Possible vascular complications due to anatomical variations in dental surgical treatments

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SUMMARY

The facial artery undergoes multiple anatomic variations that condition the territory that vascularizes to the facial level. During the dissection of several pieces, we find a curious anatomic alteration in which the transverse facial artery is the one that replaces the facial artery because it disappears at the level of the submandibular gland. This anatomic variance can help to improve the knowledge of the vascularization of this area and be helpful in the different surgical or aesthetic processes in the facial region, and doing so minimizes the damages that can be caused in the anatomical surfaces treated.

This is why in the planning of the treatment it would be always useful to know the path of the main vessels and nerves to avoid their possible injury and, in this case, we recommend the use of means such as ultrasound.

Key words: Facial artery – Transverse facial artery – Anatomy – Dissection

INTRODUCTION

Facial aging is a complex process, dynamic and generally not uniform, of a multifactorial origin, which includes alterations at various levels: anatomic, biochemical, and genetic (Urdiales-Gálvez et al., 2017).

From the anatomic point of view, aging presents the loss of support at the skin level, causing numerous esthetical changes visible in the skin, such as skin folds or wrinkles, which in the facial plan are located recurrently in the holes like eyes, mouth, and nose. This has led to the development of antiaging techniques within the esthetic medicine field for the treatment of wrinkles or folds which comply with these two principles: to be effective and lasting in time, in the sense that they do not reappear again (Scarano et al., 2021).

One of the most used esthetic techniques is the infiltration of hyaluronic acid to fill up wrinkles and folds, but its application, which means the infiltration of that material at a subcutaneous level, implies the risk of affecting the vascularization or the innervation of specific anatomic areas where those structures can run at a very superficial level

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(Jitaree es al., 2021; Ryu et al., 2020), but they are predictable knowing the anatomy of the area to be treated (Herford and Lowe, 2018).

The main arteries of the face, i.e., the facial artery, maxillary artery, and superficial temporal artery, have their origin in the external carotid artery and take part in its irrigation either directly, such as the facial artery, or through its branches, such as the temporal superficial artery and the transverse facial artery, or the maxillary artery through the infraorbital, buccal and submental artery (Von and Lozanoff, 2017).

Among all previously mentioned, the facial artery is the one that gives vascular support to a great part of the face, mainly in the periductal and labial region, which is why facial surgery and esthetic level are very important.

The first detailed study of the vascularization of the skin was published in 1936 by Michael Salmon (Salmon, 1936), who described 82 independent territories of the skin using anatomical and radiological methods. The idea was to describe all the facial territory at an arterial and venous level in a way that could avoid problems derived from surgery due to the collapse of the area because of arterial blockages. Currently, this topic has been developing each time in a more precise way by mapping as dangerous certain territories when proceeding to the infiltrations of fillings (Wollina and Goldman, 2020; Jajoria et al., 2020).

In a usual way in different anatomic texts, the facial artery is considered to describe a winding journey similar to the facial vein, which runs in its backside, crossing the jaw angle in front of the anterior border of the masseter and going towards the internal angle of the eye below the facial muscles, and therefore of the Superficial Muscular Aponeurotic (SMAS) and above the buccinator muscle (Standring, 2020).

The facial artery arises from the external carotid artery in the carotid triangle of the neck, passes beneath the submandibular gland, and gives rise to the submental artery, which supplies the gland. It then proceeds in an ascending direction along the frontal edge of the masseter muscle, reaching the orbicularis muscle of the lips, where it divides into the superior and inferior labial arteries, responsible for lip vascularization. Common anastomoses occur with the transverse facial artery, infraorbital (superior labial artery), and submental (inferior labial artery).

Continuing upwards in the cheek, it reaches the lateral border of the nose, branching into the nasal lateral artery, providing blood to the nose's tip and sides. Finally, it reaches the medial eye angle, becoming the angular artery supplying the lower eyelid region, and anastomosing with branches from the ophthalmic artery (internal carotid artery) (Yamamoto et al., 2022; Ashton et al., 2018; Ogut and Barut, 2021).

Despite its regular path, anatomical variations in origin, course, branches, and endings exist, including division into three branches at the jaw angle or the presence of a significant back branch (masseteric) alongside the main facial artery.

