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SWISS DENTAL JOURNAL SSO 128: 382–392 (2018)

Accepted for publication: 12 September 2017

# The Face – A Vascular Perspective

A literature review

#### KEYWORDS

Anatomy  
 Face  
 Vascular supply  
 Arteries  
 Veins  
 Lymphatics  
 External/internal carotid arteries

#### SUMMARY

Vascular supply is key for maintenance of healthy tissue conditions but also with regard to healing following trauma or therapeutic interventions. The face is probably the most exposed part of the body and any changes of vascularity are readily visible (skin blanching, ecchymosis, hematoma, edema). With regard to the arterial supply, all vessels reaching the facial skin originate from the bilateral common carotid arteries. The ophthalmic artery is considered the major arterial shunt between the internal and external carotid artery

systems. Main arterial contributors to the face include the facial, transverse facial, and infra-orbital arteries. In general, homonymous veins accompany the arteries, but there are some exceptions (inferior ophthalmic vein, retro-mandibular vein). Furthermore, the facial vein demonstrates a consistently more posterior course compared to the facial artery. Lymphatic vessels including lymph nodes play an important role for facial drainage.

## Introduction

This is the second article regarding anatomical aspects of the face. While the first article addressed the neurosensory supply to the skin of the face (VON ARX ET AL. 2017), this paper is directed at the vessels of the face. The vascular structures include arteries, veins and lymphatics. They are all important to maintain tissue conditions and provide the necessary vascular support for healing and drainage after injuries or surgeries. Spasms of arteries result in skin blanching whereas damage to blood vessels will lead to bruising and/or hematomas that are particularly irritating for the patient when they are located in the face. Furthermore, blood vessels and lymphatics play a role with regard to spread of infections and tumors.

This review is based on the findings of dissections in previously colored latex-injected and formalin-fixed cadavers. Dissection procedures were in accordance to the standard operating procedures of the Willed Body Program at the John A. Burns School of Medicine, University of Hawai'i, Manoa, and are available for public review (LABRASH & LOZANOFF 2007).

## Arteries

All arteries supplying the face originate from the bilateral common carotid artery (Fig. 1–4). The common carotid artery arises on the right side from the brachiocephalic artery and on the left side directly from the aorta (aortic arch). At the level of the fourth cervical vertebral body/hyoid bone, the common carotid

artery divides into the external and internal carotid arteries. Both arteries ascend in a vertical direction to the head.

The main arteries of the face originate either directly from the external carotid artery (facial artery, superficial temporal artery) or from branches of the external carotid artery (transverse facial artery from superficial temporal artery, infraorbital artery from maxillary artery) (VON ARX & LOZANOFF 2017). A major arterial contributor to the forehead is the ophthalmic artery arising from the internal carotid artery.

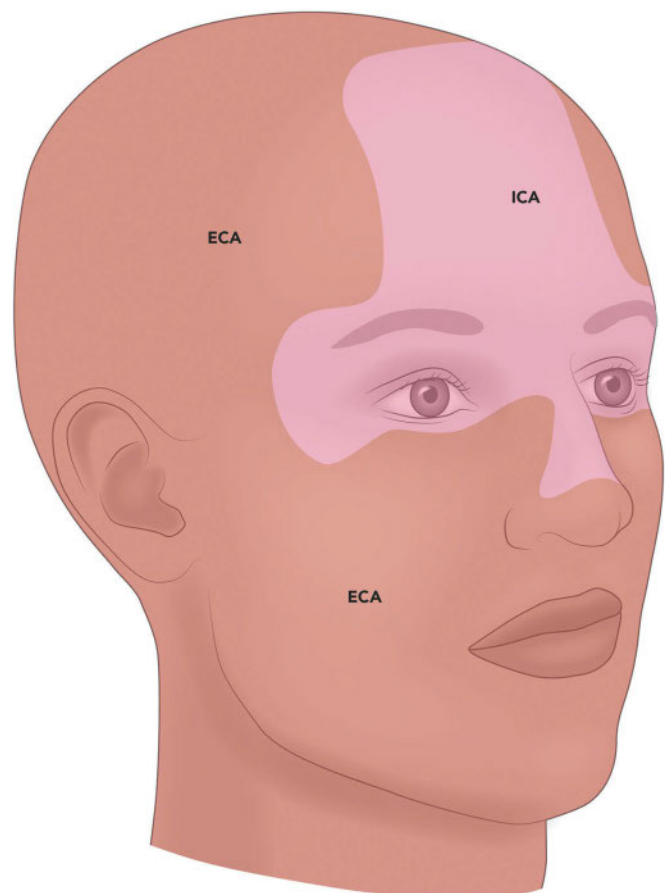
According to SOIKKONEN ET AL. (1991), the blood supply to the face is mainly provided by the facial, transverse facial and infraorbital arteries that are in hemodynamic balance. In their cadaver study they also demonstrated that the facial artery had a greater tendency to tortuosity than the other two arteries, and that the severity of tortuosity was positively correlated with age. The underlying causes of arterial tortuosity include increase in diameter and elongation of arteries as a result of reduced elasticity and arterial hypertension (SOIKKONEN ET AL. 1991).

According to HOUSEMAN ET AL. (2000), the blood supply to the skin follows the connective tissue framework. The main arterial skin perforators pierce the deep fascia originating from their source arteries, then radiating to the skin areas of the face. In general, the vessels are intimately related to the superficial musculo-aponeurotic system ("facial musculature"). Midline anastomoses of arterial vessels are especially rich in the forehead and lips (HOUSEMAN ET AL. 2000). WHETZEL & MATHES (1992) described that the lateral areas of the face are characterized by only few arterial perforators. In contrast, hundreds of small arterial perforators that terminate in a fine vascular network provide vascularization of anterior facial areas. Deep fascial as well as a subdermal arterial plexuses exist throughout the face connected by arterial perforators. The cutaneous arterial supply of the face can be divided into an anterior facial region containing musculocutaneous perforating arteries and a lateral area containing fasciocutaneous perforating arteries. The transition between these zones consistently occurs immediately lateral to the nasolabial region (WHETZEL & MATHES 1992).

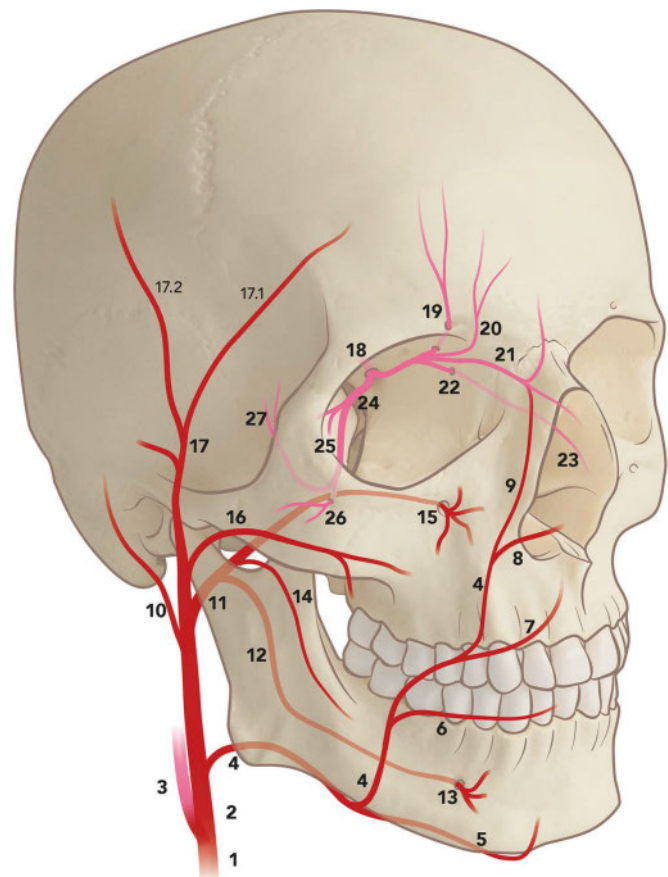
### Ophthalmic artery

The ophthalmic artery is the artery of the orbit (Fig. 2). It originates from the internal carotid artery within the middle cranial fossa, travels through the optic foramen, and divides into multiple arterial branches within the orbital cavity (orbit). Occasionally, the ophthalmic artery arises from the middle meningeal artery (LIU & RHOTON 2001). The ophthalmic artery is also considered a major arterial shunt between the internal and external carotid arteries (MACCHI & CATINI 1993).

