Received: 12 April 2018 | Accepted: 27 June 2018
DOI: 10.1111/jocd.12728

ORIGINAL CONTRIBUTION

WILEY JCD Journal of Cosmetic Dermatology

# The layered anatomy of the jawline

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## Abstract

**Background:** To investigate the layered anatomy of the jawline and to provide anatomic background for the formation of the labiomandibular sulcus, the jowl deformity, and the "double-chin" for safe and effective minimally invasive procedures.

**Materials and Methods:** Seventy-two fresh-frozen human cephalic cadavers (32 males, 40 females; mean age 75.2 ± 10.9 years, BMI 24.2 ± 6.6 kg/m$^2$, 99% Caucasian ethnicity) were investigated by layer-by-layer anatomical dissection. Magnet resonance and computed tomographic imaging was additionally carried out to support the anatomical findings.

**Results:** No major neuro-vascular structures were found to run in the subdermal plane or in the subcutaneous fat. The jowl deformity was identified to be caused by the loose adherence of the platysma to the mandible, which occurs posterior (but not anterior) to the mandibular ligament. The formation of the submental sulcus was identified to be caused by the submental septum, an osteo-cutaneous adhesion spanning all facial layers in the submental area. The formation of the labiomandibular sulcus was caused by the change in the subcutaneous fibro-connective arrangement rather than by an underlying adhesion or ligament.

**Conclusion:** The layered arrangement of the jawline predisposes this region for subdermal and subcutaneous treatment options located superficial to the platysma. Subdermal subcision procedures might have a beneficial effect on the labiomandibular sulcus as the boundary between the different types of subcutaneous arrangement, which form the sulcus, is being smoothened.

KEYWORDS
buccal fat pad, buccal space, facial aging, facial artery, facial fat compartments, facial vein

## 1 | INTRODUCTION

Facial aging is a multifactorial process, resulting in a range of physiologic and morphologic changes in both the skeletal and soft tissue composites—the bones, ligaments, muscles, fasciae, subcutaneous fat, and skin. The onset and the pace of the observed age-related changes in each structure vary between different individuals, gender, and ethnicity.[1] Due to the heterogeneity of the clinical manifestations of the effects of aging, it is difficult to decipher which of the participating structures may be the key player in the observed clinical changes during facial aging.

Most of the changes observed during facial aging occur in the middle[2] and the lower face[3] due to the effects of gravity.[4] Frequently observed age-related features are a prominent labiomandibular sulcus, the jowl deformity, and submental laxity leading to the formation of a "double-chin". The anatomical background of these clinical presentation is still poorly understood with multiple circulating theories.

One of the recent advances in our understanding is provided by the identification of different types of subcutaneous fat.[5] Three different types of facial adipose tissue have been described, which are located either superficially (dermal white adipose tissue) or deep (subcutaneous white adipose tissue): fibrous (perioral locations), structural (major parts of the midface), and deposit (buccal fat pad and deep temporal fat pad). The boundaries between these different types play a crucial role in the formation of the above-mentioned age-related clinical manifestations.[5] Another important shift in paradigms occurred after the introduction of the 5 Layers of the face: Layer 1: Skin, Layer 2: Subcutaneous fat including retinacula cutis (composed of fibrous connective tissue), Layer 3: Superficial musculo-aponeurotic system (SMAS), Layer 4: Deep fat, and Layer 5: Periosteum or deep fascia.[6] This layered arrangement of the face provides anatomic guidance for the identification of discrete anatomic structures, thereby increasing the safety of minimally invasive applications and/or enabling the surgeon to target desired structures for the best esthetic outcomes.

The objective of this dissection-based investigation was to describe the detailed anatomy of the jawline and to thus explain the underlying anatomy of clinically relevant age-related changes including the formation of the labiomandibular sulcus, the jowl deformity, and the "double-chin".

## 2 | MATERIAL AND METHODS

### 2.1 | Total sample

Seventy-two fresh-frozen human cephalic specimen (32 males, 40 females) with a mean age of 75.2 ± 10.9 years and a body mass index 24.2 ± 6.6 kg/m$^2$ were investigated in this study. Seventy-one cadavers were of Caucasian and one (1.4%) of Afro-American ethnicity. None of the investigated specimens had previous facial surgery or any relevant disease affecting the integrity of the facial anatomy.

