Facelift: History and Anatomy

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KEYWORDS

• Facelift • SMAS • Facial nerve • Retaining ligaments

KEY POINTS

- The facelift operation significantly evolved in the past 50 years. This is mainly due to the better understanding of the complex 3-dimensional anatomy of the face. An understanding of the facial anatomy is critical for any surgeon planning a facelift.
- The description of the SMAS (superficial musculoaponeurotic system) by Mitz and Peyronie was a keystone in moving the facelift operation to the next level.
- The SMAS, galea aponeurotica, frontalis muscle, superficial temporal fascia, and platysma are all considered to be in the same plane of dissection.
- The facial nerve branches are always 1 layer deeper to the SMAS. They remain covered by the deep fascia until they exit to supply their target muscle.
- Releasing the retaining ligaments is an essential step in achieving a powerful facelift result. Understanding the anatomy of the retaining ligaments, especially as they relate to the facial nerve is key.

The fear of Surgery is the fear of Anatomy
—Ian Taylor.

INTRODUCTION

Despite the introduction of numerous nonsurgical techniques, facelift surgery remains the cornerstone of facial rejuvenation, the most powerful and durable method for correction of the facial aging process. This operation significantly evolved in the past 50 years. superficial musculoaponeurotic system (SMAS) manipulation, using either superficial plication techniques or SMAS elevation and reanchoring, is thought to be critical to success. Hence, an in-depth knowledge of the 3-dimensional anatomy of the facial layers will minimize misadventures. Controversies exist regarding the best approach to the neck during facelift surgery, with one school of thought favoring the anterior approach and the other a posterior approach.

HISTORY

Skoog[1] initiated the era of modern facelift surgery by raising a cervicofacial flap deep to the platysma in the neck and the superficial fascia in the face. Further understanding of the anatomy of the SMAS,[2] retaining ligaments,[3] and the danger zones[4] contributed to the evolution of the facelift operation. Hamra[5] and Barton[6,7] modified Skoog's[1] initial operation and likewise used a composite skin and SMAS flap in their deep plane and composite facelifts.

Owsley,[8,9] Connell,[10,11] Aston,[12] and Stuzin and colleagues[13] separated the skin from the SMAS in a bilamellar approach, to maximize vector control, despite the loss of enhanced blood supply provided by the Hamra[5] approach and the risk of potentially tearing the SMAS flap. Baker[14] and Tonnard and colleagues[15] later described the short scar and minimal access cranial suspension facelift techniques, respectively.

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The introduction of endoscopy[16] and limited incision foreheadplasty[17] allowed forehead rejuvenation and browlift surgery to be added to the facelift operation with smaller incisions and minimal scar problems. Direct outcome comparison of these techniques to the other approaches are, however, lacking.

Other adjuncts to facelift surgery have enhanced the surgical result. This includes lipofilling, a technique popularized by the work of Coleman[18] and others,[19–21] skin resurfacing, facial implants, and lip-lifting techniques.

Skin resurfacing, whether mechanical (dermabrasion, microneedling), chemical, or energy based (lasers), leads to improvement in the quality of the skin.[22–24] Standard CO_2, fractional CO_2, erbium laser, and chemical peels have their advocates. Although full-face laser resurfacing at the time of facelift has been documented to be safe by several investigators, others recommend simultaneous peeling on nonundermined areas only.[25–28]

SURGICAL ANATOMY OF THE FACELIFT

Layers of the Face

Similar to the scalp, the face is also designed in layers. The 5 layers of the scalp, and their correspondent layers in the face are skin (layer 1), subcutaneous tissue (layer 2), galea aponeurotica (layer 3, SMAS), loose areolar tissue (layer 4, retaining ligaments and spaces), and periosteum (layer 5, deep fascia).[29] The loose areolar tissue in the scalp allows the gliding of the more superficial layers onto the deeper fixed layers (periosteum or deep temporal fascia).

