

Morpho-dynamic anatomy of the face for aesthetic medicine

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Over the last decade, aesthetic facial injections have become a widely accepted enhancing and rejuvenating treatment and one of the most performed non-surgical procedures throughout the world. Thereby, the incidence of both adverse outcomes and complications have increased substantially. In order to avoid undesirable results and obtain satisfactory outcomes, the physician must have a thorough knowledge of facial anatomy. It is imperative for doctors to perceive the facial anatomy as three-dimensional (3D) structures and not as a two-dimensional (2D) view like it is shown in medical textbooks.¹

During procedure, the injector must know where is the tip of the needle, if it is placed in the correct plane and at the appropriate injection point, and if there are anatomical dangers around its path. This is an important and useful notion to consider because in the same area there may be anatomical dangers for the deep plane but not the superficial one, and vice versa. In this case, an injection can be performed safely into the superficial plane and thus avoid the deep dangers.^{1, 2} Besides having familiarity with the 3D anatomy, physicians should also clearly understand the dynamic anatomy of the face and consider the specificities of each patient when determining the injection technique.³

3D ANATOMY

Overall, structures of the face are mainly distributed in five layers as follows, from superficial to deep: skin, superficial fat, muscles, deep fat, and bone (**Figure 1.1**). However, there are some other anatomical elements, such as vessels, nerves, ligaments, and some muscles, that pass through different planes. For example, the path of the main facial arteries begins in a deep plane and goes to a more superficial layer: either to a muscle or the skin.²

Some facial muscles, which we call 3D muscles, also chart a course through several planes running from the deep bone origin to the superficial skin insertion.¹ There are ligaments that cross several facial layers and attach a superficial plane to a deeper one, such as the orbital retaining ligament, the zygomatic ligament, or the mandibular ligament, which tie the subcutaneous tissue to the bone.^{4, 5}

Anatomical danger zones of the face are mainly represented by some arterial structures, where the risk of intravascular injection during the procedure can be greater compared with elsewhere. However, it is also useful to have an integral knowledge of the anatomy of the concerned area, including the venous and nervous elements.²

Arterial vasculature

The face is predominantly vascularized by the terminal branches of the external carotid artery, and to a lesser extent by some terminal branches of the internal carotid artery (Figure 1.2).

External carotid artery

The facial artery, a branch of the external carotid artery, provides the main blood supply for the face. It travels through tissues at different depths along its path. After passing over the mandibular gland, the facial artery gives rise to the submental artery and then runs along the inferior border of the mandible to enter the face by turning upward in front of the anterior-inferior angle of the *masseter* muscle. At this point, it is located in a deep layer behind the skin, superficial fat, and *platysma* muscle.^{2,6}

As soon as it starts going up medially toward the modiolus region, the facial artery gives rise to the horizontal labiomental and the inferior labial arteries separately or by a common trunk passing behind the *depressor anguli oris* muscle.^{7,8} After that, it continues its tortuous course toward the inner corner of the eye, traveling inside or adjacent to the nasolabial fold (NLF), passing behind the *zygomaticus major* muscle and then becoming superficial. Regarding the passage of the facial artery through the NLF area, some authors have reported that the artery travels up from the medial side of this fold in 42.9% of cases, arising from the lateral side of the NLF in 23.2% of cases, crossing the NLF laterally in 19.6% of cases, and crossing the NLF medially in 14.3% of cases.²

The superior labial and the subalar arteries branch from the facial artery at the labial commissure level or above this latter.⁹ The superior labial artery runs toward the midline in or just above the vermilion-mucosa junction, deeply between the *orbicularis oris* muscle and the mucosa. It anastomoses with its homologue from the opposite side. Septal arteries arise from this arterial network to ascend through the columella to the nasal tip. The inferior labial artery follows a pathway similar to the superior labial artery into the submucosal plane in or adjacent to the red lip-mucosa junction.³ The subalar artery becomes superficial in the upper third of the nasolabial fold to supply the nasal ala. For this anatomical reason, this region constitutes an area of high risk for vascular injury during filler injection.²

While running obliquely in the superomedial direction of the face near the nasal ala, the facial artery gives rise to the lateral nasal artery, which vascularizes the nasal ala and nasal *dorsum*. The angular artery, the terminal branch of the facial artery, follows its final course along the nasojugal fold above the *levator labii superioris alaeque nasi* and *orbicularis oculi* muscles. In the medial *canthus* area, the angular



Figure 1.1. 3D-Anatomy.

