The Anatomy of the Facial Vein: Implications for Plastic, Reconstructive, and Aesthetic Procedures

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Background: Anatomical knowledge of the facial vasculature is crucial for successful plastic, reconstructive, and minimally invasive procedures of the face. Whereas the majority of previous investigations focused on facial arteries, the precise course, variability, and relationship with adjacent structures of the facial vein have been widely neglected.

Methods: Seventy-two fresh frozen human cephalic cadavers (32 male and 40 female cadavers; mean age, 75.2 ± 10.9 years; mean body mass index, 24.2 ± 6.6 kg/m^2; 99 percent Caucasian ethnicity) were investigated by means of layer-by-layer anatomical dissection. In addition, 10 cephalic specimens were investigated using contrast agent–enhanced computed tomographic imaging.

Results: The facial vein displayed a constant course in relation to the adjacent anatomical structures. The vein was identified posterior to the facial artery, anterior to the parotid duct, and deep to the zygomaticus major muscle. The angular vein formed the lateral boundary of the deep medial cheek fat and the premaxillary space, and the medial boundary of the deep lateral cheek fat and the sub–orbicularis oculi fat. The mean distance of the inferior and superior labial veins, of the deep facial vein, and of the angular vein from the inferior orbital margin was 51.6 ± 3.1, 42.6 ± 2.3, 27.4 ± 3.0, and 4.2 ± 0.7 mm, respectively.

Conclusions: This work provides detailed information on the course of the facial vein in relation to neighboring structures. The presented clinically relevant anatomical observations and descriptions of landmarks will serve as helpful information for plastic, reconstructive, and aesthetic surgeons. (*Plast. Reconstr. Surg.* 139: 1346, 2017.)

Knowledge of the anatomy of the facial vasculature and its most relevant clinical applications is crucial for a plethora of surgical and minimally invasive procedures in the face. Access pathways,[1] pedicled and free flap transfer,[2] and explantation and transplantation of total faces are based on the proper assessment and use of the facial veins and arteries. Although the general anatomy, including variations of the facial artery and its branches, has been well described previously,[3–6] reports in the literature are few when referring to the detailed course and variations of the facial vein.[7,8]

With the increasing popularity of volumizing facial procedures for rejuvenating purposes, the understanding of the facial fat compartments is essential for long-lasting and safe applications. The facial vein has been previously shown to form the lateral boundary of the deep medial cheek fat,[9–12] the lateral boundary of the premaxillary space (containing the deep nasolabial fat compartment),[7,13] and the medial boundary of the sub–orbicularis oculi fat.[9,14] This pivotal role of the facial vein as a hallmark structure in the face is of great importance when trying to understand the detailed anatomy of the facial fat compartments and to avoid complications. Of those, irreversible blindness resulting from filler or autologous fat transfer procedures is considered the most dangerous one.[15] However, to

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date there is still incomplete understanding of the pathophysiology behind this severe complication, but it is suspected that the facial vasculature might play an important role.[16,17]

At present, there is no detailed description of the course of the facial vein available between the mandible and the medial canthus, including its course in reference to the layered arrangement of the face and in relation to the most relevant surrounding structures (i.e., motor branches of the facial nerve, parotid duct, muscles of facial expression, and facial fat compartments). Therefore, the goal of this report is to present the detailed course and the precise position of the facial vein in relation to its adjacent structures by using cadaveric dissection and contrast-enhanced computed tomographic imaging.

MATERIALS AND METHODS

Total Sample

Seventy-two fresh frozen human cephalic specimens (32 male and 40 female cadavers) with a mean age of 75.2 ± 10.9 years and a mean body mass index of 24.2 ± 6.6 kg/m^2 were investigated in this study. Seventy-one cadavers were of Caucasian ethnicity and one (1.4 percent) was of African American ethnicity. None of the investigated specimens had previous facial surgery or any relevant disease affecting the integrity of the facial anatomy. From the total sample, 10 cephalic specimens were included in the computed tomographic imaging part of this investigation. Of those were four male and six female cadavers, with a total mean age of 72.6 ± 8.2 years and a mean body mass index of 25.0 ± 5.1 kg/m^2.