### 2.2 | Anatomical dissection

The dissection procedure of the cephalic specimen was based on layer-by-layer identification of facial structures located in the lower face. Special focus was placed on the structures of the jawline starting from the midline and reaching to the angle of the mandible.

Magnet resonance (sagittal T1 Vista [parameter: field of view 270 × 270 × 205 mm, voxel size 0.7 × 0.7 × 0.35 with a voxel recon size of 0.352 mm, SNR 1.0, TE 18, TR 350, 586 slices per dataset]; T2 3D STIR [parameter: field of view 270 × 270 × 204 mm, voxel size 0.9 × 0.9 × 0.45 with a voxel recon size of 0.422 mm, SNR 1.0, TE 308, TR 3000, and 454 slices per dataset]), and computed tomographic (slice thickness 0.6 mm, field of view 200 mm, increment 0.5 mm, voltage 140 kV, and current 400 mA/s) imaging were additionally carried out to support the anatomical findings.

## 3 | RESULTS

### 3.1 | Surface landmarks and their anatomic correlate

#### 3.1.1 | Submental sulcus

Independent of age, gender, or ethnicity, a depression was observed inferior to the chin. This depression is termed the submental sulcus and extends from the left-right mandibular ligament across the anterior portion of the submental area (Figure 1). Anatomic dissections revealed that the sulcus is caused by an osteo-cutaneous adhesion termed the submental septum, which originated from the posterior aspect of the mandibular symphysis and inserted into the skin (Figure 2). This adhesion formed the anterior boundary of the deep subplatysmal fat (located deep to platysma), connected the platysma to the mandible, and spanned the subcutaneous fat before reaching the skin (Figure 2).

#### 3.1.2 | Labiomandibular sulcus

Independent of age, gender, or ethnicity, a depression was observed extending from the lateral corner of the mouth perpendicular and inferior to the mandible. This depression was consistent in the upper one third in all of the investigated specimen but inconsistent in the lower two thirds. This depression is termed the labiomandibular sulcus (LMS) and was also detectable after the skin was removed (Figures 1, 2, and 3). Dissections revealed that the skin was loosely connected to the fat lateral to the LMS, ie to the jowl (subcutaneous) fat compartment, but strongly adherent medial to the LMS in

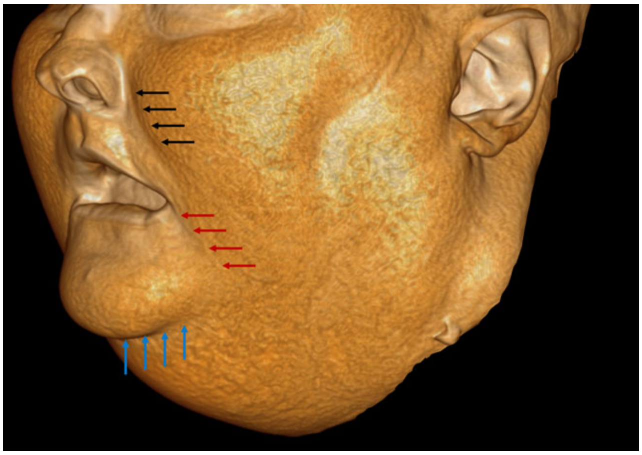

**FIGURE 1** Three-dimensional reconstruction of a cranial CT scan showing the following surface landmarks: nasolabial sulcus (black arrows), labiomandibular sulcus (red arrows), and the submental sulcus (blue arrows)

**FIGURE 2** Cadaveric dissection of the left lower face showing the submental septum (red circle) and the labiomandibular sulcus (red arrows). Note the subdermal dissection deep to the hair follicles

all of the dissected specimen. Medially, the subcutaneous arrangement was more fibrous and dissection procedures more strenuous. In the line of the LMS at the level of the mandible a strong osteocutaneous ligament was observed: the mandibular ligament (Figures 4 and 5). This ligament originated as a horizontally oriented bilaminar fibrous bundle from the bone, connected the platysma to the mandible, and after emerging from the platysma, it marked the boundary between the muscle fibers of the depressor anguli oris (DAO) muscle (medial) and the platysma (lateral) (Figure 3). This separation was not a clear boundary but upon dissections it was observed that the color of the DAO was substantially more intense than the color of the platysma and the muscle fiber orientation was vertical as compared to horizontal of the platysma (Figures 3 and 4).