The transverse facial artery originates from the zygomatic process as a collateral branch of the superficial temporal artery. It runs above the parotid gland, parallel to the Stenon duct, and over the upper masseter muscle, mainly irrigating the major and minor zygomaticus muscles. This artery often anastomoses with the facial, buccal, and infraorbital arteries, the latter two being branches of the maxillary artery (Pills et al., 2016; Vijayalakshmi et al., 2018; Padur and Kumar, 2019; Loukas et al., 2006).

The main objective of this study is to show the anatomic variance found during dissecting a side face at the facial artery level and the transverse facial artery, in a way that can help to improve the knowledge of the vascularization of this area and be helpful in the different surgical or aesthetic processes in the facial region and doing so minimize the damages that can be caused in the anatomical surfaces treated.

MATERIALS AND METHODS

The present work consists of a descriptive-analytical study for which five heads were selected and preserved in formalin in a 4% percentage dilution, from the Dissection Ward of the Medicine Faculty of the University of Murcia. Previous to the dissection, red latex (prevulcanized latex low in nitrosamines), was injected through the common carotid artery in the ten-half faces, to highlight the arterial path before starting the dissection. Before dissection, the pieces were removed from their preservation liquid to facilitate their manipulation. The superficial layers of the skin and subcutaneous cellular tissue were dissected in ascending direction from the area of the mandibular angle where the facial artery appears on the face at a superficial level in the lower border of the jaw to expose the course of the facial artery and not break its terminal branches, describing their variations.

RESULTS

Our results showed that the path of the facial artery was usually described in all dissected half-faces but one.

We find an anatomic variation on the right side of the face, not described until now, that consists of a short facial artery arising at the lower border of the mandible after running deep to the submandibular gland and that gives rise to the submental artery, which irrigates that same gland. From that point on, the facial artery, which should ascend across the body of the jaw to go towards the *depressor anguli oris* and the *orbicularis oris* and split in the superior and inferior labial arteries, disappears, giving several small gauge terminal branches (Fig. 1). In this case, the facial artery did not continue that ascending path towards the nasolabial fold where it should start the lateral nasal artery and the angular artery in the medial angle of the eye, but it runs out in that lateral area to the chin, irrigating backward the most frontal part of the masseter muscle and also originating