Anatomical Dissection

Cephalic specimens were dissected and objectively investigated at the Surgical Course Center, Salzburg, Austria. The dissection procedure was based on layer-by-layer identification of facial structures. The facial/angular vein was identified and followed between the mandible and the medial canthus. Relationships with surrounding structures, especially the deep facial fat

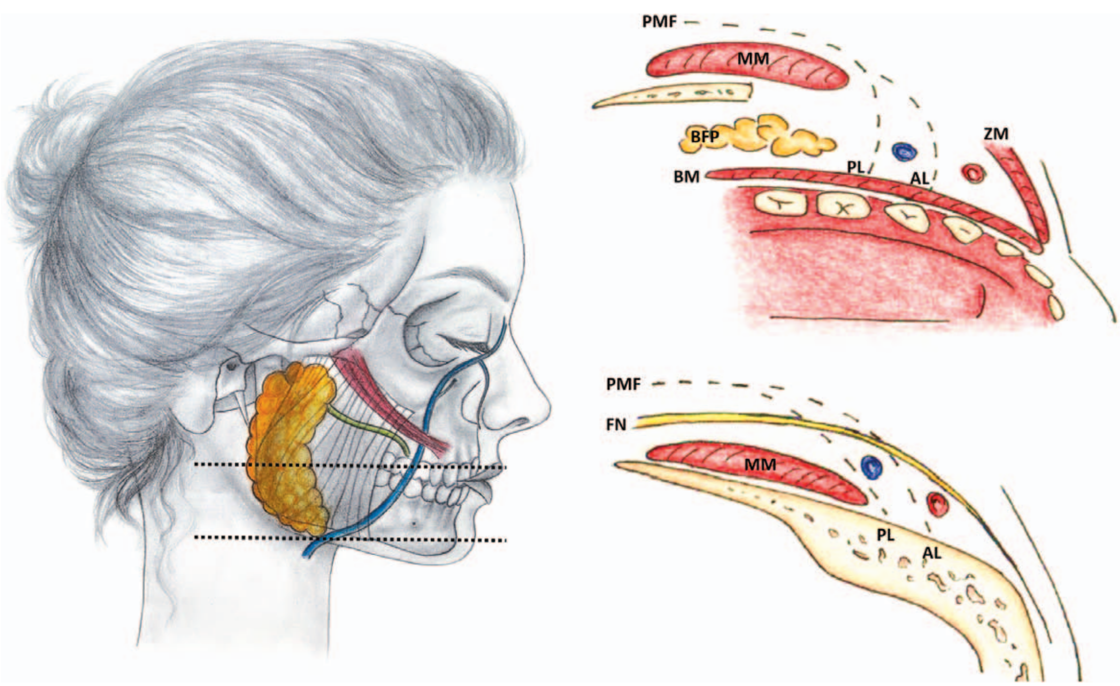

Fig. 1. Schematic drawings of the adjacent structures of the facial vein (*blue*): parotid gland (*orange*), parotid duct (*green*), zygomaticus major muscle (*red*). (*Right*) Cross-sections are indicated by the *dotted lines* in the overview (*left*). (*Below*, *right*) Cross-section indicated by the *lower dotted line* at the level of the mandible. *MM*, masseter muscle; *FN*, marginal mandibular branch of facial nerve; *PMF*, parotideomasseteric fascia; *PL*, posterior lamina of parotideomasseteric fascia; *AL*, anterior lamina of parotideomasseteric fascia; *blue circle*, facial vein; *red circle*, facial artery. (*Above*, *right*) Cross-section indicated by the *upper dotted line* at the level of the upper lip. *MM*, masseter muscle, *BFP*, buccal fat pad; *PMF*, parotideomasseteric fascia; *PL*, posterior lamina of parotideomasseteric fascia; *AL*, anterior lamina of parotideomasseteric fascia; *blue circle*, facial vein; *red circle*, facial artery; *BM*, buccinator muscle; *ZM*, zygomaticus major muscle.

compartments, the muscles of facial expression, motor branches of the facial nerve, the facial artery, and the parotid duct were recorded.

Computed Tomographic Imaging

For imaging purposes, a subset of the total study sample was referred for computed tomographic imaging with additional visualization of the facial fat compartments and the facial venous system. Imaging of the facial fat compartments was accomplished by injecting Visipaque 320 mg/ml (Iodixanol; GE Healthcare, Little Chalfont, United Kingdom) in combination with Resource ThickenUp Clear (Nestle HealthCare Nutrition GmbH, Vienna, Austria), whereas radiopaque dye (Lipidiol Ultra-Fluid Iohexol: Omnipaque; Amersham, Princeton, N.J.) was used to contrast the veins. Repeated computed tomographic scans were performed to ensure maximum achievable filling of the compartments and to visualize their relationship to the facial vein. The following parameters were applied to each of the performed computed tomographic scans: field of view, 200 mm; slice thickness, 0.6 mm; increment, 0.4 mm; voltage, 120 kV; and current, 400 mA/second.