## 3.2 | Jowl deformity

The formation of an inferior bulging of the buccal region was inconsistently observed and was more frequently seen when the cephalic specimen was positioned upright. The inferior bulging occurred independent of age or gender or ethnic background and was identified as the jowl deformity. The jowl deformity was observed posterior to the mandibular ligament and anterior to the anterior one third of the masseter muscle (Figure 1). The jowl deformity was not observed after the subcutaneous fat was removed. When performing manual traction on the platysma, it was detected that the region anterior to the mandibular ligament was tightly adherent to the anterior margin of the mandible. Posterior to the mandibular ligament, no firm connection was observed between the platysma and the bone.

When reflecting the platysma (Figures 5 and 6), a variable amount of deep fat was seen posterior to the mandibular ligament in which the facial vein and the facial artery were embedded as they crossed the mandible. At the level of the masseter muscle, a variable (but visibly lesser) amount of deep fat was observed. Here, the

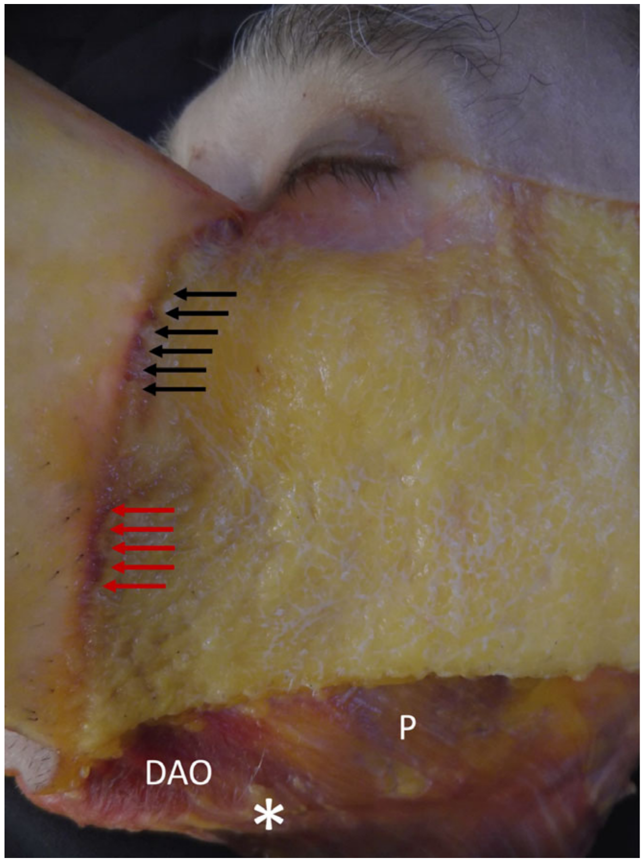


**FIGURE 3** Cadaveric dissection of the left middle and lower face exposing the subcutaneous fat (Layer 2) in the midface and the muscular layer (Layer 3) at the jawline. Black arrows, nasolabial sulcus; Red arrows, labiomandibular sulcus; DAO, Depressor anguli oris muscle; P, Platysma; White asterisk, Mandibular ligament

platysma was directly covering the parotideo-masseteric fascia (Figure 6).

## 3.3 | Vasculature of the jawline

Using the layer-by-layer approach, no major vessels were observed in the subdermal plane (Figures 7 and 8) or within the subcutaneous fat overlying the platysma (Figure 8). Albeit the facial artery was in a subplatysmal location when crossing the mandible, it became subdermal when approaching the modiolus (Figure 9). Deep to the platysma the artery crossed the mandible in 100% of the observed cases anterior to the facial vein and in 100% of the cases posterior to the mandibular ligament (Figure 10).