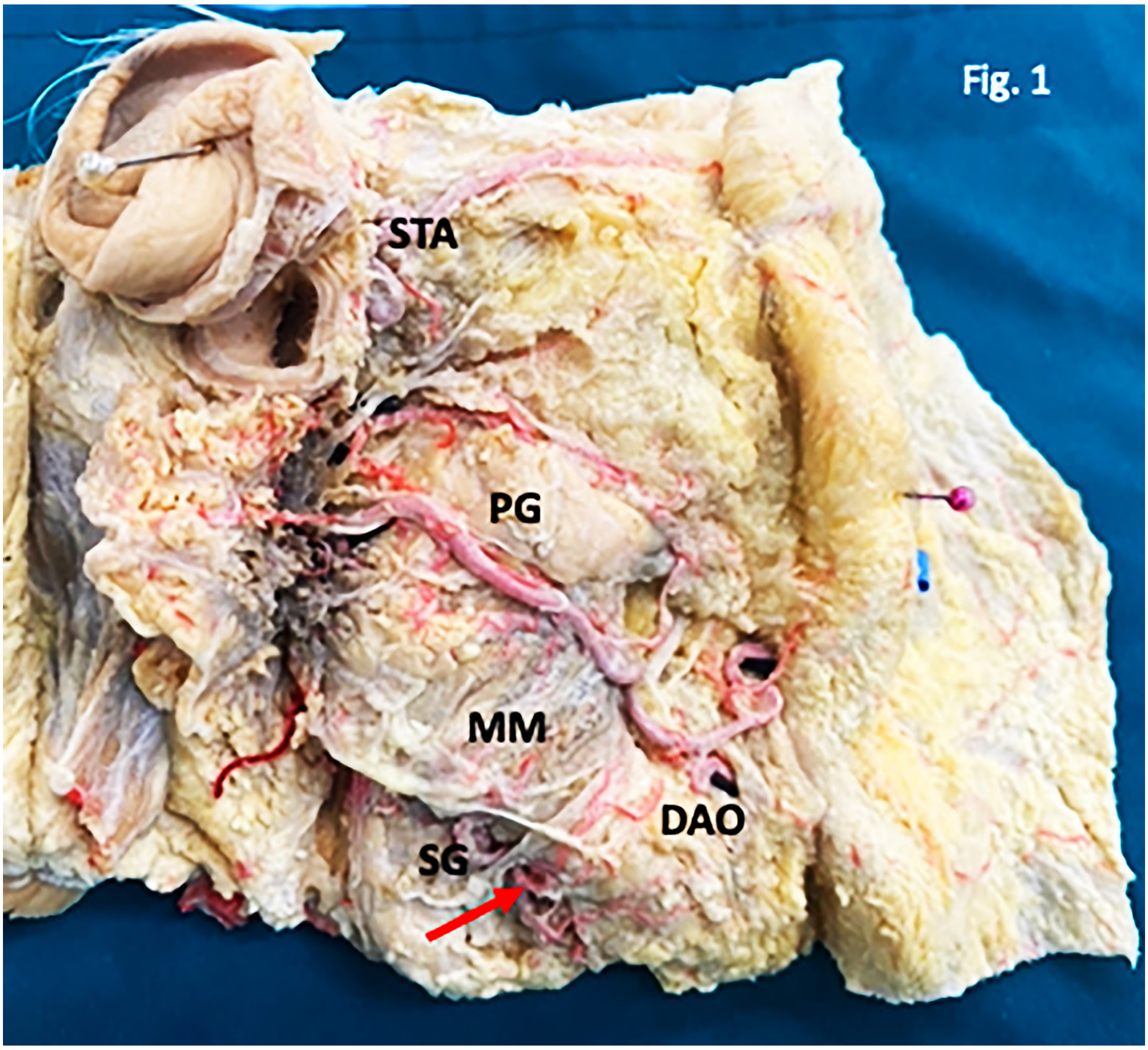

Fig. 1.- A short facial artery (arrow) after running deep to the submandibular gland (SG), arises at the lower border of the mandible and disappears giving several small gauge terminal branches (arrowheads) to the masseter muscle (MM) and the depressor anguli oris (DAO). PG: Parotid gland; STA: Superficial temporal artery

