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ORIGINAL PAPER

The Assessment of the Anatomical Risk in the Perioral Region

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ABSTRACT

Introduction: *Safe and effective procedures in the perioral region rely on a clear understanding of the facial anatomy, as insufficient knowledge of this aspect can lead to severe complications.*

Materials and methods: *We performed thorough layer-by-layer dissections of the perioral region on 11 freshly formalinized cadaver heads. Dissections were performed between 2020 and 2022 in the dissection laboratory of the Anatomy Department, where the ethical conducts were regulated by „Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania, and fall under its jurisdiction. Dissections were digitally photographed and edited without altering the scientific content. By performing minute dissections, a considerable amount of attention has been paid to the trajectory and diameter of the superior and inferior labial arteries and their relations with the surrounding structures.*

Results: *We demonstrated the presence of the fibro-muscular compartment above the philtrum, where the superior labial artery passes and gives off the columellar and septal branches, and where it can be compressed in case of either the migration of the filler or quick bolus injections of substance. We also emphasized the importance of the labial salivary glands as risk elements in the perioral region. The depth of the inferior labial artery varied between 4.1-5.4 mm and that of the superior labial artery between 4.8-5.6 mm.*

Discussion: *Safe and complication-free procedures require an exact knowledge of the anatomy of the main neurovascular bundle of each facial region and their anatomical variability should be highlighted.*

Conclusions: *The clinically relevant anatomical observations and descriptions of landmarks presented in our research serves as crucial information for plastic, reconstructive and aesthetic surgeons and dentists. Doppler ultrasound imaging has a considerable potential for both diminishing the risk and facilitating*

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the prompt treatment of complications, especially because it is an affordable, repeatable, quick and reliable procedure. Cadaveric dissection for anatomy training provides an unparalleled opportunity to precisely understand the structure of actual human tissue and the clinical and structural relationships between the multitude of anatomical risk elements.

Keywords: labial arteries, mental nerve, fibromuscular compartment, Doppler ultrasound, anatomical risk, perioral region

INTRODUCTION

Successful facial procedures in the fields of anesthesia, dentistry and plastic surgery, require a proper understanding of the regional anatomy (1).

The number of minimally-invasive techniques for rejuvenating the perioral region has increased in popularity worldwide in the last decades and the number of complications has followed proportionally. In addition to this, specific anatomical knowledge is neglected because of either the practitioner's overconfidence or the belief that the procedures are addressed to a simple risk-free region (2).

Vascular damage is one of the most dreaded complications caused by the hazardous use of injectable fillers (3, 4). Accidental intravascular injection of the substance can lead to vessel obstruction, followed by ischemia and necrosis, and can even determine embolization and blindness (3). In order to avoid such risks, rigorous knowledge of the topography and course of the anatomical structures is crucial when assessing and planning an aesthetic technique meant to enhance the volume of the perioral region (5). The practitioner must know the importance of anatomical variations of the blood supply when performing filler injections, dental procedures, or anesthesia (2).

Increasing patients' satisfaction and improving the outcomes have become the priority of each dermatologist, dentist or plastic surgeon. Thus, correct knowledge and appreciation of the depth of the puncture in territories traversed by arteries or veins is of the utmost importance for successful aesthetic surgery (6-8). Ultrasonography has proven to be a relatively simple and affordable method that can be used for the benefit of the patient, in order to avoid the vascular risk (7). ❑

MATERIALS AND METHODS

Over a period of three years (2020-2022), facial dissections on 11 (eight male, three female) formalinized corpses (by immersion in a 9% formaldehyde-based solution) with ages ranging from 56 to 88-years were performed by us in the dissection laboratory of the Anatomy Discipline of „Carol Davila" University of Medicine and Pharmacy in Bucharest, where the ethical conducts are regulated by the University and fall under its jurisdiction. In Romania, the manipulation of cadavers is regulated by Law no. 104/2003, which does not require special ethical conditions to accomplish dissections and to use the dissection images.

Depending on the level of detail of the dissection, we used magnifying loupes. Dissections were performed topographically and by following the anatomical layers, focusing on the main neurovascular bundles of the face. The dissected regions were digitally photographed and the obtained images were edited without altering the scientific content. Our approach took into consideration both the individuality and anatomical peculiarity as well as the existing data in the specialty literature.