The facial vein crossed the mandible in 100% of the cases deep to platysma and posterior to the facial artery before entering the facial vein canal (Figures 10, 11, and 12). Whereas the vein had a more direct course in cranial direction inside the facial vein canal (Figure 11), the artery had a more torturous course inside the buccal space travelling an anterior-superior direction toward the modiolus. Within the buccal space, the artery gave off in variable anatomical locations the horizontal labiomental artery and/or the inferior labial artery (Figure 7).

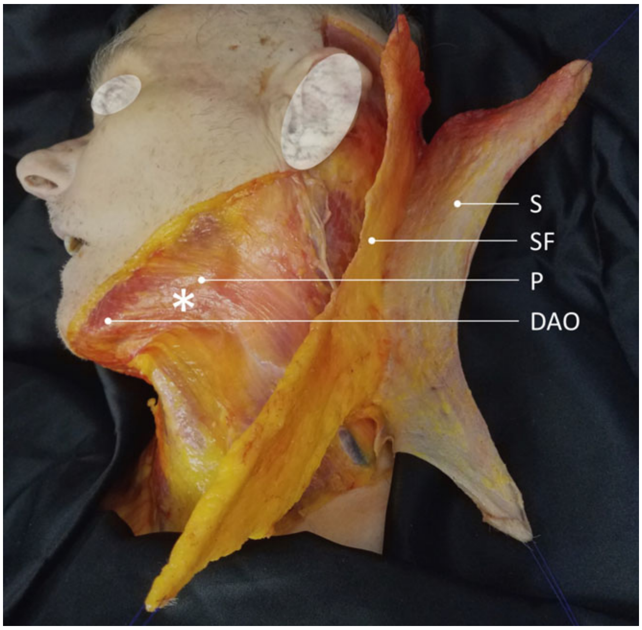


**FIGURE 4** Cadaveric dissection of the left jawline and neck reflecting the skin (S) (layer 1) and the subcutaneous fat (SF) (layer 2) exposing the muscular layer (Layer 3). DAO, Depressor anguli oris muscle; P, Platysma; White asterisk, Mandibular ligament

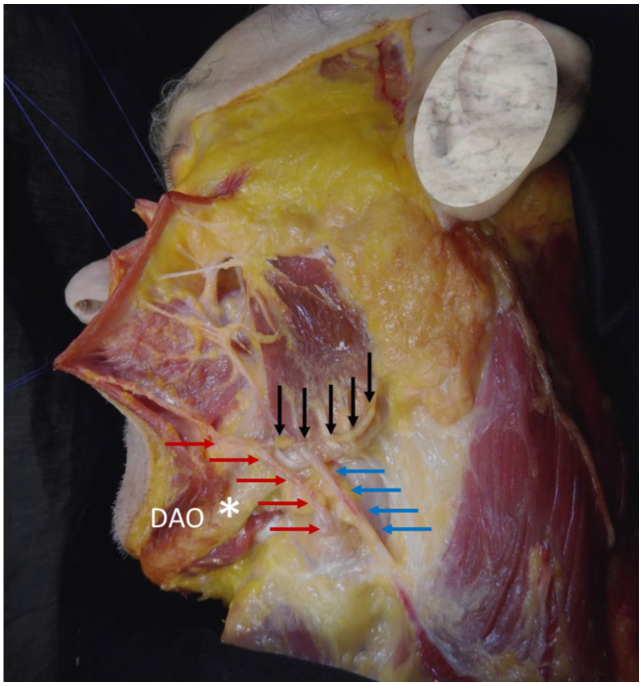


**FIGURE 6** Cadaveric dissection of the left lower face after removing the skin, subcutaneous fat, and the platysma exposing the facial vein (blue arrows), facial artery (red arrows), and the marginal mandibular branch of the facial nerve (black arrows). White asterisk, Mandibular ligament; DAO, Depressor anguli oris muscle