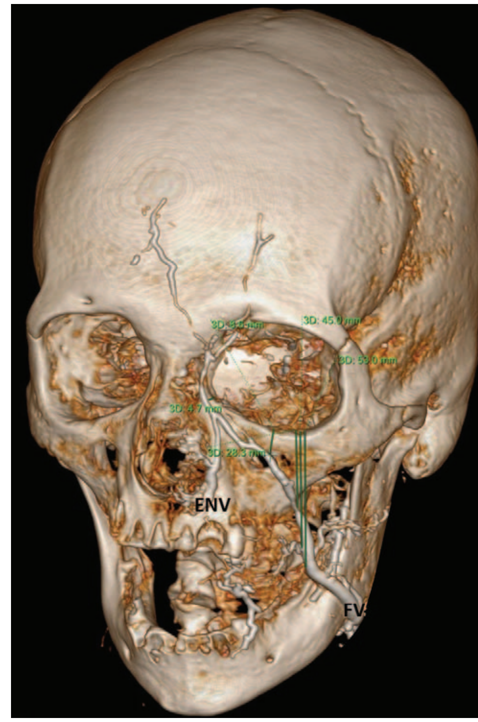

Fig. 2. Contrast agent–enhanced computed tomographic scan showing the facial vein (*FV*) and the external nasal vein (*ENV*). Measures of distances are given in relationship to the inferior orbital rim for the angular vein, the infraorbital foramen, the deep facial vein, and the superior and inferior facial veins.

RESULTS

Evaluation of anatomical dissections revealed a constant course of the facial/angular vein in relation to the investigated neighboring structures, with 0 percent variation between investigated specimens ($n = 72$) or between the two sides within one individual.

Course of the Facial Vein

Mandibular Segment of the Facial Vein

The facial vein was identified to cross the mandible at the anterior margin of the masseter muscle. A 0.2 - 1.0 cm overlap was identified between the most anterior attachment of the masseter muscle and the facial vein. In all of the investigated cases (100 percent), the facial vein was identified posterior to the facial artery and deep to the marginal mandibular branch of the facial nerve (Fig. 1).

After detaching the parotideomasseteric fascia from the parotid gland and reflecting it anteriorly, it was identified that anterior to the masseter muscle the fascia split into two laminae (i.e., an anterior lamina and a posterior lamina of the parotideomasseteric fascia). Both laminae curved around the anterior masseter margin to connect in depth with the fascia of the buccinator muscle—the buccopharyngeal fascia. The two laminae were previously described as the masseteric ligaments, albeit we observed no direct connection to the masseter muscle itself. The two laminae formed a slit-like canal, which served as a sheltered fibrous sheath for the facial vein. In all of the investigated cases, the facial vein was found to course within this fibrous canal—the facial vein canal—embedded in fat and loose connective tissue.

Buccal Segment of the Facial Vein

The main trunk of the facial artery was found to course outside of the facial vein canal (i.e., anterior to the anterior lamina of the parotideomasseteric fascia and anterior to the facial vein). In this segment of the facial vein, the inferior and superior labial veins branched off; a mean distance of 51.6 ± 3.1 mm for the inferior labial vein and 42.6 ± 2.3 mm for the superior labial vein was measured, when calculated from the inferior margin of the orbit (Figs. 1 and 2).

The parotid duct was identified to lie deep to the parotideomasseteric fascia in the parotid region. At the anterior margin of the masseter muscle, the duct pierced the posterior lamina of the parotideomasseteric fascia and entered the facial vein canal (Fig. 3). The duct was found in all of the investigated cases to lie posterior to the facial vein.