The purpose of this study is to highlight the musculo-aponeurotic and neurovascular structures corresponding to the perioral region through dissection.

We also conducted an ultrasonographic study, where we performed Doppler ultrasounds on 30 healthy non-smoker volunteer patients (bilateral hemiface) and measured the distance between the labial and facial vessels and the skin. For the labial arteries, we performed consecutive centimeter by centimeter measurements on their pathway, starting from the level of the modiolus and ending at the philtrum. For this study we used an Esaote color Doppler ultrasound scanner and a 7.5 MHz linear probe. Informed consent was obtained for all subjects included in the study. ❑

RESULTS

In all dissected corpses, the facial artery and the superior and inferior labial arteries were identified and their various trajectories, depth, and types of branching were observed.

Lateral to the oral commissure, we found the modiolus, a musculo-tendinous structure located at the place of intersection of the muscles converging towards the corner of the mouth. The muscles attached to the modiolus include rizorius, depressor anguli oris, depressor labii inferioris, zygomaticus major and minor, levator anguli oris and orbicularis oris. It is a known fact that when the patient smiles forcefully, the modiolus contracts and becomes palpable. This fact makes the modiolus an extremely valuable landmark for the location and depth of the facial vessels and for the origin of the labial arteries. The facial vessels pass lateral and deep to the modiolus and the labial arteries have their origin in close proximity.

In Figure 1, the trajectory of the facial artery can be observed. It is found at the anterior margin of the masseter muscle, directed towards the modiolus, where it gives off its terminal branches: the superior and inferior labial arteries. The superior labial artery enters a fibromuscular compartment (Figure 1a – 1) formed by the aponeurosis of the upper lip (folded – Figure 1b) and the orbicularis oris muscle. This stratigraphy confirms that the artery can be compressed by rapid bolus injection of volumizing substance, determining symptoms of compartment syndrome due to the surpassing of the maximum distensibility of the labial aponeurosis. The image shows one of the types of branching of the facial artery from which the lateral nasal artery (found in eight cadavers) emerges. The lateral nasal artery provides the vascular supply to the ala of the nose.

In Figure 1c we can observe the difference between the diameter of the facial artery (1) lateral to the oral commissure and that of the angular artery (2) in the nasolabial fold. The facial artery is continued by the angular artery, which is narrower and has a less tortuous trajectory towards the medial palpebral commissure.

The facial artery passes underneath the mimic muscles that insert at the level of the modiolus (Figure 1a). This anatomical element becomes particularly relevant when performing injections in this area. By contracting the muscles, the landmark that indicates the position of the artery becomes palpable, and thus, the artery can be avoided.

In its pathway, the superior labial artery gives off a branch towards the ala of the nose (variably, this branch can emerge directly from the facial artery) and a columellar artery, which goes to the base of the nasal septum. We would like to point out that, aside from these branches, there are multiple and various small caliber arteries, which also emerge from the superior labial artery and ascend towards the base of the nose. These vessels are likely to be damaged either directly, by

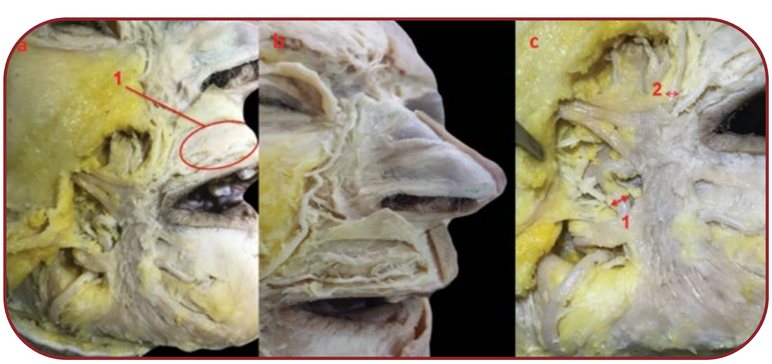

FIGURE 1. a) The superior labial artery between the orbicularis oris muscle and the aponeurosis of the upper lip; **b)** the trajectory of the angular artery, the origin of the lateral nasal artery and the aponeurosis, which is folded; **c)** the caliber of the facial artery near the modiolus (1) *vs.* the angular artery in the nasolabial fold (2)