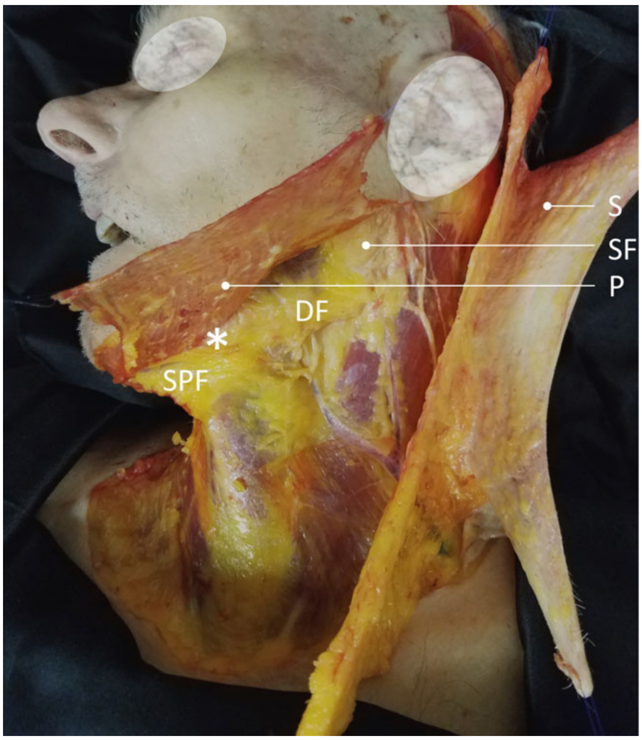


**FIGURE 5** Cadaveric dissection of the left jawline and neck reflecting the skin (S) (layer 1),the subcutaneous fat (SF) (layer 2), and the muscular layer (Layer 3) including platysma (P) and the Depressor anguli oris muscle (DAO) exposing the subplatysmal fat (SPF) and deep fat (DF) (layer 4). White asterisk, Mandibular ligament

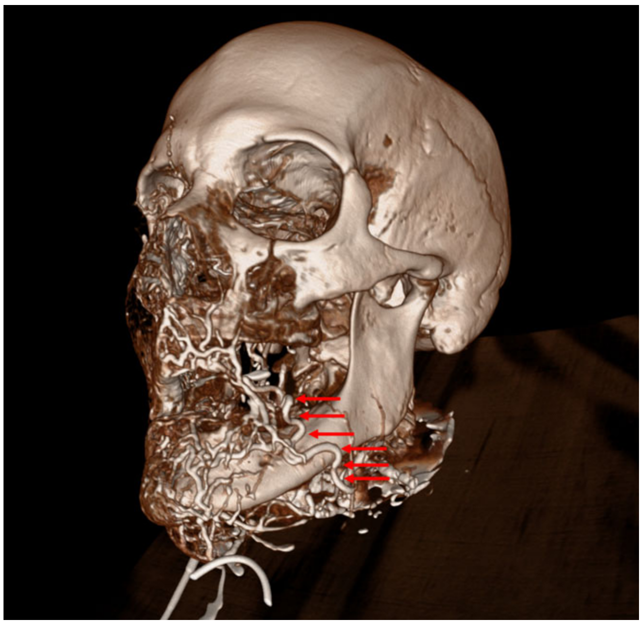

**FIGURE 7** Three-dimensional reconstruction of a cranial CT scan showing the course of the contrasted facial artery (red arrows)

## 3.4 | Nerves of the jawline

No major nerves were detected using layer-by-layer dissections in the subdermal or the subcutaneous plane between the angle of the mandible and the midline. When reflecting the platysma, a variable

**FIGURE 8** Cadaveric dissection of the left lower face showing the red latex injected subdermal plexus after reflecting the skin