The discussion is confined to arterial branches from the ophthalmic artery supplying the skin of the face. The arterial branches ascending to the skin of the forehead include the supraorbital and supratrochlear arteries (Fig. 5). Both also pro-



**Fig. 1** The arterial blood supply to the face is provided by two sources: the external carotid artery (ECA, red area) and the internal carotid artery (ICA, pink area)



**Fig. 2** Arteries with branches to the face (in red originating from the external carotid artery, in pink originating from the internal carotid artery): 1 = common carotid a.; 2 = external carotid a.; 3 = internal carotid a.; 4 = facial a.; 5 = submental a.; 6 = inferior labial a.; 7 = superior labial a.; 8 = lateral nasal a.; 9 = angular a.; 10 = posterior auricular a.; 11 = maxillary a.; 12 = inferior alveolar a.; 13 = mental a.; 14 = buccal a.; 15 = infraorbital a.; 16 = transverse facial a.; 17 = superficial temporal a. (17.1 = frontal branch, 17.2 = parietal branch); 18 = ophthalmic a.; 19 = supraorbital a.; 20 = supratrochlear a.; 21 = dorsal nasal a.; 22 = anterior ethmoidal a.; 23 = external nasal a.; 24 = lacrimal a.; 25 = zygomatic a.; 26 = zygomaticofacial a.; 27 = zygomatico-temporal a.

vide minor branches to the medial and middle portions of the upper and lower eyelids via the medial palpebral arteries (Fig. 6A). The ophthalmic artery provides anterior and posterior ethmoidal arteries that course through the anterior and posterior ethmoidal foramina, respectively (Fig. 6B). The anterior ethmoidal artery terminates as the external nasal artery supplying lateral portions of the nose (Fig. 7A).

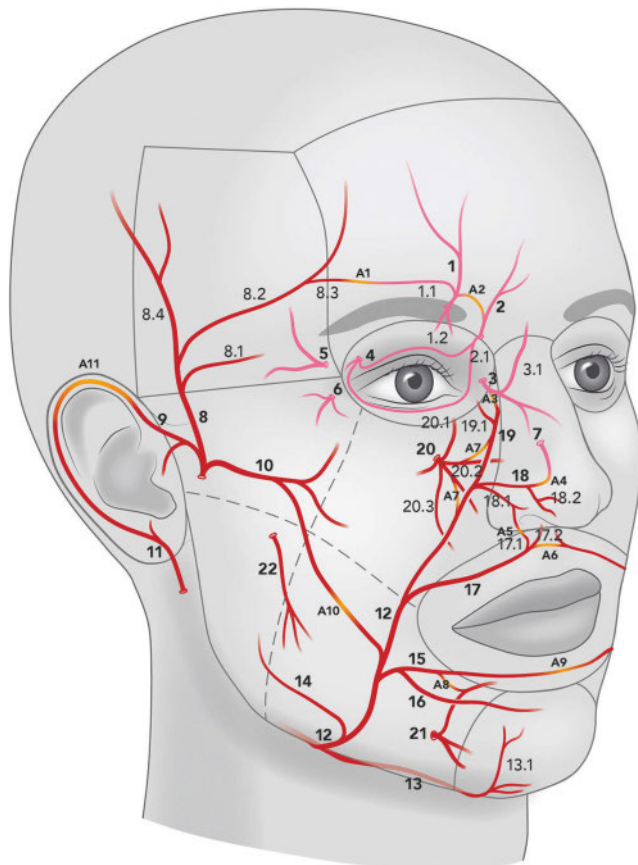
The dorsal nasal artery (Fig. 2, 3) is a terminal branch of the ophthalmic artery that exits the orbit above the medial palpebral ligament (HAYREH 1962). It supplies the skin of the medial

eye angle, the lacrimal sac and the bridge of the nose. The dorsal nasal artery (a companion to the infratrochlear nerve) also connects with the angular artery of the facial artery, thus represents an anastomosis between the internal and external carotid artery systems.

The lacrimal artery – a large branch of the ophthalmic artery – courses along the lateral wall of the orbit to supply, among other structures, the lateral portions of the upper and lower eyelids (Fig. 3, 5). The zygomatic artery, also arising from the lacrimal artery, enters the zygomatic bone and subdivides into the zygomaticofacial and zygomaticotemporal arteries (Fig. 2, 3).

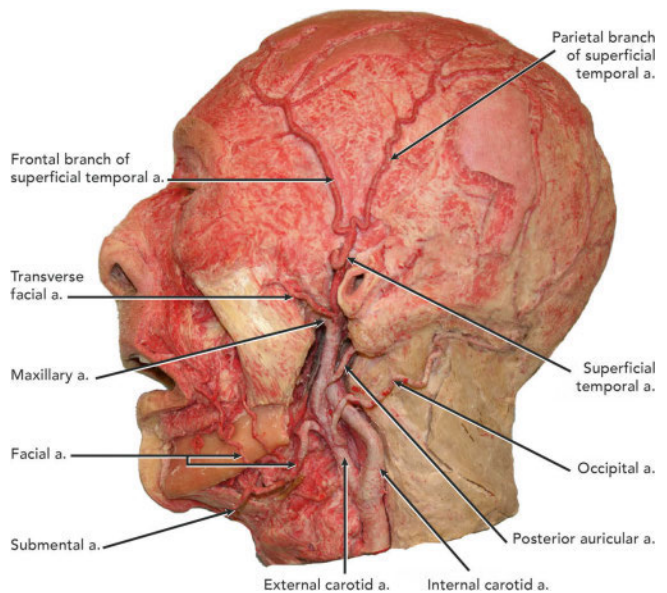
### Superficial temporal artery

The superficial temporal artery (Fig. 2–4) is a terminal branch of the external carotid artery. It arises within the parotid gland at the level where the maxillary artery bifurcates from the external

