the parotid region. In this region, the SMAS is thick, whereas it becomes very thin and discontinuous in the cheek area, and it is impossible to identify or to dissect it, even by microsurgical technique. In concordance with Gosain et al.,[22] there is no evidence of continuity between the SMAS and the temporoparietal fascia, but in contrast, in the lower eyelid there is a continuity only with the lateral portion of the orbicularis oculi muscle. Based on our findings, we have sufficient rea-

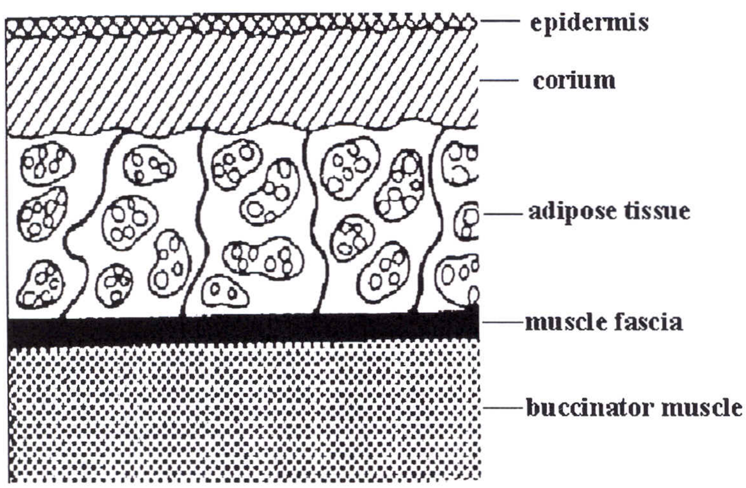

FIG. 13. The subcutaneous layers in the buccal region.

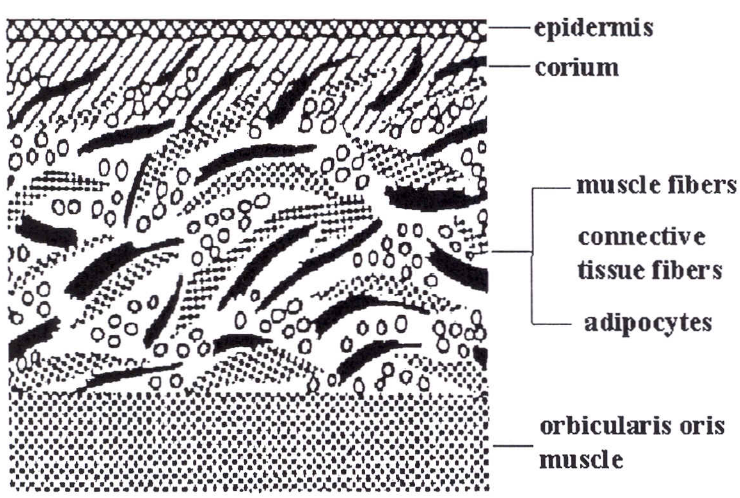

FIG. 14. The subcutaneous layers in the oral region.

son to redefine the superficial topography of the face and neck as described above.

We conclude that it is not justifiable to generalize a SMAS for all regions in the face and neck. On one hand, the platysma is considered the cornerstone of the SMAS, and on the other, the SMAS is defined as being in continuity with the platysma, including muscle fibers.[1,16,22] By this interpretation, the SMAS in the neck could be defined as the platysma with platysma fascia.

Functional Considerations

The described differences of insertion between the so-called skin muscles and the surface may have functional significance for the transmission of the muscular contractions to the skin. A fascia indirectly transfers the muscular contraction through septa to the skin. In the region of the lip and nose, a fascial layer does not exist. However, muscle fibers coalesce directly with the connective tissue of the corium, so that a direct transfer of the muscular contraction to the skin results.

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