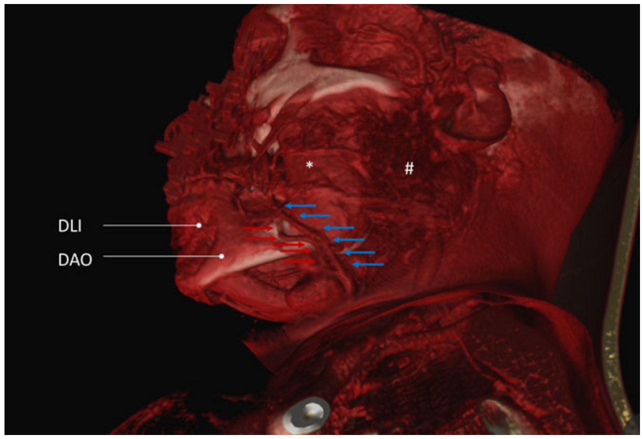


**FIGURE 10** Three-dimensional reconstruction of a cranial CT scan showing the contrasted facial vein (blue arrows) and facial artery (red arrows) at the mandibular crossing. Hash, Parotid gland; White asterisk, Masseter muscle; DAO, Depressor anguli oris muscle; DLI, Depresso labii inferioris muscle

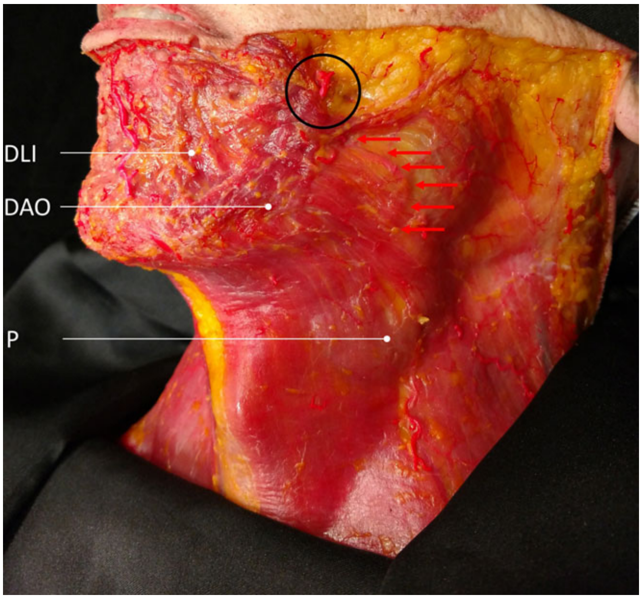


**FIGURE 9** Cadaveric dissection of the red latex injected left lower face exposing the muscular layer including the platysma (P), depressor anguli oris muscle (DAO), and depressor labii inferioris muscle (DLI). Note the course of the facial artery deep to the platysma is indicated by the red arrows. Posterior to the modiolus the artery is shown to run subdermally (black circle)

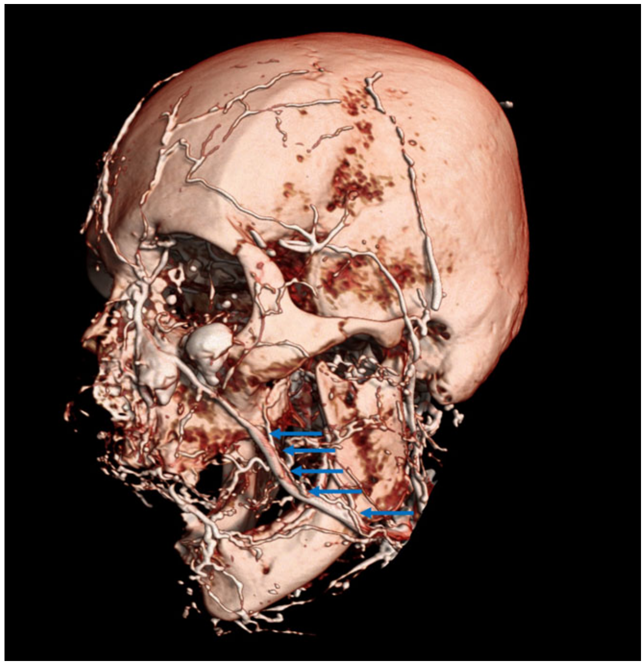

**FIGURE 11** Three-dimensional reconstruction of a cranial CT scan showing the contrasted facial vein at the mandibular crossing (blue arrows)

number (1-5) of branches of the marginal mandibular nerves was observed at the angle of the mandible deep to the parotideo-masseteric fascia after emerging from the parotid gland. These nerve branches were travelling in the wall of the inferior premasseteric space and crossed the facial vein and the facial artery superficially in 100% of the cases after running in the roof of the facial vein canal (Figure 6). The branches of the marginal mandibular division of the facial nerve run deep to the DAO muscle and separated to reach the depressor labii inferioris (DLI), the orbicularis oculi (OOM), and the mentalis muscles.