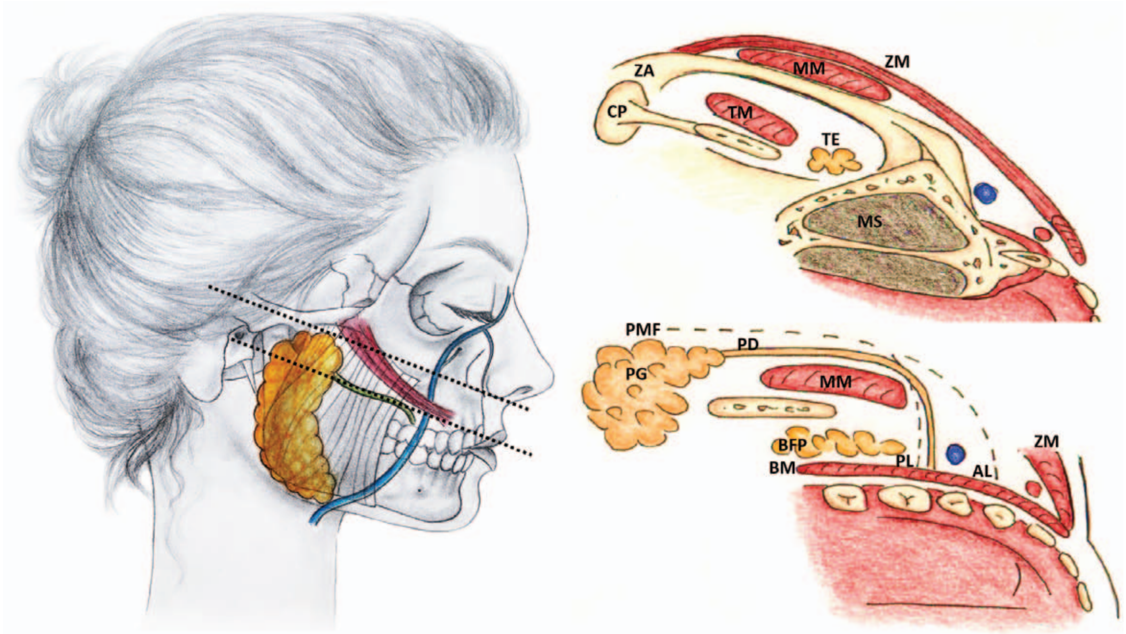

Fig. 3. Schematic drawings of the adjacent structures of the facial vein (*blue*): parotid gland (*orange*), parotid duct (*green*), zygomaticus major muscle (*red*). (*Right*) Cross-sections indicated by the *dotted lines* in the overview (*left*). (*Below*, *right*) Cross-section indicated by the *lower dotted line* at the level of the parotid duct. *MM*, masseter muscle; *PG*, parotid gland; *PD*, parotid duct; *PMF*, parotideomasseteric fascia; *PL*, posterior lamina of parotideomasseteric fascia; *AL*, anterior lamina of parotideomasseteric fascia; *blue circle*, facial vein; *red circle*, facial artery; *BM*, buccinator muscle; *ZM*, zygomaticus major muscle; *BFP*, buccal fat pad. (*Above*, *right*) Cross-section indicated by the *upper dotted line* at the level of the zygomatic arch. *MM*, masseter muscle; *TE*, temporal extension of the buccal fat pad; *ZA*, zygomatic arch; *CP*, condylar process; *TM*, temporalis muscle; *MS*, maxillary sinus. The zygomaticus muscle is embedded in the parotideomasseteric fascia and therefore not visible here.

The mandibular, buccal, and zygomatic branches of the facial nerve were variable in course and number but were constantly deep to the parotideomasseteric fascia within the parotid region. At the level of the anterior boundary of the masseter muscle, the nerve branches pierced the posterior lamina of the parotideomasseteric fascia, and ran within the roof of the facial vein canal and thus superficial to the facial vein. Anterior to the facial vein, the nerve branches left the facial vein canal, which was superficially connected to the superficial musculoaponeurotic system (SMAS), and changed planes from sub-SMAS to supra-SMAS locations and reached the muscles of facial expression from deep and posterior (Fig. 4).

Transitional Segment from the Facial to the Angular Vein

The zygomaticus major muscle originated from the anterior lower one-third of the zygomatic arch, superior to the McGregor patch. The muscle coursed antero-inferiorly toward the lateral third of the upper lip and the corner of the oral commissure. Although the anterior and posterior laminae of the parotideomasseteric fascia enclosed both the parotid duct and the facial vein within the facial vein canal, the zygomaticus major muscle was found superficial to the parotid duct and the facial vein in 100 percent of the investigated cases (Fig. 3).