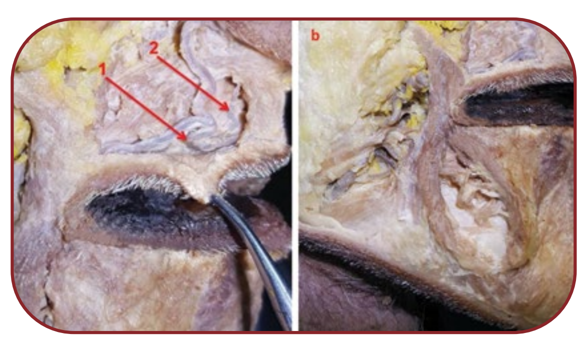

FIGURE 2. a) Anatomical variant of the branching of the superior labial artery from which the lateral nasal artery arises: 1 – sinuous superior labial artery, and 2 – septal branch; **b)** the muscles acting on the oral commissure and the branches of the mental nerve

the puncture needle or, more frequently, by compression exerted by the inserted filler.

This compression is made possible by the specific layering that exists at the level of the upper lip, where the superficial fascia of the orbicularis oris is well represented and can close the space that we previously mentioned, thus creating an almost closed compartment. Consequently, any mass substitute introduced into this compartment may compress the small, variable branches of the superior labial artery, determining, in the worst cases, ischemia of the septum or nasal ala.

In Figure 2a, the superior labial artery (1) is the origin of multiple branches that supply the skin, the muscles and the mucosa of the upper lip, as well as of other ascending branches (2) which supply the nasal septum and the nasal ala. In three cases, we noted an anatomical variant of the lateral nasal artery which emerged from the superior labial artery. The superior labial artery has a larger external diameter at its origin compared to the inferior labial artery, which is positioned deeper.

The muscles that mobilize the buccal commissure, including zygomatic major, levator anguli oris, risorius, buccinator, depressor anguli oris, can be observed from superior towards inferior.

The superior labial artery follows its perioral route, passing underneath the insertion of the levator labii superioris muscle, heading close and parallel to the vermillion border. Accidental injection of one of these columellar or alar branches leads to necrosis of the base of the nasal septum and of the ala of the nose.

From the lower lip muscle complex, the depressor anguli oris and the depressor labii inferioris muscles are highlighted in our dissection.

After removing the fibers of the depressor labii inferioris muscle, we reached the osseous plane and then the mental nerve (the terminal branch of the inferior alveolar nerve) was dissected. We noticed that, immediately after the emergence from the mandible, it divided into branches that were distributed towards the skin of the chin and of the lower lip. Consequently, its injury, either directly or through the quick injection of a volume substitute, will be accompanied by mento-labial paresthesia or anesthesia. Around the branches of the mental nerve, we encountered a connective-adipose atmosphere, because of the presence of deep fat tissue in the chin region.

The labial arteries are directly related to the glandular plane. It is obvious that a deep local regional puncture that damages the artery can simultaneously damage these labial glands, and saliva can be added to the content of the hematoma.

Even though there are numerous reports of labial artery injuries in the literature, we have not found any articles mentioning complications related to the damage of the labial glands.

Furthermore, we consider that, given the anatomical stratification, the injury of the labial glands should be regarded as a serious possible complication among the other possible incidents in facial surgery and dental procedures.

We measured the distance between the skin and the inferior labial vessels (both artery and vein) at the half point between the midline and the oral commissure. In Figure 4, the measured

FIGURE 3. a, b) The relation of the labial salivary glands with the superior and inferior labial arteries

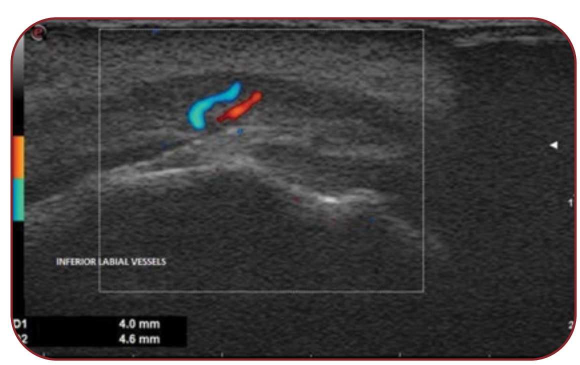

FIGURE 4. Ultrasonographic measurement of the depth of the inferior labial vessels at the half of the distance between the midline and the modiolus