## 4 | DISCUSSION

The results of this dissection-based investigation provide a detailed description of the anatomy of the jawline and form thus an understanding of the age-related changes observed during facial aging: formation of the labiomandibular sulcus, the jowl deformity, and the "double-chin". The dissection of 72 fresh-frozen human cephalic specimen (32 males, 40 females) revealed a constant layered arrangement independent of age, gender, or ethnic background. The facial artery and the facial vein were found in 100% of the cases to

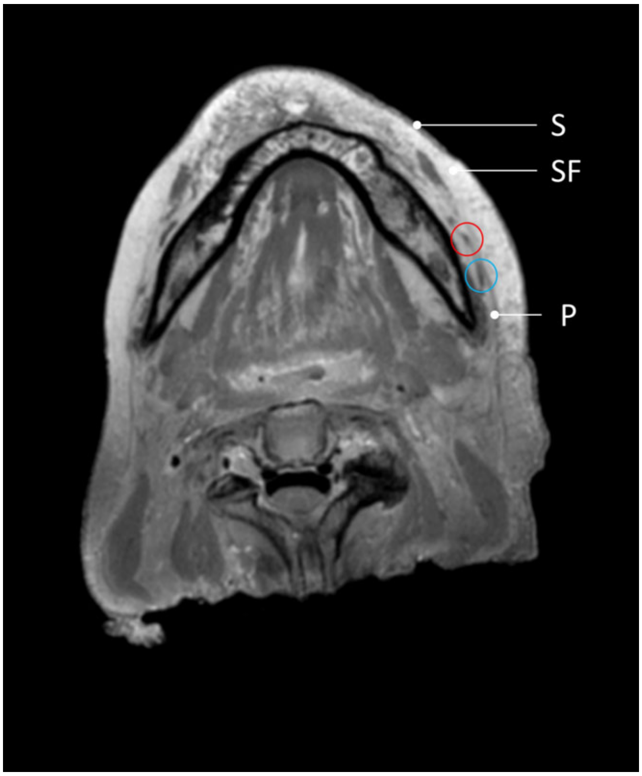


**FIGURE 12** Axial MRI scan of the lower face showing the anterior two thirds of the mandible in the horizontal plane. The facial artery (red circle) runs anterior to the facial vein (blue circle) deep to the platysma (P). S, Skin; SF, Subcutaneous fat

run deep to the platysma when crossing the mandible, whereas the marginal mandibular nerve was found to run likewise in 100% of the cases superficial to these vessels but still deep to platysma. No major neuro-vascular structures were found to run in the subdermal or the subcutaneous fat. The jowl deformity was identified to be caused by the loose adherence of the platysma to the mandible, which was seen posterior to the mandibular ligament. The formation of the submental sulcus was identified to be caused by the submental septum, an osteo-cutaneous adhesion spanning all facial layers present in this area. The formation of the labiomandibular sulcus was caused by a change in subcutaneous arrangement rather than by an underlying adhesion or ligament.

A strength of the present investigation is the large sample investigated using a total of 72 fresh frozen human cephalic specimen, of which 32 were males and 40 were females. Due to this close male:female ratio, we were able to analyze potential anatomic differences via careful dissection. Our results, however, revealed that no differences were observed as the underlying anatomy did not display significant variation between genders. Thus, one conclusion of the study is that there is no gender difference in the formation of the labiomandibular sulcus, the jowl deformity, and the "double-chin" when looking at the cadaveric anatomy exclusively. A limitation of the study is, however, that we investigated only one cephalic specimen of African-American ethnicity, which limits the interpretability of the results to other ethnic groups apart from individuals of Caucasian ethnic background.