Deep to the crossing of the zygomaticus major muscle, the facial vein gave off, in a posterior direction, the deep facial vein at a mean distance from the inferior orbital margin of 27.4 ± 3.0 mm. The emerging angular vein connected with branches of the infraorbital veins coming from the infraorbital foramen deep to the levator labii superioris alaeque nasi muscle at a distance of 8.1 ± 0.6 mm from the infraorbital rim (Figs. 2 and 5).

Infraorbital Segment of the Angular Vein

The angular vein was identified in all of the investigated cases coursing superficial to the levator labii superioris alaeque nasi muscle but deep to the orbicularis oculi muscle. The vein ran in the lateral boundary of the deep medial cheek fat and in the lateral boundary of the premaxillary space (Fig. 6). Furthermore, the angular vein

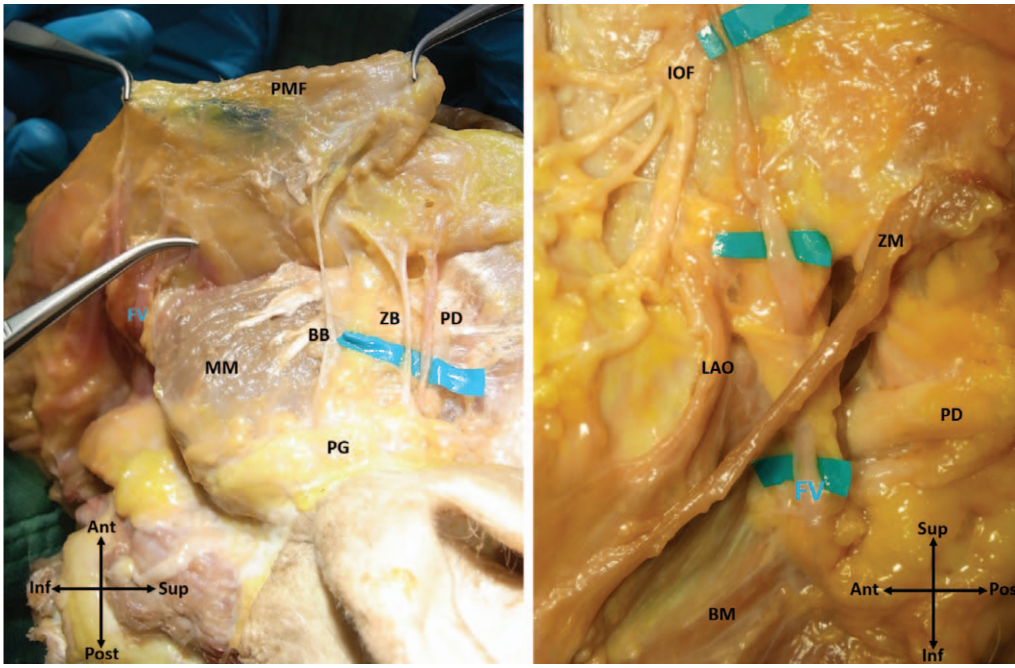

Fig. 4. Cadaveric dissection of the midface. Orientation in each image is given by a cross (*lower left* and *lower right*, respectively). *Ant*, anterior; *Post*, posterior; *Sup*, superior; *Inf*, inferior. (*Left*) View from posterior after reflection of the parotideomasseteric fascia (*PMF*). The parotid gland (*PG*), parotid duct (*PD*), zygomatic branch of the facial nerve (*ZB*), buccal branch of the facial nerve (*BB*), and the masseter muscle (*MM*) are exposed. The facial vein (*FV*) is indicated by the forceps to cross the mandible and to enter the fibrous sheath formed by the anterior and posterior laminae of the parotideomasseteric fascia. (*Right*) Magnification of the transitional segment of the facial vein (highlighted by the *green labels*) showing the relationships with the parotid duct (*PD*), zygomaticus major muscle (*ZM*), levator anguli oris muscle (*LAO*), infraorbital foramen (*IOF*), and buccinator muscle (*BM*).

was identified within the medial boundary of the deep lateral cheek fat and in the inferior/medial boundary of the sub–orbicularis oculi fat.