The SMAS invests the muscles of facial expression and thus is necessarily a mobile structure that needs to glide on the deeper fascia. The SMAS is intimately adherent to the deep fascia in the nonmobile areas of the face, as well as in areas of ligamentous attachment or areas of fusion of the superficial and deep fascia. Although areas of dense attachments have traditionally been described as retaining ligaments (zygomatic, masseteric, mandibular), Pessa has more recently suggested that these areas represent fusion zones between the superficial and deep fascia.[29,30,31]

The deep fascia is a cranial extension of the deep cervical fascia in the neck, and corresponds to the periosteum cephalad, and the deep temporal fascia in the temple area. The proximal facial nerve branches lie deep to this fascia as they exit the parotid, making it an important landmark in facelift surgery. Of note, the plane under the deep fascia in the anterior face also contains the parotid duct and the buccal fat pad.

The Superficial Musculoaponeurotic System

The SMAS (layer 3) is a well-defined structure over the lateral face; in this area it is nonmobile and fixed to the parotid gland. The SMAS thins out as it extends medially into the cheek area and lower face. In the lower face, it tends to be more muscular, as it is in fact the cranial continuation of the platysma[2] (**Fig. 1**). The challenge in the 2-layered dissection of Marten and Stuzin is to avoid tearing of the distal SMAS during elevation.[30,32]

According to Stuzin and colleagues,[30] the SMAS invests the superficial mimetic muscles. It continues as the superficial temporal fascia in the temple area and is analog to the galea in the scalp. The SMAS is part of the superficial fascia that forms a continuous sheath throughout the head and neck area.[30]

Retaining Ligaments and Septa

The concentric layers of the face are supported in position by a series of retaining ligaments, or areas of fusion between superficial and deep fascia, that run from the deeper (fixed) structures to the dermis. The origin of the retaining ligaments can be from bone, and hence are called osteocutaneous ligaments (zygomatic and mandibular cutaneous ligaments are examples), or from confluences of the superficial and deep fascia, like the masseteric cutaneous ligaments[30] (**Fig. 2**).

The retaining ligaments or areas of fusion run in close proximity to the facial nerve branches, thus an understanding of their anatomy is critical in delivering a safe procedure.

The main zygomatic and upper masseteric retaining ligaments are located at a mean distance

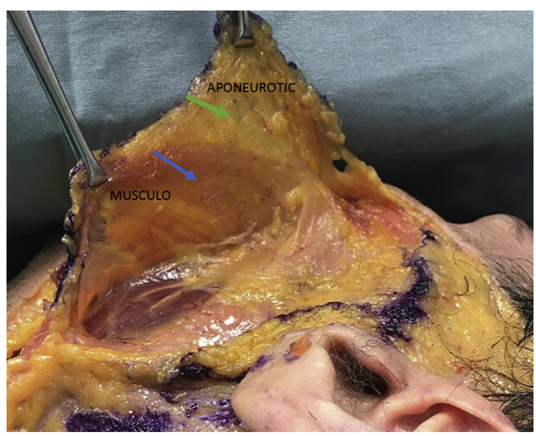

Fig. 1. Cadaver dissection of the left face. The skin has been raised and resected. The SMAS layer is raised. The SMAS is muscular (*blue arrow*) in the lower face and aponeurotic (*green arrow*) further cephalad.

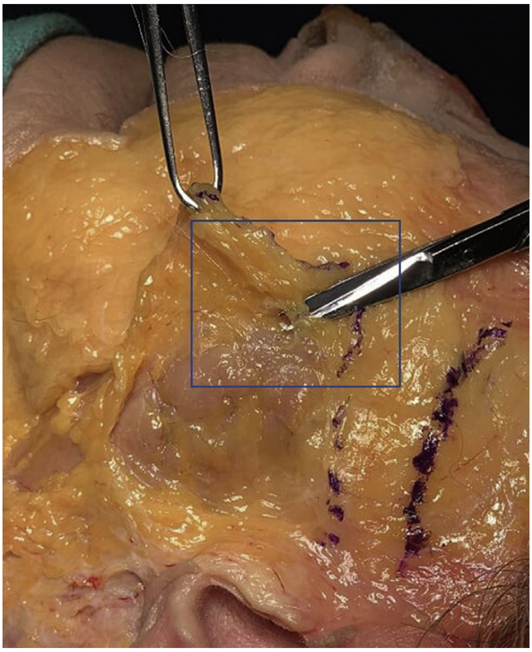

Fig. 2. Cadaver dissection showing the zygomatic retaining ligament at the inferior border of the zygomatic arch.