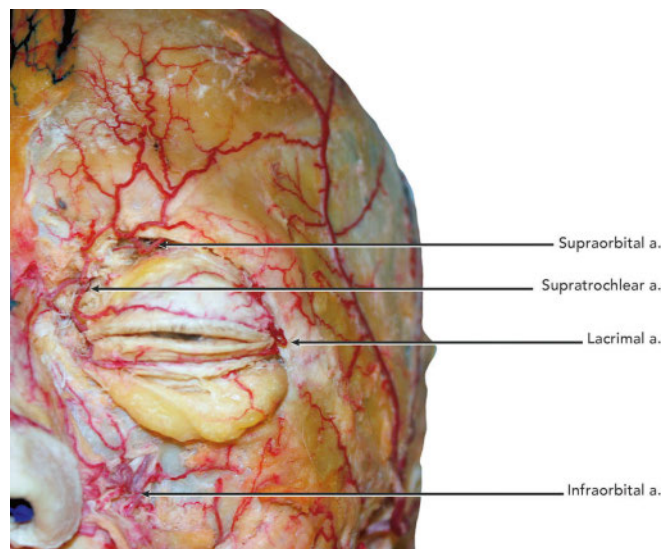


**Fig. 3** Arteries contributing to the vascular supply of the face (in red originating from the external carotid artery, in pink originating from the internal carotid artery, in orange arterial anastomoses): 1 = supraorbital a. (1.1 = horizontal frontal branch, 1.2 = superior palpebral branches); 2 = supratrochlear a. (2.1 = superior/inferior palpebral branches); 3 = dorsal nasal a. (3.1 = central a.); 4 = superior/inferior palpebral branches from lacrimal a.; 5 = zygomaticotemporal a.; 6 = zygomaticofacial a.; 7 = external nasal branch from anterior ethmoidal a.; 8 = superficial temporal a. (8.1 = temporo-orbital branch, 8.2 = frontal branch, 8.3 = transverse frontal branch, 8.4 = parietal branch); 9 = anterior auricular a.; 10 = transverse facial a.; 11 = posterior auricular a.; 12 = facial a.; 13 = submental a. (13.1 = vertical labiomental a.); 14 = masseteric branch from facial a.; 15 = inferior labial a.; 16 = horizontal labiomental a.; 17 = superior labial a. (17.1 = inferior alar branch, 17.2 = septal branches); 18 = lateral nasal a. (18.1 = superior alar branches, 18.2 = nostril branches); 19 = angular artery (19.1 = medial palpebral branch); 20 = infraorbital a. (20.1 = inferior palpebral branch, 20.2 = nasal branch, 20.3 = superior labial branches); 21 = mental a.; 22 = buccal a.

Arterial anastomoses: A1 = anastomosis between supraorbital a. and frontal branch of superficial temporal a.; A2 = anastomosis between supraorbital a. and supratrochlear a.; A3 = anastomosis between dorsal nasal a. and angular a.; A4 = anastomosis between lateral nasal a. and external nasal branch from anterior ethmoidal a.; A5 = anastomosis between superior labial a. and lateral nasal a.; A6 = anastomosis between bilateral superior labial a.; A7 = anastomosis between facial a. and infraorbital a.; A8 = anastomosis between inferior labial a. and mental a.; A9 = anastomosis between bilateral inferior labial a.; A10 = anastomosis between facial a. and transverse facial a.; A11 = anastomosis between anterior and posterior auricular a.



**Fig. 4** Lateral view of the arterial facial blood supply. The external carotid artery provides all extracranial branches (formalin-fixed and colored-latex injected cadaveric head).



**Fig. 5** Frontal view of the left orbit with periorbital arteries (formalin-fixed and colored-latex injected cadaveric head).

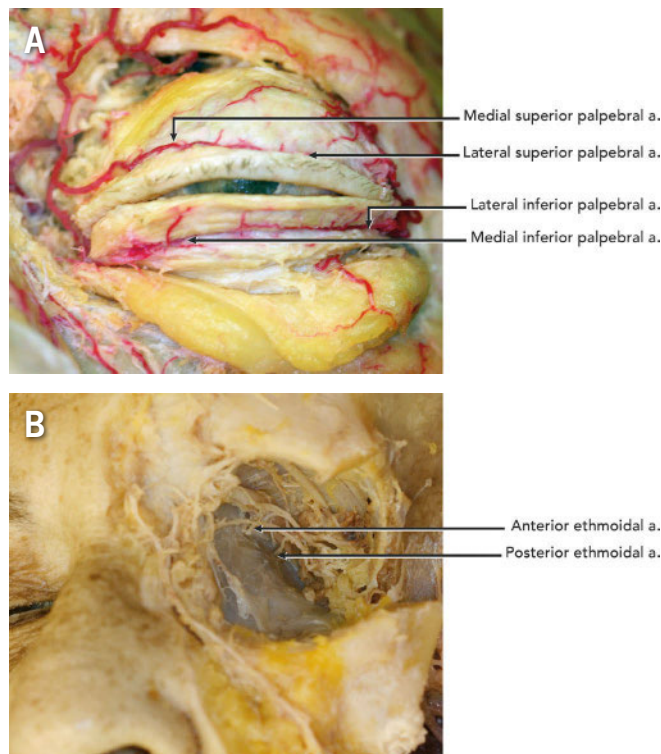
carotid artery. It ascends over the posterior root of the zygomatic arch approximately 1 cm anterior to the ear (HUANG COBB ET AL. 2016; TUBBS ET AL. 2007). Bilaterally, the superficial temporal artery provides arterial supply to a large area of the facial skin including the lateral forehead, temple, zygoma, and ear (PINAR & GOVSA 2006). A major artery arising from the superficial temporal artery is the transverse facial artery (Fig. 2–4, see also below). In some patients, the superficial temporal artery is visible through the skin, occasionally presenting a tortuous course. Its pulse can be palpated above the zygomatic arch in front of the ear.

TUBBS ET AL. (2007) assessed the superficial temporal artery in 26 adult cadaveric hemifaces. The artery bifurcated on average 3 cm superior to the tragus into frontal and parietal branches. The mean angle between the two branches was 87 degrees.

### Transverse facial artery

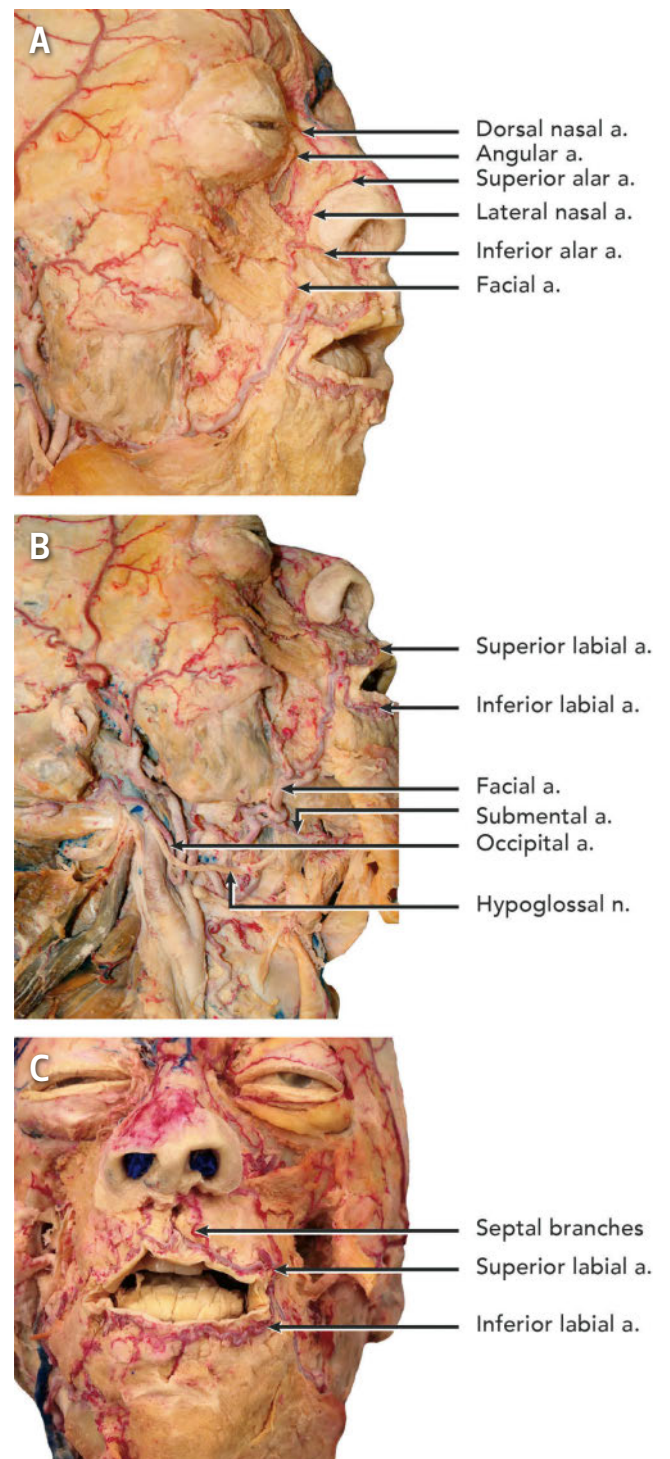
The transverse facial artery (Fig. 2–4) originates from the superficial temporal artery within the parotid gland. It courses anteriorly, sometimes also in a slightly downward direction, to the cheek. In cases with hypoplastic facial arteries, the transverse facial artery may compensate and vice versa (SOIKKONEN ET AL. 1991; TUBBS ET AL. 2005).