Within the tear trough, the angular vein was found to course at a mean distance of 4.2 ± 0.7 mm inferior to the inferior orbital rim. There, it gave off variable small veins piercing the orbital septum and traveling into the orbit. In addition, in 100 percent of the specimens, the angular vein gave off the external nasal vein in an inferior direction (Figs. 2, 5, and 6), which ran in the medial boundary of the premaxillary space (Fig. 6).

Supraorbital Segment of the Angular Vein

The angular vein constantly connected by means of the dorsal nasal vein to the contralateral side at the level of the root of the nose. At the level of the superior orbital rim, the angular vein connected with the superior ophthalmic vein, which pierced the orbital septum and ran within the superior portion of the orbit (Fig. 5). There, the angular vein collected blood from supratrochlear and supraorbital venous branches and from the central frontal vein(s).

DISCUSSION

In our sample of 72 fresh frozen cephalic specimens, we were able to provide evidence for the constant course of the facial/angular vein in relation to the investigated structures. We identified a fibrous canal formed by the anterior and posterior laminae of the parotideomasseteric fascia, which provided a sheltered passage for the vein along its course anterior to the masseter muscle (i.e., the facial vein canal). The facial vein coursed deep to the motor branches of the facial nerve, anterior to the parotid duct, and formed the lateral boundary of the deep medial cheek fat and the premaxillary space, and the medial boundary of both the deep lateral cheek fat and the sub–orbicularis oculi fat.

The majority of anatomical descriptions of the facial vessels focus on the facial artery and its branches. There, a high variation of the course and number of branches of the artery have been described, whereas the facial vein has mostly been neglected in previous investigations.[18–21] The present study focused exclusively on the spatial pathway of the facial/angular vein and revealed

Fig. 5. Contrast agent–enhanced computed tomographic scans with decreased filter (*left*) allowing facial soft tissues to be transparent for a better illustration of the surface landmarks and orientation during minimally invasive procedures and with bone imaging exclusively (*right*). *FV*, facial vein; *ENV*, external nasal vein; *AV*, angular vein; *SOV*, superior orbital vein.

a remarkably constant course of the facial vein within the investigated sample. Our results are in line with a previous description by Lohn and colleagues,[22] where a variation of 1.5 percent (of 197 investigated facial veins) was reported. Our results are also in line with several other reports describing a constant branching pattern of the facial vein, with variations ranging between 0.3 and 2 percent.[20,23–25]

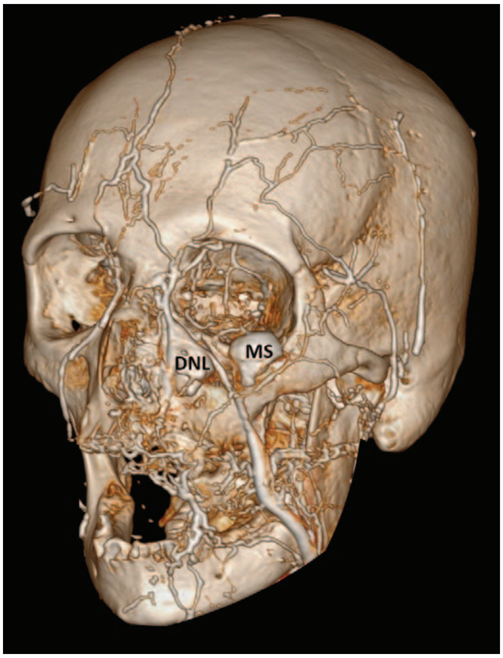

Fig. 6. Contrast agent–enhanced computed tomographic scan showing the facial vein in relation to the deep fat compartments. *DNL*, deep nasolabial fat compartment within the premaxillary space; *MS*, medial sub–orbicularis oculi fat pad.

The unreliable course of the facial vessels is frequently considered to be a surgical risk for delicate facial microsurgical procedures. In cases of nasal replantation procedures, surgeons have independently reported that, in proximity to the nose, no suitable vein was identified.[25–27] Based on the results of the present study, the location of the facial vein can be identified anterior to the anterior margin of the masseter muscle within the facial vein canal. This location can be easily palpated and marked when the patient is asked to bite. This finding will facilitate the identification of the facial vein during preoperative assessments and during the intraoperative procedure, especially when an intraoral approach is used (Fig. 7).