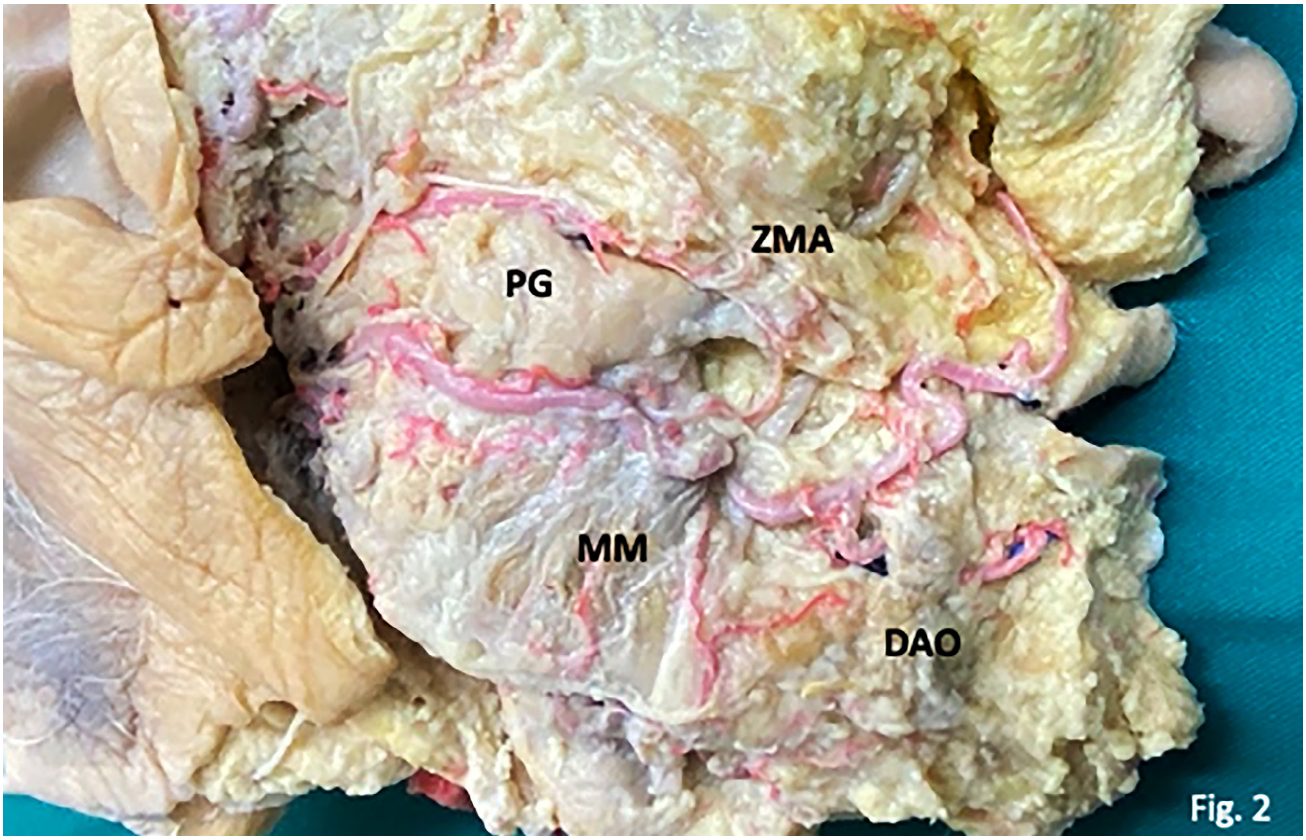

Fig. 2.- The latex-injected transverse facial artery (arrow) originates within the parotid gland and courses forward below Stenon's duct and the accessory parotid artery (asterisk) over the masseter muscle (MM) and anastomoses with zygomatic-orbital artery (circle), parallel to the zygomatic branch of the facial nerve. It then courses forward and downward, crossing the path of the facial vein (cushion) that runs below the zygomaticus major muscle (ZMA) to the medial angle of the eye. The transverse facial artery then goes to the lip corner and originates the superior and inferior labial arteries (arrowheads), the latter runs below the depressor anguli oris muscle (DAO). The transverse facial artery then ascends in the nasolabial groove and ends as angular artery (double arrow).

back branches of very small gauge to irrigate the depressor *anguli oris*.

Dissecting in search for the labial arteries, we find that its origin was in the transverse facial artery, which, instead of the usual path towards the cheek parallel to the zygomatic apophysis, ran forward and downward, and gave branches that irrigate the different structures that go through it.

Near its origin in the temporal superficial artery, this transverse facial artery gives a branch at the level of the Stenon conduct, which anastomoses with a secondary branch of the superficial temporal artery: it is the zygomatic-orbital branch. This branch is going to irrigate the major and minor zygomatic muscles.

Next, it gives branches towards the masseter muscle, above all in its portion more cranial, and when the artery arrives at the orbital muscle of the lips it splits into two branches which will be the superior and inferior labial arteries. (Fig. 2)

The path of both labial arteries is deep at the orbicularis muscle fibers, the same in the case of the described labial arteries as the division of the facial artery.

The vascularization of the lateral portion of the nose and the medial angle of the eye comes from the same transverse facial artery of the face and not from the facial artery.

Regarding the other hemiface, this piece presents the same anatomic variation as its collateral, but the latex injection does not show the facial artery with the terminal branches, because the piece already had a window at the maxillary sinus, and its path is not appreciated in all its length.

DISCUSSION

In odontology or maxillofacial surgery, it is of vital importance to know the anatomy and the vascularization of the area it is going to be worked. This will avoid complications that can come up during the clinical manoeuvres, such as excessive bleeding, fibrosis, and ischemia (Cotofana and Lachman, 2019; Herford and Lowe, 2018).

The facial artery has been very much studied regarding all its variations because of its importance which implies the localization of the labial arteries in the peribuccal aesthetical procedures (Salmon, 1936; Park et al., 1994). The most frequent variations described take place at the labial edges level where the facial artery gives the labial branches. These arteries usually go deep to the orbicular oris muscle of the lips to change regarding size and thickness and mainly the height in which those arteries originate or the distance regarding the edge of the mouth. Park et al. also described the bilateral presence of the superior labial artery in 90% of the cases studied with superficial and deep septal branches (Nakajima et al., 2002).