of 44.91 ± 9.72 mm and 46.35 ± 8.34 mm from the tragus.[4] The mandibular osteocutaneous ligament (MOCL) is the counterpart of the zygomatic retaining ligament in the lower face area. Our cadaver dissections found the MOCL to be at 56.2 ± 3.1 mm from the gonial angle along the mandibular border and 9.3 ± 1.6 mm superior to it.[33]

The platysma-mandibular ligament (PML) was described by Feldman and others,[3,33–35] and according to our cadaver dissections, is found at the anterior inferior border of the mandible.[33] The distal marginal mandibular nerve lies just superior and medial to it as it innervates the depressor anguli oris.

As mentioned earlier, the masseteric cutaneous ligaments are described as planes of fusion between the SMAS and the masseteric fascia.

Septa are defined as longitudinal lines of attachment of superficial tissue to bone or deep fascia. The superior temporal septum represents the fusion of the deep temporal fascia to the periosteum at the cranial border of the temporalis muscle. The superior temporal septum terminates at the lateral corner of the orbital rim, an area termed the temporal ligamentous adhesion.[36] The inferior temporal septum can be found extending from the superior lateral corner of the orbital rim to the external auditory canal and more importantly, the frontal branch of the facial nerve and sentinel vein are found caudal and parallel to it. This anatomy is essential for the surgeon performing a brow lift operation[36,37] (**Fig. 3**).

The orbicularis retaining ligament (ORL), also known as the orbitomalar ligament, is a circumferential structure around the orbit that functions as an anchor of the orbicularis muscle and its overlying tissue to bone[38] (**Fig. 4**). Varying degrees of release of the ORL is critical in procedures designed to blend the lid-cheek junction as well as to access the midface through the lower eyelid incision.[11] Detailed anatomy concerning the lower eyelid rejuvenation as well as forehead rejuvenation are beyond the scope of this article.

Facial Nerve

As they exit the parotid gland, facial nerve branches lie deep to the parotid-masseteric fascia. They stay deep to this fascia and they exit into a sub-SMAS cleavage plane to innervate the undersurface of their target muscles, except 3 muscles: levator anguli oris, buccinator, and mentalis, which are innervated on their outer surface. Facial nerve branches pass through this cleavage plane distal to the retaining ligaments. Therefore, until the ligaments are encountered, nerve branches are relatively deep and out of harm's way. The frontal and marginal mandibular branches have fewer interconnections with the other branches of the facial nerve and hence pose a clinical problem if injured. Although injury

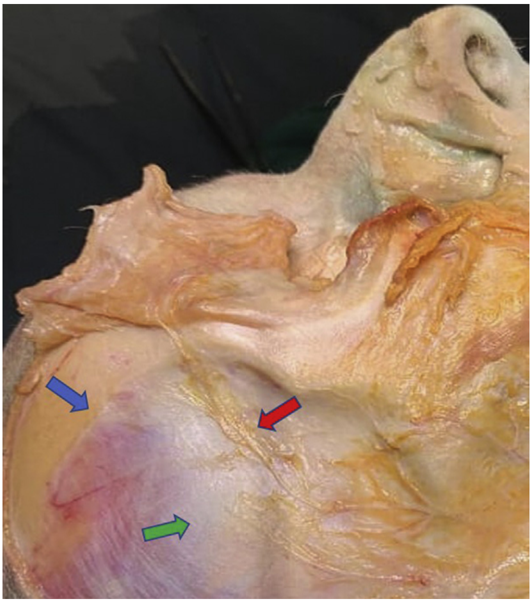

Fig. 3. Dissection of the right face. Blue arrow: Superior Temporal line. Green arrow: inferior temporal line. Red Arrow: Frontal branch of the facial nerve.