Our results expand previous findings by Wong et al., who found the angular artery to be running within the medial boundary of the premaxillary space.[9] The contrast agent-enhanced computed tomographic scans, obtained from our imaging sub-sample of 10 cephalic specimens, as well as our anatomical dissections, revealed that the external nasal vein can additionally (to the angular artery)

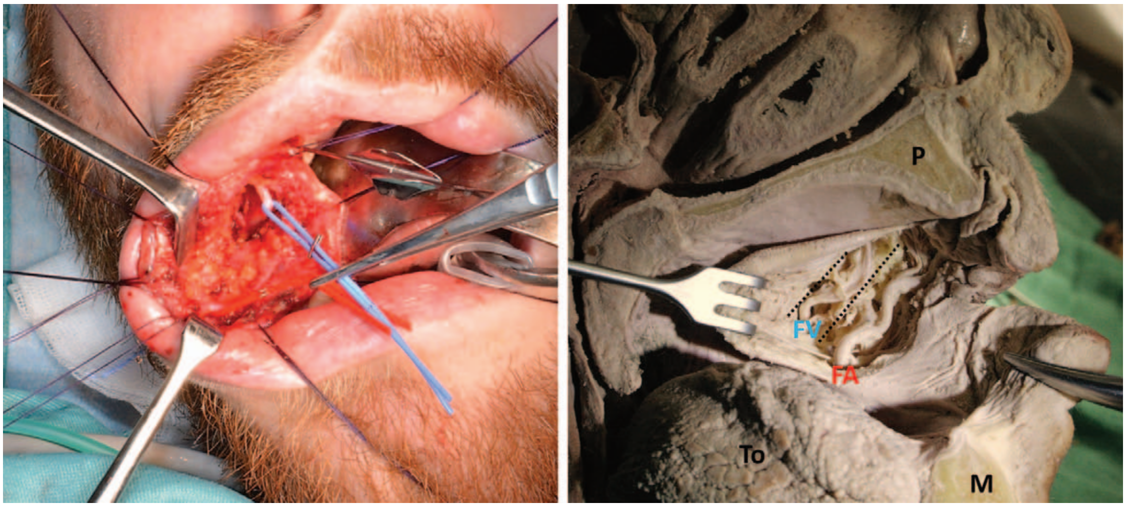

Fig. 7. Intraoperative (*left*) and intraoral views (*right*) of a hemisected formalin-embalmed cadaver showing the facial vein (*FV*) (*blue string*) and the facial artery (*FA*) (*red string*). *To*, tongue; *M*, mandible; *P*, palate. Note that the facial vein is posterior to the facial artery. *Dotted lines* show the remaining anterior and posterior laminae of the parotideomasseteric fascia. The buccinator muscle is retracted by the retractor.

be identified within the medial boundary of this deep fat compartment.[9] These results are in line with a previous publication likewise using venous contrasting and computed tomographic imaging where the external nasal vein was likewise identified in the same location.[28] In regard to the lateral boundary of the premaxillary space, our results confirm the findings by Wong et al.,[9] as here the lateral boundary is formed by the angular vein, which lies superficial to the levator labii superioris alaeque nasi muscle but deep to the orbicularis oculi muscle. With respect to the structural limitation of the sub–orbicularis oculi fat and the deep lateral cheek fat, our results are in line with a previous report by Cotofana et al.,[11] where the facial vein forms the medial boundary of both.

One of the most important findings of this investigation, however, is the relationship of the angular vein with the inferior margin of the orbital rim. The distance between the angular vein and the inferior orbital margin in the tear trough was measured to be 4.2 ± 0.7 mm. These results provide anatomical support for frequently performed minimally invasive filler applications in that area. Injections at the level of the inferior margin of the tear trough—into the nasojugal groove—seem to be a risk for venous vascular complications (e.g., hematoma), whereas injections closer to the orbital rim (in the middle or upper portion of the tear trough) proved to be "safer," as the angular vein was not identified there. This finding is visualized in Figure 5, where the overlying soft tissues are also included in the provided computed tomographic image for a better orientation during minimally invasive procedures.

CONCLUSIONS

The results of this study revealed a constant course of the facial/angular vein between the mandible and the medial canthus. The vein was found to course within a fibrous sheath, (i.e., the facial vein canal), formed by the anterior and posterior laminae of the parotideomasseteric fascia. We also found that the facial vein constantly coursed posterior to the facial artery. A distance of 4.2 mm between the angular vein and the inferior orbital rim was measured, which provides anatomical support for safer minimally invasive approaches to the tear trough.

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