YANG ET AL. (2010) evaluated in detail the topographical anatomy of the transverse facial artery in 44 cadavers. The transverse facial artery consistently divided into superior and inferior emerging branches. The mean number of perforators to the superficial cutaneous layer was 1.9 (range 1–4), mostly extending from the superior emerging branch over the masseter muscle. Occasionally, the transverse facial artery formed an anastomosis with the facial artery.



**Fig. 6** (A) Arteries associated with the eyelids (formalin-fixed and colored-latex injected cadaveric head). (B) Left orbit with eyeball removed to demonstrate the anterior and posterior ethmoidal arteries entering the nasal cavity via the anterior and posterior ethmoidal foramina (formalin-fixed cadaveric head).

According to WHETZEL & MATHES (1992), staining of the transverse facial territory in cadaver heads is highly reproducible. They described the vascular territory (height approximately 7 cm, width approximately 6 cm) of the transverse facial artery extending horizontally from the lateral canthus to around 1.5 cm anterior to the auditory canal and vertically from around 1.5 cm above the zygomatic arch to a level approximately 1 cm below the commissure.



**Fig. 7** Nasal (A) and perioral vascularization (B, C) with primary arteries indicated. Note the course of the hypoglossal nerve around the occipital branch of the external carotid artery (B) (formalin-fixed and colored-latex injected cadaveric head).

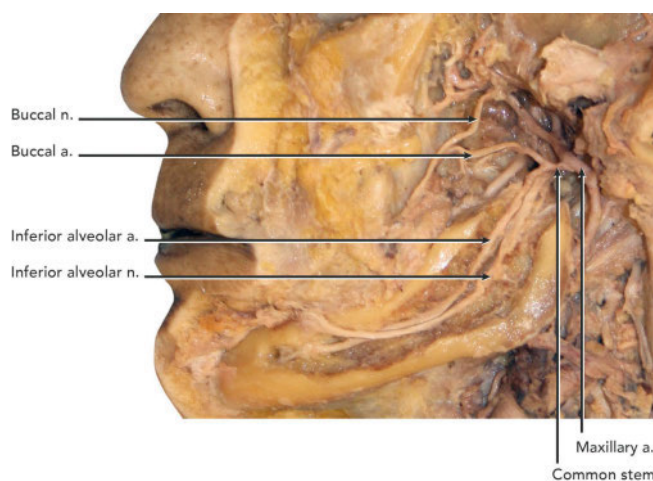
## Facial artery

The facial artery, a relatively large vessel, originates from the external carotid artery at the level of the angle of the mandible (Fig. 2–4). Occasionally, the facial artery forms a common trunk with the lingual artery (PANTOJA ET AL. 2014). The facial artery travels to and curves around the inferior border of the mandible just anterior to the prominent masseter muscle. At this location, a pulse can usually be felt. The facial artery then ascends in an oblique direction towards the medial eye angle that it, however, not always reaches (CROUZET ET AL. 1998; PINAR ET AL. 2005). Most frequently, the oblique portion of the facial artery is located medial to the nasolabial fold (YANG ET AL. 2014). The facial artery is the main artery of the cheek. It provides several arterial branches to neighboring structures including skin areas of the chin, lips, and nose (ZHOU ET AL. 2017). It may further anastomose with branches from the maxillary and ophthalmic arteries.

Commonly, the terminal branches of the facial artery include the lateral nasal artery or the angular artery (KOH ET AL. 2003), in other words, after the lateral nasal artery originates from the facial artery, it is called angular artery (NAKAJIMA ET AL. 2002) (Fig. 7A). The same authors demonstrated that branches originating from the facial artery might form common trunks: superior and inferior labial branches, superior labial and inferior alar branches, and inferior alar and lateral nasal branches. Others have also documented the great and complex variability in the branching pattern of the facial artery regarding its arteries to the lips and nose (NAKAJIMA ET AL. 2002; LOUKAS ET AL. 2006). LEE ET AL. (2015) categorized the course of the facial artery into three types after studying 54 cadaveric adult faces: type I (nasolabial pattern), type II (nasolabial pattern with infraorbital trunk), and type III (forehead pattern).

## Infraorbital artery

The infraorbital artery (Fig. 2, 3, 5) is a terminal branch of the maxillary artery. It exits the infraorbital canal at the infraorbital foramen and divides into several branches supplying the skin of the lower eyelid (inferior palpebral branches), the lateral aspects of the nose (nasal branches), and the upper lip (superior labial branches). The branches from the infraorbital artery may communicate with branches from the facial artery (KELLY ET AL. 2008).



**Fig. 8** Infratemporal fossa dissection demonstrating the inferior alveolar artery (IAA) and its course through the mandible as well as the buccal artery that arose from a common stem shared with the IAA and then distributing with the buccal nerve (formalin-fixed cadaveric head).

## Buccal artery

The buccal artery arises from the “pterygoid” segment of the maxillary artery within the infratemporal fossa. From there, the buccal artery courses antero-inferiorly to the cheek (Fig. 2, 3, 8).

## Mental artery

The mental artery is a terminal branch of the inferior alveolar artery (Fig. 2, 3). The latter originates from the “mandibular segment” of the maxillary artery deep to the mandibular condyle within the infratemporal fossa. The mental artery exits the mental foramen and distributes to the lower lip and chin areas. The mental artery may communicate with branches from the facial artery, mainly with the inferior labial artery but also with the submental artery (PINAR ET AL. 2005).

## Arterial supply of the skin by subunits of the face

The arteries providing arterial supply to the skin of the facial subunits are depicted in Figure 3.

### Forehead

The blood supply to the forehead is provided by the supraorbital and supratrochlear arteries, both originating from the ophthalmic artery (Fig. 3, 5). Furthermore, the frontal branch of the superficial temporal artery supplies the lateral part of the forehead and frequently forms anastomoses with the supraorbital and supratrochlear arteries (PINAR & GOVSA 2006) (Fig. 3, 4).

KLEINTJES (2007) described in detail the arterial vascularization of the forehead in 60 cadaveric hemiheads: the frontal branch (mean diameter approximately 2 mm) of the superficial temporal artery was consistently the largest supplier compared to the other arteries with a mean diameter of around 1 mm. The frontal branch of the superficial temporal artery may provide a transverse frontal branch, most often anastomosing with an oblique branch from the supraorbital artery. The latter has superficial branches (vertical and brow branches) and deep branches (medial, oblique, lateral rim branches). The supratrochlear artery steadily emerged from the superomedial orbit close to a vertical line at the medial palpebral commissure. Laterally, the supratrochlear artery may have communicating branches with the supraorbital artery, whereas medially with the angular artery. KLEINTJES (2007) also described a central artery in the midline of the forehead arising from the dorsal nasal artery.

### Eyelids

#### Upper eyelid

The arterial supply to the upper eyelid includes the lacrimal, supraorbital, and supratrochlear arteries that provide palpebral branches to the lateral, middle and medial portions of the upper eyelid (Fig. 3, 6A) (KLEINTJES 2007).

#### Lower eyelid

The lower eyelid is supplied by the palpebral branch of the infraorbital artery as well as by the lateral and medial palpebral branches from the lacrimal and supratrochlear arteries, respectively (Fig. 3, 6A). The palpebral branch of the infraorbital artery emerges from the infraorbital foramen and courses superiorly and laterally to the orbital septum, subsequently piercing the septum close to the infraorbital rim (HWANG ET AL. 2011). A small branch of the angular artery may also supply the medial lower eye lid.