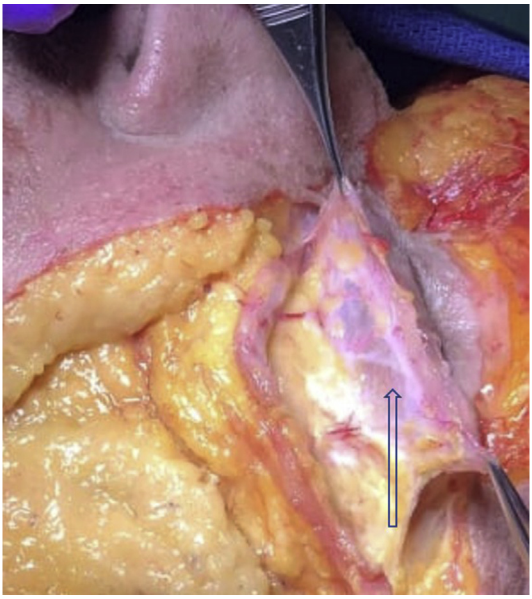

Fig. 4. Dissection of the left face. Arrow pointing at the ORL.

to the zygomatic and buccal branches can affect the patient's smile, these 2 branches have multiple interconnections making this clinically adverse outcome unlikely.[4,30]

The frontal branch anatomy as it relates to the facelift operation has been extensively studied. The original article by Pitanguy and Ramos[37] describes 4 variations in the branching pattern of the nerve. The investigators note that the direction of the "temporofrontal" branch was constant along a line projected on the skin from a point 0.5 cm below the tragus to a point 1.5 cm above the lateral "extremity of the eyebrow" (**Fig. 5**).[37]

Alghoul and colleagues[4] studied the sub-SMAS danger zone and detailed a safe passageway between the main zygomatic retaining ligament and the upper masseteric cutaneous ligament.[4] The upper zygomatic branch of the facial nerve was found consistently to be located deep to the upper third of the zygomatic major muscle and in the sub-SMAS dissection plane. The inferior zygomatic branch passes inferior to the upper masseteric ligament or at times penetrates its inferior margin. The masseteric ligaments act as sentinels to the zygomatic branches, hence the term "sub-SMAS danger zone."[4] This particular anatomy is extremely useful not only when raising the SMAS, but also when engaging maneuvers that address elevation of the malar fat pad.

The marginal mandibular nerve (MMN) has been well studied, especially as it relates to the facial artery.[39] It has on average 2.1 branches and exits the parotid gland within 1 to 2 cm of the gonial angle (**Fig. 6**). After exiting the parotid gland, the nerve crosses the facial vessels at 23.1 mm from the gonial angle along the mandibular lower border and 3.1 mm superior to it, remaining deep to the parotid-masseteric fascia. Distal to the facial vessels, the MMN is invariably found to be cranial to the lower border of the mandible, whereas before