When investigating the formation of the labiomandibular sulcus (LMS), our results are in line with previous investigations reporting on the change in subcutaneous arrangement occurring among the facial superficial musculo-aponeurotic system (SMAS), the subcutaneous fat, and the skin.[7] Two different types of arrangement were demonstrated: one type (Ghassemi Type 1[7]) is located lateral to the LMS with relatively small fibrous septa enclosing lobules of fat cells, whereas another type of arrangement (Ghassemi Type 2[7]) is located medial to the LMS, where the subcutaneous fat consists of a dense collagen-muscle fiber meshwork surrounding the fat cells. The change in this arrangement, loose adhesion of skin vs tight adhesion of skin to the underlying musculo-aponeurotic layer, results in the formation of a sulcus when age-related changes drive soft-tissue laxity.[5] The soft tissues lateral to the LMS migrate either medially and/or inferiorly resulting in the formation of the LMS, which becomes more prominent with advancing age. The fact that we did not find in our dissection any ligament or septum deep to the LMS as previously suggested[8] supports the theory of the formation of this sulcus by the change subcutaneous arrangement (Figures 1, 2, and 3).

On the contrary, we found in all of our dissected cephalic specimen a fibrous adhesion originating from the posterior aspect of the mandibular symphysis and inserting into the skin. This osteo-cutaneous fibrous connection was observed independent of gender, age, or ethnic background in our samples. Our findings are supported by the clinical presentations of patients with an excessive amount of fat in the submental area, where this adhesion forms the anterior boundary of the subplatysmal fat, which is located deep to the platysma, and prevents that tissue laxity or the "double-chin" formation extends into the chin.[9] Interestingly, the submental septum connected both mandibular ligaments, which are known to be true osteo-cutaneous fibrous connections[10] and extend, thus, the anatomic observations made previously.[8]

Our anatomical dissections provided an explanatory model for the formation of the jowl deformity. We identified that posterior to the mandibular ligament, the facial artery and facial vein crossed the mandible deep to the platysma surrounded by a variable amount of deep fat. This fat was shown to be not connected to the fat inside the buccal space, not to be influenced by increased age, and not to be connected to the buccal fat pad (of Bichat).[8] This fat seemed to have a protective function for the facial artery and the vein as they are here in an exposed position and thus prone to injury if not properly secured against mechanical influences. As the platysma is not connected here to the mandible (due to the underlying fat and vasculature), it is more mobile against the mandible as compared to anterior to the mandibular ligament or close to the mandibular angle. The platysma forms the fundament for the overlying subcutaneous jowl fat compartment[11] and the skin and a displacement of the platysma inferiorly results in the displacement of the overlying tissues leading to the clinical appearance of the jowl deformity. The formation of the jowl is thus a process including the platysma, subcutaneous fat, and the skin.

Based on the results of our dissections, minimally invasive procedures aiming to treat the jowl deformity should avoid deep applications of agents or energy in the location of the jowl deformity as the facial neuro-vasculature can be identified deep to the platysma. On the contrary, superficial applications, ie superficial to the platysma, are of less risk as the major neuro-vasculature can be identified deep to the platysma.

In general, along the jawline major vessels and nerves are found deep to the platysma, which predisposes this area to superficial, ie subdermal and subcutaneous, treatment options. When targeting the LMS, subcision procedures can have a rejuvenating effect, as the boundary between the two different types of subcutaneous arrangement is smoothened and the contours are softened. The resulting effect is a less aged appearance of the face as the LMS is less pronounced.

## 5 | CONCLUSION

The layered arrangement of the jawline predisposes this region for subdermal and subcutaneous treatment options located superficial to the platysma. The facial artery and vein as well as the marginal mandibular branch of the facial nerve are located deep to the platysma. Subdermal subcision procedures might have a beneficial effect on the labiomandibular sulcus as the boundary between the different types of subcutaneous arrangement, which form the sulcus, is being smoothened.

## CONFLICT OF INTEREST

None of the authors listed have any commercial associations or financial disclosures that might pose or create a conflict of interest with the methods applied or results presented in this study.

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**How to cite this article:** Suwanchinda A, Rudolph C, Hladik C, et al. The layered anatomy of the jawline. *J Cosmet Dermatol*. 2018;00:1–7. https://doi.org/10.1111/jocd.12728