## Nose

There is a rich vascular network of small arteries in the alae, tip and columella of the nose (Fig. 3, 7A). The main contributing vessels are the lateral nasal artery from the facial artery and alar branches, directly originating either from the facial artery or indirectly from the lateral nasal artery or from the superior labial artery (JUNG ET AL. 2000; NAKAJIMA ET AL. 2002). Usually, there are two alar branches. Small vessels from the inferior alar branch supply the alar base and nostril floor, whereas small twigs from the superior alar branch perfuse the nasal dorsum and superior rim of the nostril (NAKAJIMA ET AL. 2002). Also, LOUKAS ET AL. (2006) documented several different perfusion patterns with regard to the arterial blood supply from the facial artery to the nose. For example, separate inferior alar and septal branches ascended from the superior labial artery, with inferior alar branches as a bilateral continuation from the midline septal branch. Furthermore, they described great variability with regard to the origin of the superior and inferior alar branches.

The second major source of the arterial supply to the nose is the dorsal nasal artery that arises as the terminal branch of the ophthalmic artery (HAYREH 1962) (Fig. 3, 6B, 7A). The dorsal nasal artery emerges from the medial orbit and courses over the anterior surface of the nasal bones. Then it runs down the nasal dorsum to anastomose freely with the lateral nasal branch of the facial artery on each side (HOUSEMAN ET AL. 2000). The dorsal nasal artery usually proceeds to the nasal tip by passing over the lateral nasal artery, where it contributes to the arterial arcade of the nasal tip (TORIUMI ET AL. 1996).

The external nasal artery, a terminal branch of the anterior ethmoidal artery, surfaces at the junction of the nasal bone and lateral nasal cartilage. This artery supplies the inferolateral areas of the nose and may also anastomose with the lateral nasal artery.

## Lips

### Upper lip

The primary arterial source of the upper lip is the superior labial artery, originating from the facial artery at the level of the commissure. Further arterial supply to the upper lip may occur from labial branches of the infraorbital artery.

PINAR ET AL. (2005) observed in all dissected cadavers that the superior labial artery anastomosed with the opposite artery in the middle of the upper vermilion (Fig. 3, 7B, 7C). Nine to ten short and thin branches of the uniting right and left superior labial arteries went to the skin and the mucosa of the upper lip. NAKAJIMA ET AL. (2002) demonstrated with angiograms that the bilateral superior labial arteries anastomosed in the middle of the lip. They further described ascending superficial branches reaching the skin of the lip, but also forming a vascular plexus that continued to the nasal tip plexus. Furthermore, superficial ascending branches lateral to the philtrum anastomosed with branches from the inferior alar branch from the lateral nasal artery (NAKAJIMA ET AL. 2002). CROUZET ET AL. (1998) as well as AL-HOQAIL & MEGUID (2008) demonstrated in their dissections, that apart from the main arterial supply from the superior labial artery, subalar and septal branches from the lateral nasal artery contribute to the vascularization of the upper lip.

### Lower lip

Three labial arteries provide the blood supply to the lower lip: the inferior labial artery as well as the horizontal and vertical labiomental arteries (KAWAI ET AL. 2004; PINAR ET AL. 2005; AL-HO-

QAIL & MEGUID 2008; AWNI & CONN 2016). The inferior labial artery (Fig. 3, 7B, 7C) originates either directly from the facial artery or indirectly from a common trunk with the superior labial artery. The horizontal labiomental artery, also arising from the facial artery, is located lower than the inferior labial artery. The vertical labiomental artery is a branch from the submental artery. All three arteries form a vascular network in the subcutaneous and submucosal tissues of the lower lip with tiny vessels branching to the skin, mucosa and muscles (KAWAI ET AL. 2004).

## Chin

The main artery of the chin is the mental artery, one of the terminal branches of the inferior alveolar artery (Fig. 3). In the lower part of the chin and submental region, perforators from the submental artery reach the skin (RAHPEYMA & KHAJEH AHMADI 2014). The submental artery (Fig. 1, 7B) supplies an area of around 5 × 5 cm. It extends vertically from around 3 cm below the mandibular border to around 1 cm below the oral commissure, and horizontally from around 1.5 cm posterior to the commissure to around 2 cm anterior of the sternocleidomastoid muscle. Occasionally, it can also supply a part of the chin (WHETZEL & MATHES 1992).

IWANAGA ET AL. (2016) described a perforating median artery in the lower part of the chin passing through a midline bone canal to the facial aspect and ascending to the chin region. The authors speculated that this artery originated from the sublingual or submental artery. Another artery was observed on the right paramedian side of the chin curving around the inferior alveolar border and coursing upwards to the lower lip – the latter artery also had an anastomosis with the right inferior labial artery.

## Temple region

The temporal region receives its arterial supply from the frontal branch of the superficial temporal artery and from the zygomaticotemporal branch of the zygomatic artery, the latter a branch from the lacrimal artery (Fig. 3). Also, the zygomatico-orbital artery – though it is inconsistently present – may supply this region (WHETZEL & MATHES 1992). The zygomatico-orbital artery originates either directly from the main trunk of the superficial temporal artery, or from one of its branches, such as the middle temporal artery. Hence, the arterial supply to the temporal region has two different sources: the external carotid artery with the superficial temporal artery as well as the internal carotid artery with the zygomatic artery.

## Cheeks

The main blood supply to the cheeks is from arterial perforators originating from the transverse facial artery (Fig. 3, 4) and from the facial artery (WHETZEL & MATHES 1997; WOLFF ET AL. 2005; SCHAEVERIEN ET AL. 2009). The latter supplies the lower anterior part of the cheek (buccal region), whereas the transverse facial artery provides its supply to the posterosuperior parts of the cheek (zygomatic and parotid-masseteric regions). The zygomatic area of the cheek further receives arterial supply from the zygomaticofacial branch of the lacrimal artery. The buccal artery (Fig. 5) originating from the maxillary artery perfuses the lower anterior portion of the cheek (buccal region).

## Ears/auricles

The anterior part of the ear is supplied by the anterior auricular artery originating from the superficial temporal artery (PINAR & GOVSA 2007). Branches from the posterior auricular

artery (Fig. 3, 4), originating from the external carotid artery, supply the posterior part of the ear, but frequently reach the anterior part (WHETZEL & MATHES 1992). Anterior and posterior auricular arteries regularly show anastomoses (PINAR & GOVSA 2007). HOUSEMAN ET AL. (2000) described arcades formed in the upper portion of the ear between the superficial temporal and posterior auricular arteries. The branch to the ear usually arises from the main trunk of the superficial temporal artery before the latter divides into its frontal and parietal branches, or it may originate from the parietal branch. This auricular branch from the superficial temporal artery courses through the superior sulcus above the root of the ear to join the posterior auricular artery (HOUSEMAN ET AL. 2000).