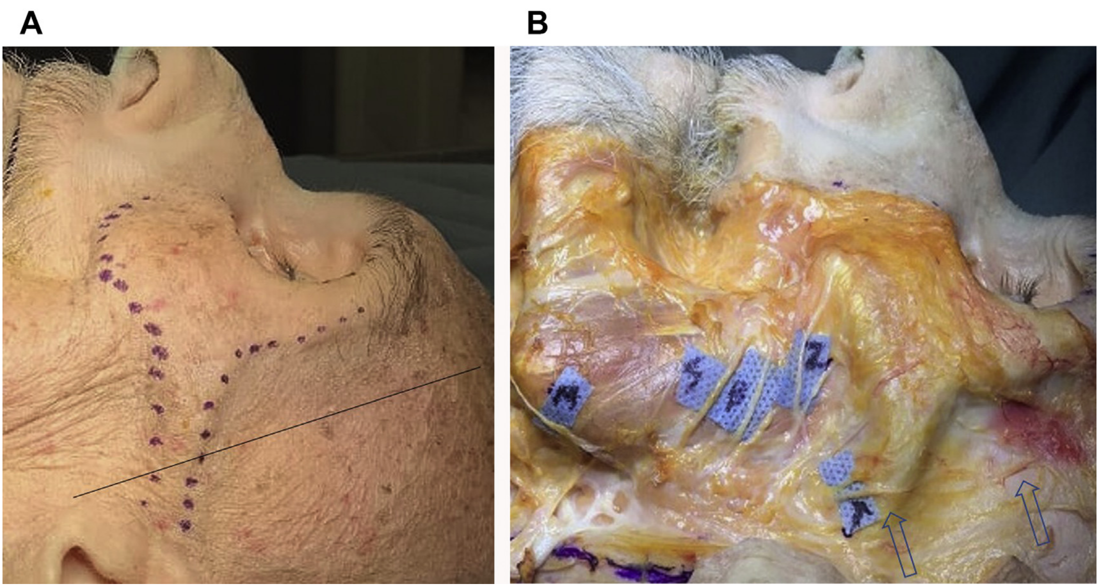

Fig. 5. (*A*) The Pitanguy line describes the course of the frontal branch: 0.5 cm inferior to the tragus to 1.5 cm superior to the eyebrow. (*B*) Left side facial nerve dissection with arrows pointing to the frontal (T) branch. B, buccal branch; M, MMN; S, stenson duct; T, temporal (frontal) branch; Z, zygomatic branch.

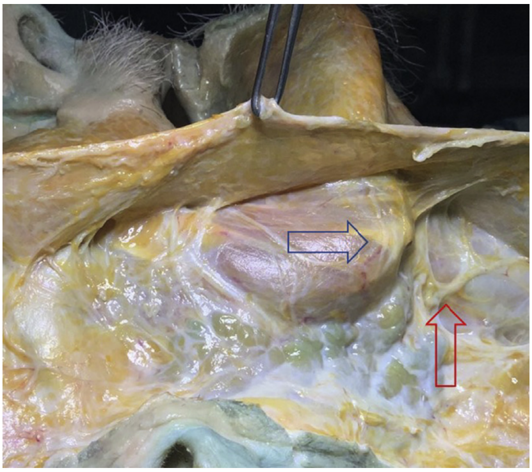

Fig. 6. Dissection of right face. Blue arrow points to the MMN. Red arrow points to the cervical branch.

it crosses the facial vessels, it is located cranial to the mandibular border 80% of the time.[33] Further distally, the MMN supplies the depressors of the lower lip.

The cervical branch supplies the platysma muscle, which is also a depressor of the corner of the mouth. An injury to the cervical branch can be differentiated from an MMN injury by asking the patient to pucker/evert his or her lower lip. If lower lip eversion is possible, this suggests that the marginal mandibular nerve is intact because the MMN innervates the mentalis (see **Fig. 6**). The cervical branch exits the parotid gland within 1.5 cm of the gonial angle, is under the deep investing fascia only briefly, and changes to the sub-platysmal plane. It branches into multiple rami 1.75 cm, and the most caudal branch lies 4.5 cm caudal to the lower mandibular border.[40,41]

Spaces

The complex 3-dimensional design of the SMAS and other related structures is in part responsible for the intricate nature of facial expression. This complexity accommodates, as described by Mendelson, the delicate balance “between the simultaneous needs for mobility and stability”.[42] Stability is provided by the retaining ligaments of the face, responsible for binding the soft tissues of the face to either bone or deep fascia. As the facial nerve branches pass from deep to superficial, they stay in proximity with these ligaments, providing areas of stability and protection. In-between the retaining ligaments are spaces that facilitate mobility. They represent gliding planes that facilitate independent movements of the perioral and periorbital soft tissues.[43]