The transverse facial artery has been less studied at the surgical procedures level, because beforehand its natural path does not present any complication at the surgical level, if it is avoided when planning the treatment (Thwin et al., 2010; Pierrefeu et al., 2019; Koziej et al., 2019). However, works from Toure et al. (2021), describe three types of transverse facial artery: type 1, of small gauge and does not extend towards the masseter; type 2, in nasolabial direction and it gets anastomosed with the facial artery (this also occurs in the variation we have found); and type 3, of great gauge and substitutes at nasal level the facial artery, getting anastomosed with the nasal dorsal artery. It also described the presence of facial artery hypoplasia, in which the transversal artery helps in the irrigation of the nose area. Other studies such as the Yang et al. (2010) referred to 44 corpses for the topographic anatomy of the transverse facial artery, and they found four types of variation only in the artery divisions; however, the paths and areas of irrigation are classically described.

None of the described cases in the literature has found that the transverse facial artery substitutes completely for the facial artery, giving its main branches, labial and angular coronaries, as in the case we described.

Koziej et al. (2022) conducted a meta-analysis, in which they gathered information regarding the termination patterns of the facial artery. They established that the most common pattern is the one that ends in the lateral nasal or angular artery. In conclusion, they emphasize the importance of thoroughly understanding this artery and its branches when performing procedures such as dermal fillers or facial flaps to minimize complications arising from the treatment.

The majority of the esthetic treatments at oral and nose levels are aimed at the infiltration of hyaluronic acid, a procedure not as invasive as it can be the implementation of tightening threads. These procedures have as an objective the superficial layer of the skin to SMAS because, in the deeper layers, we find the vessels and nerves that irrigate and innerve the skin, as well as the facial musculature.

Notwithstanding, these procedures run the risk, when we make fillings with hyaluronic acid at the labial area level, of introducing material in the interior of the coronary artery, clogging it, and causing an ischemic area and vascular compromise which, although the arterial disposition of that area is compensated with the coronary artery of the other side, is an accident that should be avoided. Likewise, they can break one of the coronary branches and cause heavy bleeding, in cases in which the path of such arteries is more superficial concerning the orbicular muscle of the lips.

Knowledge of the paths and dispositions of the main vascular and nervous elements is imperative or necessary to achieve the highest parameters of security in these maneuvers, but the existence of anatomical variations is a probability that cannot be avoided.

This is why in the planning of the treatment it would be always useful to know the path of the main vessels and nerves to avoid their possible injury, and in this case we recommend the use of means such as ultrasound, which allows the location of the arteries in each area to be treated, and facilitates the execution of a correct clinical procedure without complications (Lee et al., 2020; Tansatit et al., 2019; Zhang et al., 2016).

Similarly, the procedures used in dentistry to extract the Bichat fat ball require precise knowledge of the anatomical area by the professional in order to avoid complications such as profuse bleeding due to arterial rupture (Grillo et al., 2021; Alcântara et al., 2021; Pimentel et al., 2021; Hwang et al., 2005).

In addition to esthetic procedures that can cause arterial damage in the field of dentistry, we also encounter dental and maxillofacial interventions that can lead to vascular complications.

Takeshita et al. (2021) studied the arterial injuries caused during the third molar extraction process, highlighting that the facial artery could be damaged if the surgery extended into the soft tissues during the surgical procedure, exacerbating the damage to soft tissues.

Iwanaga et al. (2020) conducted a cadaver study where they analyzed the risk of vascular damage in the periosteal-releasing incision technique in mandibular buccal periosteum. They dissected the lateral periosteal fat tissue to locate the facial artery (and its branches), measuring its diameter and course. The results showed that in all specimens studied, and on both sides of the individuals, the inferior labial artery was consistently positioned in the lateral fat tissue near the mandibular periosteum. They concluded that excessive bleeding during wisdom tooth extraction procedures was attributed to periosteal invasion with damage to this arterial vessel.

Lee et al. (2018) conducted a highly detailed review of the facial artery's topography, and established a novel anatomical nomenclature to standardize terminology and assist clinicians in diagnoses and treatments. These authors emphasize the importance of the facial artery in all interventions, both surgical and non-surgical, and highlight the significance of understanding the course of all vessels involved in that region. They conduct a very detailed review, but do not consider the anatomical variation described by us.

In conclusion, anatomical variations at the facial level can complicate surgical procedures, so, when planning surgery, we must always take into account such considerations. At the level of the facial artery, variations are much more frequent than at the level of the facial transverse artery, but, as we show in our work, they also exist.

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