## Veins

Many veins in the face accompany the homonymous arteries, but there are some exceptions to the rule (inferior ophthalmic vein, retromandibular vein) (Fig. 9, 10). Furthermore, the facial vein and artery run a different course in the face at a certain distance from each other. While the facial vein and artery lie in close proximity at the lower border of the mandible, the artery has a tortuous course among the midface muscles of facial expression, but the vein has a direct path, running from the medial canthus to the lower mandible (HOUSEMAN ET AL. 2000; ZHOU ET AL. 2017). The facial vein is consistently located on average 15 mm posterior to the facial artery (range 5–30 mm) (PHUMYOO

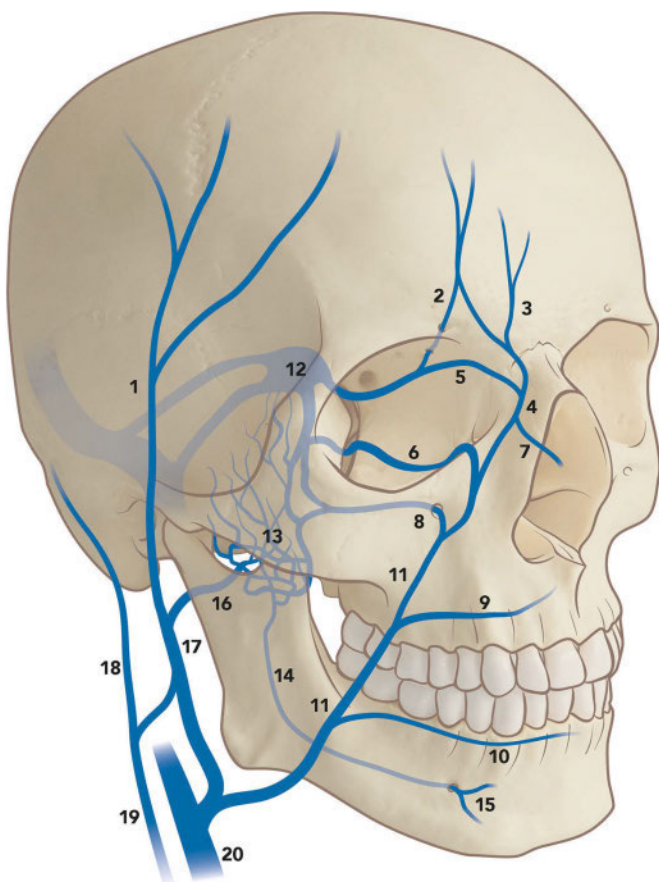
ET AL. 2014). Anatomically interesting but of medical concern are the many communications between facial and intracerebral veins.

Venous drainage of the lateral forehead and temporal/parietal regions occurs via the superficial temporal vein. The latter may have one to three major branches. The superficial temporal vein demonstrates an independent course and a larger supply area than the superficial temporal artery, except for its proximal portion (IMANISHI ET AL. 2002). The venous drainage of the middle forehead and upper eyelid occurs via the angular vein to the ophthalmic veins (superior and inferior) that communicate with the cavernous sinus. The angular vein is formed by the union of the supratrochlear and supraorbital veins. The caudal continuation of the angular vein inferior to the junction with the external nasal vein (for some authors inferior to the junction with the superior labial vein) is usually referred to as the facial vein. Thus, blood may flow from the angular vein either inward to the ophthalmic veins or downward to the facial vein.

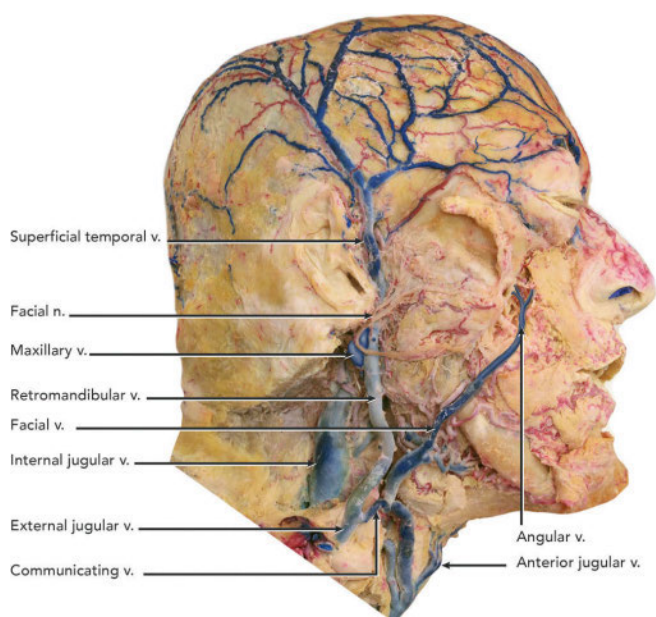
Venous drainage of the midface occurs via the infraorbital vein and pterygoid plexus that also has connections to the cavernous sinus. In addition, the midface (lips, cheeks) drains to the prominent facial vein that shows a similar oblique course as the facial artery. The venous blood from the chin flows via the mental and inferior alveolar veins to the maxillary vein. The latter unites behind the mandibular head with the superficial temporal vein to form the retromandibular vein.

The retromandibular vein has two divisions, an anterior deep and a posterior superficial division. The posterior division merges with the posterior auricular vein to form the external jugular vein, whereas the anterior division merges with the facial vein and drains into the internal jugular vein.

In general, anatomical textbooks report that facial veins are devoid of valves – thus facilitating the spread of infection from the “dangerous triangle” to the intracranial venous sinuses. The so-called “dangerous triangle” of the midface is a triangular-



**Fig. 9** Veins of the face: 1 = superficial temporal v.; 2 = supraorbital v.; 3 = supratrochlear v.; 4 = angular v.; 5 = superior ophthalmic v.; 6 = inferior ophthalmic v.; 7 = external nasal v.; 8 = infraorbital v.; 9 = superior labial v.; 10 = inferior labial v.; 11 = facial v.; 12 = cavernous sinus; 13 = pterygoid plexus; 14 = inferior alveolar v.; 15 = mental v.; 16 = maxillary v.; 17 = retromandibular v.; 18 = posterior auricular v.; 19 = external jugular v.; 20 = internal jugular v.



**Fig. 10** Venous drainage of the cranial region. Note the superficial position of the facial nerve and its relationship with the superficial temporal vein (formalin-fixed and colored-latex injected cadaveric head).

shaped region extending from the angles of the mouth to the root of the nose (ZHANG & STRINGER 2010). However, cadaver studies have demonstrated the presence of valves in different veins in the facial region. NISHIHARA ET AL. (1995) confirmed the existence of valves in facial veins, most frequently observed at confluences around the lower border of the mandible. No valves were detected in the upper portion (along the nose) of the facial veins. ZHANG & STRINGER (2010) reported the presence of valves in the superior ophthalmic vein and its two main tributaries, the supraorbital and angular veins. Valves were also observed in the facial vein. The orientation of valve cusps predicted the following blood flow: in the facial vein, inferiorly; in the superior ophthalmic vein, towards the cavernous sinus, and in the angular vein, to the facial or superior ophthalmic vein (ZHANG & STRINGER 2010). The authors concluded that it is not the absence of venous valves but the existence of communications between the facial vein and cavernous sinus and the direction of blood flow that is important in the spread of infection from the face (ZHANG & STRINGER 2010).

## Lymphatics

The lymphatic system contains the capillary network that consists of pre-collecting and collecting lymph vessels, lymphatic trunks and ducts, and lymph nodes (PAN ET AL. 2010). Lymph vessels are tiny transparent channels and belong to the circulatory system. They provide additional pathways for returning interstitial fluid, the lymph, via the lymphatic ducts to the subclavian veins, localized near their junction with the internal jugular veins.

PAN ET AL. (2011) have described in detail the lymph-collecting vessels of the superficial tissues of the face (Fig. 11). In the forehead, an average of four lymph vessels drained to the pre-auricular and deep parotid lymph nodes, occasionally also to retro-auricular, nasolabial or buccinator lymph nodes. From the eyelids, there are distinct lymph vessels originating from the medial and lateral eyelid commissures draining to the parotid or submandibular lymph nodes, rarely to the buccinator lymph nodes. NIJHAWAN ET AL. (2010) demonstrated with lymphoscintigraphy that lymph vessels from the eyelids mainly drain to the pre-auricular and parotid lymph nodes irrespective of the site of injection.