The prezygomatic space (PZS) is a glide plane space located over the body of the zygoma. It is triangular and bounded superiorly by the ORL and inferiorly by the zygomatic retaining ligaments. The roof of the PZS is formed by the orbicularis muscle (orbital part) and the floor is consistent with a layer of periperiosteal fat. Also, located in the floor of this space are the origins of the zygomatic major and minor muscles. There are no facial nerve branches inside this space[42] (**Fig. 7**).[17]

The preseptal space is located cranial to the prezygomatic space. The 2 spaces are separated by the ORL (see **Fig. 7**). This space provides a bloodless access to the lower eyelid.

The premaxillary space (PMS) is another bloodless gliding rectangular space overlying the maxilla. The floor of the PMS is formed by the levator labii superioris. The roof of the PMS is formed by the orbicularis oculi (orbital part) and the cheek SMAS. The upper boundary of the PMS is the ORL, whereas the lower boundary is formed by the maxillary ligaments (upper most part of the nasolabial fold at the level of the alar base).[16]

ANATOMY OF THE NECK

The neck represents an important component of the facial aging process. Therefore, neck correction is critical to a successful facelift operation. The following structures require evaluation in every planned neck rejuvenation procedure: (1) fat compartments, (2) platysma, (3) retaining ligaments, (4) digastric muscle, (5) submandibular glands, and (6) great auricular nerve (**Fig. 8**).

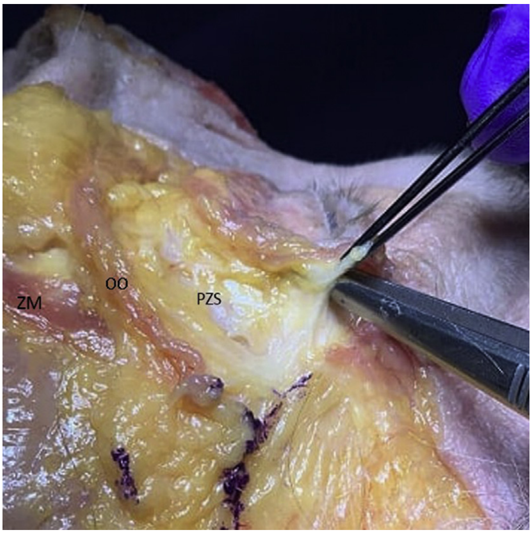

Fig. 7. Dissection in the left side of the face. The prezygomatic space is exposed through its roof (OO muscle split). Notice the surgeon entering the preseptal space with a pair of forceps.

Fat Compartments

There are 3 fat compartments in the neck: (1) superficial (supraplatysmal, which is between the skin and the platysma muscle), (2) intermediate (subplatysmal: between the platysma and the anterior digastric muscles as well as the interval between the platysma muscles), and (3) deep (deep to the digastric and submandibular glands).[44] Larsen and colleagues and Gassman and colleagues[34] showed that the superficial/supraplatysmal fat is the most abundant fat in the neck.[44] This fat is dense in nature medially and becomes less compact in the lateral aspects. The intermediate compartment contains the next greatest amount of fat. This fat is dense and fibrotic, as well as rich with blood supply and lymph nodes.[45,46] Finally, a minimal amount of fat is found in the deep compartment, and it has no clinical relevance from a neck rejuvenation standpoint.[44]

Platysma Muscles

The platysma muscles are thin sheets that originate from the clavicles and extend cranially into the SMAS (see **Fig. 1**).[2] The platysma muscles have 3 anatomic variations: type I (75%), both muscles decussate for 1 to 2 cm inferior to the symphysis menti; type II (15%), both muscles decussate from the symphysis menti all the way to the thyroid cartilage; and type III (10%), the muscles do not meet at any point in their course.[35] Platysma laxity develops with age and tends to be most troublesome in thin necks and in patients following massive weight loss. Platysma tightening in this patient group is essential for adequate neck correction. Recurrent platysmal banding is a frequent adverse sequelae in this patient group.