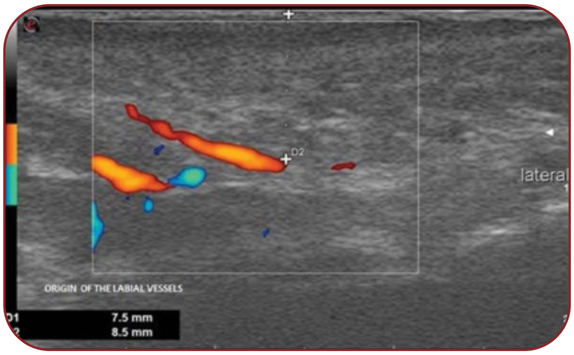

FIGURE 5. Doppler ultrasonography of the origins of the labial arteries

distances are 4 mm for the inferior labial vein and 4.6 mm for the inferior labial artery, respectively. In the present study, our values averaged 3.5-4.7 mm for the inferior labial vein and 4.1-5.4 mm for the inferior labial artery.

The origin of the labial arteries (inferior and superior) can usually be found close to the modiolus. The depth calculated in Figure 5 through Doppler ultrasound scan was measured as 7.5 mm for the inferior labial artery and 8.5 mm for the superior labial artery. The values were measured without compression on the underlying tissue, in order to accurately determine the vascular depth. The depth of the superior labial artery measured at the level of the philtrum averaged between 4.8-5.6 mm. ❑

DISCUSSION

All procedures that can be performed in the perioral region may seem free-of-risk to the inexperienced eye. However, the appropriate knowledge of the regional anatomical structures demonstrates us that there are, in fact, numerous elements that can be damaged at the buccal or peribuccal level (8, 9).

We built an inventory of anatomical structures at risk in relation to the regional topographical anatomy.

The labial arteries can be affected in two ways: either directly, in the case of punctures, or indirectly, either by the pressure generated by the bolus injection of volumizing substances that compress the vessels on the hard perilabial planes, or by the rough handling of the retractors. Thus, in order to avoid the lesions of the labial arteries, it is crucial for the practitioner to have a proper understanding of their course, variability and ramification manner, as well as of the layering at the level of the lips (4, 10). We demonstrated the existence of a labial fibromuscular compartment. If volumizing substances are quickly and abundantly injected inside this space, they determine the compression of the vessels, which, in turn, leads to ischemia at the base of the nose and the nasal ala. Arterial punctures are followed by the occurrence of hematomas, which can migrate between the perioral tissue layers (5, 11, 12). We would like to point out the importance of the anatomical landmarks (and especially the modiolus) for the correct assessment of the vascular trajectory.

The mental nerve can be damaged as well, either by punction or by compression onto the hard planes or even by excessive intraoperative retraction. The damage determines anesthesia in the ipsilateral mental region. It is vital to be aware of the ascending trajectory and the fan-shaped branching of the mental nerve, from the mental foramen (level with the second incisive tooth) up towards the inferior lip (13, 14).

An element of insufficiently recognized importance is represented by the labial salivary glands. They have a close relation to the labial vessels. In our study, we have demonstrated for the first time that the damage of the labial arteries can be accompanied by that of the labial salivary glands. In this case, the hematoma will also contain saliva. In the searched literature we found no reference to this possible complication.

Doppler ultrasonography is a relatively easy to use, accessible and repeatable investigation. Before local procedures, it can be used to calculate the depth of the vessels and to identify possible anatomical variations of the structures. During the procedures, Doppler ultrasound imagery can be used to perform ultrasound-guided anesthesia or filler injections. It can also be used after the procedures, to assess and treat the potential complications (15, 16). ❑

CONCLUSIONS

Safe and complication-free procedures require the exact knowledge of the main neurovascular bundles of the perioral region and their anatomical variability should be emphasized.

The clinically relevant anatomical observations and descriptions of the landmarks that we presented should serve as crucial information for plastic, reconstructive and aesthetic surgeons and dentists.

The Doppler ultrasound imaging has a considerable potential for both diminishing the risk and facilitating the prompt treatment of complications, especially because it is an affordable, repeatable, quick and reliable procedure.

Cadaveric dissection for anatomy training provides an unparalleled opportunity to precisely understand the structure of actual human tissue and the clinical and structural relationships between the multitude of anatomical risk elements. ❑

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