Lymph vessels from the nose empty into the buccinator or submandibular lymph nodes, infrequently to the nasolabial lymph nodes. Labial lymph vessels arise around the lip commissures and flow to the buccinator, submandibular, and rarely to the submental lymph nodes. Lymph vessels from the chin drain either to the submental or to both submental and submandibular lymph nodes.

## Discussion

The present article reviews the arterial, venous and lymphatic supply of the face. The three vascular entities are important for normal growth and tissue healing in the event of trauma or disease. Color changes of the facial skin due to vascular damage or change are readily visible, possibly affecting patients' psyche.

While the external carotid artery mainly supplies the middle and lower thirds of the face, the upper third of the face receives arteries from the internal carotid artery. Multiple arterial anastomoses have been described in the face:

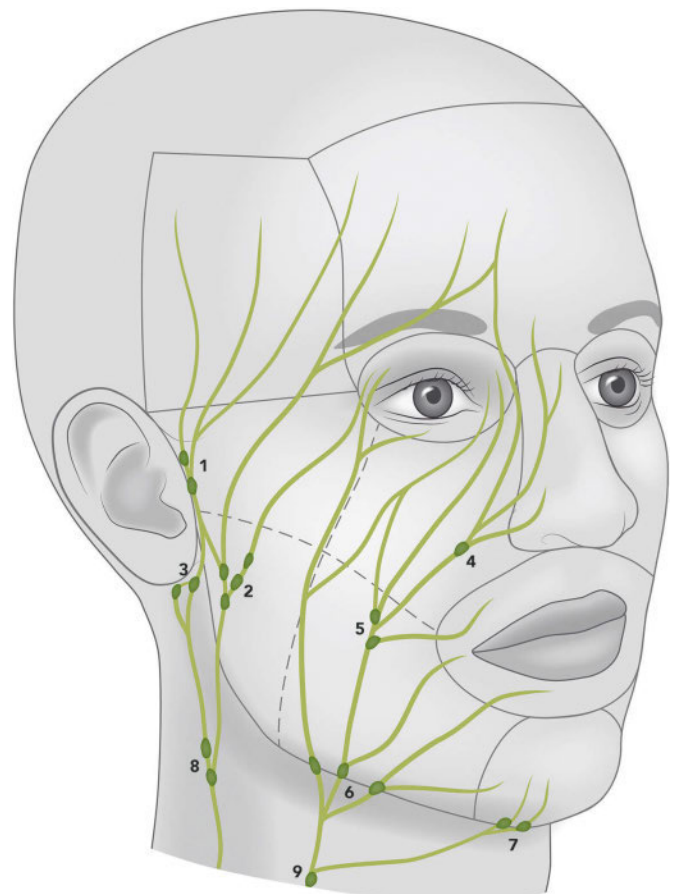
1) between right and left homonymous arteries, for instance anastomoses between the right and left superior labial arteries

- 2) between branches of the external carotid and branches of the internal carotid arteries, such as anastomoses between the frontal branch of superficial temporal and the oblique branch of supraorbital arteries
- 3) between various branches of the external carotid artery, i.e. anastomoses between the transverse facial and the facial arteries

The rich vascularization of the face ensures excellent healing following surgical interventions, provided that the surgeon pays attention to the course and topography of the arterial blood supply. Larger blood vessels of the face may have a diameter of up to 3 mm resulting in profuse hematoma formation in the event of vascular damage (CROUZET ET AL. 1998; NAKAJIMA ET AL. 2002; PINAR ET AL. 2005). At two sites of the face, a pulse can be easily palpated:

- 1) at about 1–2 cm anterior to the external auditory meatus above the zygomatic arch: superficial temporal artery
- 2) at the inferior mandibular border immediately anterior to the masseter muscle (antegonial notch of mandible): facial artery

Although many authors of anatomical textbooks claim that veins of the head and face don't have valves, recent research have demonstrated that some of the veins in the face may present valves (NISHIHARA ET AL. 1995; MIYAKE ET AL. 1996; ZHANG & STRINGER 2010). However, due to the many venous connections within the face, and due to veins eventually reaching the cav-



**Fig. 11** Vessels and nodes (Ln.) of lymphatic drainage of the face according to PAN ET AL. (2011): 1 = preauricular Ln.; 2 = parotid Ln.; 3 = infra-auricular Ln.; 4 = nasolabial Ln.; 5 = buccinator Ln.; 6 = submandibular Ln.; 7 = submental Ln.; 8 = internal jugular Ln.; 9 = anterior jugular Ln.



ernous sinus, the clinician must be aware of tumor and infection spread from the upper two facial thirds to the cerebrum (LI ET AL. 1999; MYLONAS ET AL. 2007; WOELBER ET AL. 2016). An adequate antimicrobial therapy, in terms of administration method, dose and duration, is paramount in order to prevent ascending cutaneous or dental infections to the brain when clinical and radiographic signs/symptoms point at a dangerous situation.

In conclusion, the face has an extensive arterial supply with all arteries originating from the bilateral external and internal carotid arteries. Abundant arterial and venous anastomoses can be observed within the face ensuring an excellent arterial blood supply but also posing a risk of venous infection spread.

## Acknowledgement

The authors thank Bernadette Rawyler, medical illustrator, School of Dental Medicine, University of Bern, Bern, Switzerland, for the illustrations, as well as Jesse Thompson and Beth K. Lozanoff for technical and photographic assistance. The authors acknowledge the generous donation of the anatomical materials by anonymous individuals in the Willed Body Program, the University of Hawai'i John A. Burns School of Medicine, Honolulu, HI, USA.

## Conflict of interest

The authors declare that there are no conflicts of interest related to this review.

## Zusammenfassung

Die vorliegende Arbeit bietet eine Literaturübersicht bezüglich der Gefäße (Arterien, Venen, Lymphgefäße) der Gesichtsregionen. Interventionen beim Zahnarzt, vor allem chirurgische Eingriffe, bedürfen Kenntnisse der Blutversorgung bzw. der topografischen Lage der Gefäße. Aus diesem Grunde sollte jeder Kliniker Kenntnisse der vaskulären Versorgung im Gesichtsbereich haben. Spasmen der Arterien können zu Hautanämien führen, Verletzungen der Arterien zu Hämatomen. Blut- und Lymphgefäße spielen zudem eine Rolle in der Ausbreitung von Infektionen und Tumorzellen.

Alle Arterien des Gesichtes entstammen der A. carotis communis, die rechts vom Truncus brachiocephalicus abzweigt und links direkt vom Aortenbogen. Ungefähr auf Höhe des vierten Halswirbels bzw. des Os hyoideum (Zungenbein) zweigt sich die A. carotis communis in die A. carotis externa und interna auf. Die eigentlichen Hauptarterien des Gesichtes entspringen entweder direkt von der A. carotis externa (A. facialis, A. temporalis superficialis) oder von deren Ästen (A. transversa faciei aus A. temporalis superficialis, A. infraorbitalis aus A. maxillaris). Die Hauptarterie im Stirnbereich ist die A. ophthalmica, die aus der A. carotis interna abzweigt. Die A. ophthalmica mit ihren Ästen gilt auch als bedeutender arterieller «Shunt» zwischen A. carotis interna und externa.

Neben Ästen der A. ophthalmica (A. supraorbitalis, A. supratrochlearis) versorgt auch der Ramus frontalis der A. temporalis superficialis den Stirnbereich. Dieser Ast zeigt häufig Anastomosen mit der A. supraorbitalis. Auch die A. supratrochlearis weist häufig Anastomosen auf, und zwar mit der A. angularis (aus der A. facialis) im mittleren unteren Stirnbereich. Die oberen Augenlider erhalten ihre arterielle Versorgung von diversen Ästen aus der A. lacrimalis, A. supraorbitalis sowie A. supratrochlearis, alles Gefäße von der A. ophthalmica. Die unteren Augenlider werden von Ästen der A. lacrimalis, A. supratrochlearis sowie A. infraorbitalis versorgt.