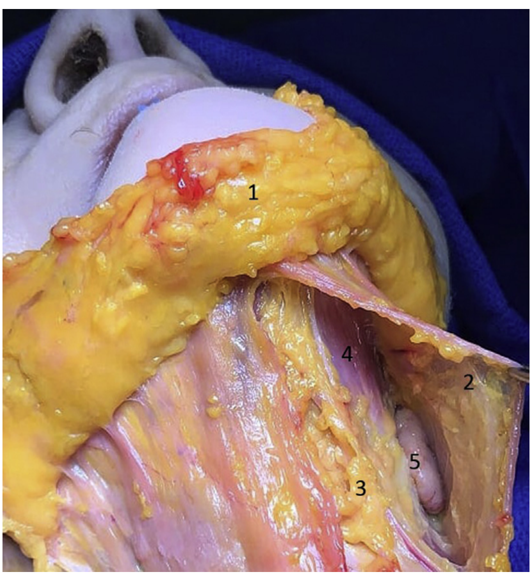

Fig. 8. Neck dissection showing the important structures to be assessed in modern neck rejuvenation surgery: 1, superficial fat (lifted up); 2, platysma; 3, subplatysmal fat; 4, digastric muscle; 5, left submandibular gland.

Retaining Ligaments and Filaments

Joel Feldman[3] provides one of the best descriptions of the retaining ligaments and filaments of the neck. According to Feldman,[3] there are 6 ligaments in the neck: mandibular, submental, mastoid-cutaneous, platysma-auricular/ear lobe, lateral sternomastoid-cutaneous, and PMLs. There are 3 filaments: medial platysma-cutaneous, medial sternomastoid, and skin crease-platysma. These ligaments and filaments hold the neck skin in place. In addition to these ligaments and filaments, there are 3 structures that attach the platysma to the deeper structures: hyoid ligament, paramedian platysma ligament, and submandibular ligament.[35] The PML has been studied extensively, and Feldman[3] describes this ligament's course as inferior-lateral to the MOCL.[35] Rohrich more recently described the mandibular septum in a location similar to the PML.[21] We believe that these 2 structures are the same.[33,34] In our cadaver studies, the PML was found consistently at the anterior border of the masseter muscle (45.6 mm from the gonial angle along the border of the mandible).[33] Located at the anterior inferior border of the mandible, it heralds the location of the distal MMN that lies immediately superior to it.[33]

Furnas[47] described the platysma-auricular ligament as a condensation of fascia that extends from the posterior edge of the platysma to the dermis of the ear region. Feldman describes 2 different ligaments holding the ear lobe downward: the platysma-auricular and the earlobe ligaments.[3] These attachments serve as a landmark to the location of the great auricular nerve, as well as the posterior edge of the platysma. In fact, some branches of this nerve can be found on the surface of this ligament or interwoven within its fibers.[3]

The Digastric Muscles

When prominent, the anterior bellies of the digastric muscles can be partially or completely resected to help with the neck contour. This can lead to deepening of the cervicomental angle secondary to the unopposed pull of the hyoid retractors.[48]

The digastric muscles are essential in understanding the anatomy of the neck, as they are part of the submental as well as the submandibular triangles.[45] The hyoid forms the inferior border of the submental triangle, whereas the anterior bellies of the digastrics form its superolateral edges. The symphysis menti forms the apex of the submental triangle, and the mylohyoid muscle is its floor.[49]

The submandibular triangle is formed by both the anterior and posterior bellies of the digastric and the lower edge of the mandible (superior margin). This triangle hosts the following important structures: submandibular glands, facial vessels, lingual nerve, and MMN. Thus, a thorough understanding of this anatomy is key when planning a neck rejuvenation procedure, especially those involving submandibular gland resection.[50]

Submandibular Glands

The submandibular glands, when prominent, can contribute to bulges or irregularities of the neck/jawline and hence affect the aesthetic outcome. This is especially true after the skin is tightened and aggressive neck defatting is performed in thin necks. The gland is invested by the deep cervical fascia, and is composed of superficial and deep lobes that lie superficial and deep to the mylohyoid muscle respectively.[51] The superficial lobe is the larger of the 2 and is the one partially resected during surgery.[45,49]

Singer and Sullivan[52] studied the anatomy of the submandibular gland and its relation to the important nearby neurovascular structures in 15 fresh fixed cadavers. The MMN was located external to the gland capsule and 3.7 cm cephalad to the inferior margin of the gland. The lingual nerve crosses the submandibular gland duct anteriorly and is located under the mandibular border. The vascular anatomy is variable, with on average 1.5 vessels entering the superficial lobe medially, 1 intermediate vessel also entering medially to supply both the superficial and deep lobes, and 1 central vessel entering centrally from the deep lobe to the superficial lobe.[51]

Mendelson and Tutino[53] described their experience in submandibular gland resection in 112 patients. They report major complications in 1.8% of patients requiring reoperation for significant hematomas (1 potentially fatal). Minor complications were reported at 10.8% (managed nonoperatively). The most frequent complications were submandibular sialocele (4.5%) and marginal mandibular neurapraxia (4.5%), and all were resolved by 3 months. In their series, no patient reported a permanent dry mouth.[52]

Resection of the submandibular gland for aesthetic reasons remains an area of debate. Those who are against it believe it places many important structures at risk. Others believe that it is critical to a successful neck rejuvenation.[54,55]

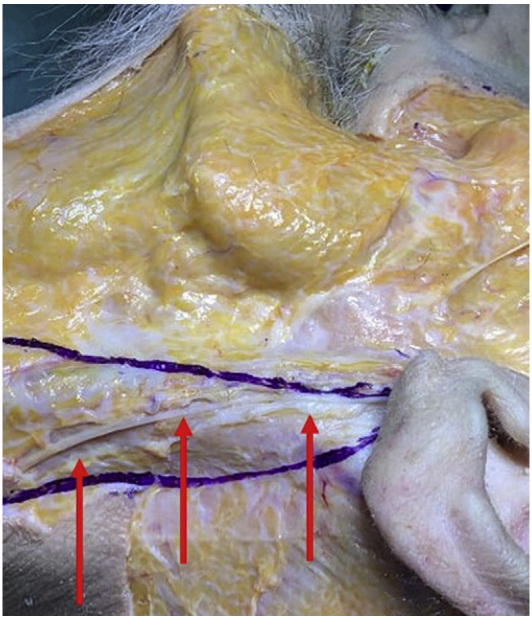

Fig. 9. Dissection of the left side of the face. Shown is the great auricular nerve (*red arrows*) within the boundaries of the Ozturk triangle.

Great Auricular Nerve

The great auricular nerve is reportedly the most frequently injured nerve during facelift surgery. The hyperesthesia that results from its injury usually resolves. However, problems from nerve entrapment or neuroma formation can be debilitating. McKinney and Katrana[56] located the nerve 6.5 cm inferior to the external acoustic meatus at the midbelly of the sternocleidomastoid muscle.

Ozturk and colleagues[57] described a failsafe method to avoid injury to the great auricular nerve during rhytidectomy (**Fig. 9**). This method relies on defining the danger zone of the great auricular nerve early in the facelift operation. This zone is defined by a vertical line perpendicular to Frankfurt horizontal plane, bisecting the lobule of the ear, and another arm extending posteriorly at 30°.[54]

SUMMARY

The signs of aging that affect the face, such as deepening of the nasolabial folds, formation of marionette lines and jowls, and sagging of the midface area, are all related to the 3-dimensional anatomy that we discussed in this article. It is also important to understand that this anatomy is highly variable, based on all the cadaveric studies that we now have available. A meticulous understanding of this anatomy is crucial for the plastic surgeon planning a facelift operation.

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