Die Nase zeigt ein dichtes Netzwerk an kleinen Arterien, hauptsächlich abstammend von der A. nasalis lateralis, aber auch von der A. labialis superior (beide aus der A. facialis). Zudem versorgt ein externer Ast der A. ethmoidalis anterior (Endarterie der A. ophthalmica) den Nasenrücken, wobei zahlreiche kleine Anastomosen mit Ästen der A. nasalis lateralis zu beobachten sind. Die Arterien der Lippen (A. labialis superior bzw. inferior) stammen aus der A. facialis und haben oft Anastomosen mit den homologen Gefäßen der Gegenseite. Die Unterlippe erhält zudem vertikale labiomentale Äste aus der A. submentalis.

Die Hauptarterie des Kinns ist die A. mentalis, ein Endgefäß der A. alveolaris inferior. Unterste Kinnabschnitte werden zudem von Ästen der A. submentalis, gelegentlich sogar von Ästen der A. sublingualis versorgt. Im Wangenbereich erfolgt die arterielle Versorgung durch die A. facialis und die A. transversa faciei, beides kräftige Arterien mit relativ ausgedehnten Versorgungsgebieten. Manchmal finden sich Anastomosen zwischen diesen beiden Gefäßen. Die A. buccalis (aus der A. maxillaris) zieht zum unteren vorderen Wangenbereich. Die arterielle Versorgung im Schläfenbereich stammt sowohl von der A. temporalis superficialis (A. carotis externa) wie auch von der A. zygomaticotemporalis (A. zygomatica aus A. lacrimalis aus A. ophthalmica, somit aus A. carotis interna).

Generell begleiten die Venen im Gesichtsbereich die Arterien, wobei es Ausnahmen gibt (V. retromandibularis, V. ophthalmica inferior). Die V. facialis verläuft durchschnittlich 15 mm weiter posterior und gestreckt im Vergleich zur A. facialis, die geschlängelt ober- bzw. unterhalb der mimischen Gesichtsmuskulatur verläuft. Anatomisch interessant, aber klinisch risikohaft sind die vielen Anastomosen zwischen Venen im Gesichtsbereich und den Venen im Gehirn (Sinus cavernosus) wegen der Verschleppung von Infekten (Hirnabszesse).

Das lymphatische System umfasst ein kapilläres Netzwerk, Lymphgefäße, Lymphknoten (LK) sowie die Trunci lymphatici zu den Vv. subclaviae. Lymphgefäße aus dem Stirnbereich ziehen zu den präaurikulären LK bzw. zu den tiefen Parotis-LK. Von den Augenlidern erfolgt die Lymphdrainage zu Parotis-LK oder submandibulären LK. Lymphgefäße sowohl von der Nase wie auch von den Lippen ziehen zu den Buccinator- oder submandibulären LK, aus der Kinnregion sowohl zu den submentalen wie auch submandibulären LK.

## Résumé

Cet article fournit une revue de la littérature concernant les vaisseaux (artères, veines, vaisseaux lymphatiques) des régions du visage. Les interventions chez le dentiste, en particulier les interventions chirurgicales, nécessitent des connaissances de l'approvisionnement en sang et la localisation topographique des vaisseaux. Pour cette raison, chaque clinicien doit avoir une connaissance de la vascularisation dans la zone du visage. Des spasmes des artères peuvent conduire à l'anémie de la peau, des lésions des artères à des hématomes. Les vaisseaux sanguins et lymphatiques jouent également un rôle dans la propagation des infections et des cellules tumorales.

Toutes les artères de la face proviennent de l'artère carotide commune, qui bifurque à droite du tronc brachio-céphalique et à gauche directement à partir de l'arc aortique. Approximativement au niveau de la quatrième vertèbre cervicale ou de l'os hyoïde, l'artère carotide commune se ramifie en artères carotides externe et interne. L'artère principale réelle de la face provient soit directement de l'artère carotide externe (artère

faciale, l'artère temporale superficielle), soit de ses branches (artère transversale du visage de l'artère temporale superficielle, artère infraorbitaire de l'artère maxillaire). L'artère principale dans la région du front, l'artère ophtalmique, bifurque à partir de l'artère carotide interne. L'artère ophtalmique avec ses branches est également considérée comme «shunt» artériel important entre l'artère carotide interne et externe.

En plus des branches de l'artère ophtalmique (artères sus-orbitaire et supratrochléaire), la branche frontale de l'artère temporale superficielle fournit également la zone du front. Cette branche montre souvent des anastomoses avec l'artère sus-orbitaire. L'artère supratrochléaire a souvent des anastomoses avec l'artère angulaire (vient de l'artère faciale) dans la zone centrale du front inférieur. Les paupières supérieures obtiennent leur alimentation artérielle de différentes branches de l'artère lacrymale, l'artère sus-orbitaire et l'artère supratrochléaire, tous des vaisseaux de l'artère ophtalmique. Les paupières inférieures sont fournies par différentes branches de l'artère lacrymale, l'artère supratrochléaire et l'artère infraorbitaire.

Le nez présente un réseau dense de petites artères, principalement dérivées de l'artère nasale latérale, mais aussi de l'artère labiale supérieure (toutes deux viennent de l'artère faciale). En outre, une branche externe de l'artère antérieure ethmoïde (artère terminale de l'artère ophtalmique) fournit le dos du nez, où de nombreuses petites anastomoses peuvent être observées avec des branches de l'artère nasale latérale. Les artères des lèvres (artères labiales supérieures ou inférieures) proviennent de l'artère faciale et s'anastomosent souvent avec les vaisseaux homologues des côtés opposés. La lèvre inférieure reçoit également des branches verticales de l'artère labiomentale, branche de l'artère submentale.

L'artère principale du menton est l'artère mentale, un vaisseau terminal de l'artère alvéolaire inférieure. Les sections les

plus inférieures du menton sont alimentées par des branches de l'artère submentale parfois même par des branches de l'artère sublinguale. Dans la zone de la joue, l'alimentation artérielle provient de l'artère faciale et de l'artère transversale du visage, ces deux puissants vaisseaux ont des zones de couverture relativement vastes. Parfois, on peut trouver des anastomoses entre ces deux vaisseaux. L'artère buccale (venant de l'artère maxillaire) se déplace vers la zone antéro-inférieure de la joue. L'alimentation artérielle dans la zone de la tempe provient à la fois de l'artère temporale superficielle (artère carotide externe), ainsi que de l'artère zygomatocotemporale (artère zygomatique provenant de l'artère lacrymale de l'artère ophtalmique, donc à partir de l'artère carotide interne).

En général, les veines accompagnent les artères dans la zone du visage, bien qu'il existe des exceptions (veine rétromandibulaire, veine ophtalmique inférieure). La veine faciale court en moyenne 15 mm plus postérieure et plus allongée par rapport à l'artère faciale, qui s'étend tortueuse au-dessus ou en dessous des muscles de la mimique. D'un point de vue anatomique intéressant mais risqué sur le plan clinique sont les nombreuses anastomoses entre les veines sur la zone du visage et les veines dans le cerveau (sinus caverneux) en raison de la propagation des infections (abcès du cerveau).

Le système lymphatique comprend un réseau de capillaires, les vaisseaux lymphatiques, les ganglions lymphatiques, les troncs lymphatiques et les veines subclavières. Les vaisseaux lymphatiques du front drainent dans le ganglion préauriculaire et le ganglion parotide profond. Le drainage lymphatique des paupières se fait dans le ganglion parotide ou le ganglion submandibulaire. Les vaisseaux lymphatiques à la fois du nez ainsi que des lèvres se déplacent avec les ganglions buccinateurs ou submandibulaires. Dans la région du menton, il s'agit à la fois des ganglions sous-mentonniers ou submandibulaires.

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