This anatomical dissection shows the structures of the cheek, from the superficial to the deep plane as follows: skin, superficial fat pad, *zygomaticus major* and *orbicularis oculi* muscles and deep fat pads: sub-orbicularis oculi fat (SOOF) and Bichat fat.

artery anastomoses with the dorsal nasal and supratrochlear arteries, both branches of the ophthalmic artery from the internal carotid vessels. A large communication exists between these latter arteries and their homonymous contralateral arteries. Due to the rich vascular network between the external and internal carotid system, this region represents a zone at high risk of embolization (and thus blindness or stroke) when performing filler injections.²

Many anatomical variations of the facial artery have been described in the literature; hence, the standard pattern described above exhibits a variable frequency depending on the study. In this way, some series have described the ending of the facial artery as the lateral nasal artery or as two equal terminal branches together with the angular artery. It can also end near the nasal ala and then divide into the lateral nasal and subalar arteries. Rarely, the superior labial artery can be the terminal branch of the facial artery.^{2,6} Other anatomical variations of the facial artery refer to its path, so it is not uncommon to find it along the midcheek groove instead of a more medial course. Finally, it is also possible to find a double facial artery.²

The maxillary artery is one of the two terminal branches of the external carotid artery. It has 14 collateral branches, of which some may be affected by injections. The mental artery exits by the mental foramen with the nerve of the same name to supply the chin and the lower lip. The anterior and posterior deep temporal arteries travel deeply within the *temporalis* muscle, diminishing in diameter as they ascend the temporal fossa. The infraorbital artery emerges through its foramen accompanied by the homonymous nerve and divides into several branches to vascularize the cheekbone, the cheek, the lacrimal sac, the lateral part of the nose, and the lower eyelid (Figure 1.3).²

The superficial temporal artery is the other terminal branch of the external carotid artery (Figure 1.2). It gives off a first branch, the transverse facial artery, that follows a course between the zygomatic arch and the parotid duct, under the superficial fat layer, to supply blood to a part of the skin of the cheek, the *masseter* muscle, as well as the parotid gland and its duct. The second branch is the middle temporal artery, which branches just above the zygomatic arch and runs deep toward the deep temporal fascia. It anastomoses with the deep temporal arteries. Finally, the superficial temporal artery ends its

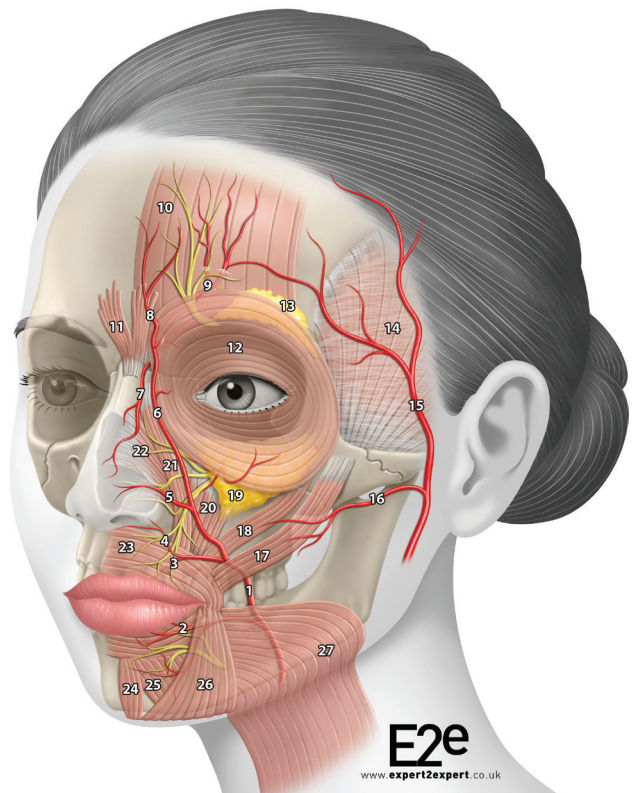


Figure 1.2. Arteries and muscles of the face (superficial structures):

1) facial artery, 2) inferior labial artery, 3) superior labial artery, 4) subalar artery, 5) lateral nasal artery, 6) angular artery, 7) dorsal nasal artery, 8) supratrochlear artery, 9) supraorbital artery, 10) *frontalis* muscle, 11) *procerus* muscle, 12) *orbicularis oculi* muscle, 13) retro-orbicularis oculi fat (ROOF), 14) *temporalis* muscle, 15) superficial temporal artery, 16) transverse facial artery, 17) *zygomaticus major* muscle, 18) *zygomaticus minor* muscle, 19) sub-orbicularis oculi fat (SOOF), 20) *levator labii superioris* muscle, 21) *levator labii superioris alaeque nasi* muscle, 22) *nasalis* muscle, 23) *orbicularis oris* muscle, 24) *mentalis* muscle, 25) *depressor labii inferioris* muscle, 26) *depressor anguli oris* muscle, and 27) *platysma* muscle.

upward course by passing through the temporal fossa inside the superficial temporal fascia, then it divides into two terminal branches, the frontal and parietal arteries. The frontal branch vascularizes the *frontalis* muscle and the skin of the forehead; it anastomoses with the supraorbital and supratrochlear arteries.^{2, 5, 10} The temporal area is another high-risk zone for superficial injection techniques because the course of the superficial temporal artery, or its temporal branch, through the superficial temporal fascia is superficial and highly variable.

Internal carotid artery

The branches of the internal carotid artery that may constitute a risk for injury when performing aesthetic injections of the face are some collateral branches of the ophthalmic artery. Its first branch is the central retinal artery; it supplies the retina. The lacrimal artery that supplies the lacrimal gland gives off the superior and inferior lateral palpebral arteries, the zygomaticotemporal artery, which anastomoses with the deep temporal arteries passing through the foramen of the same name, and finally the zygomaticofacial artery. This latter branch passes through its foramen to anastomose with the zygomatico-orbital artery, a branch of the middle temporal artery.²

The supraorbital artery and nerve exit from the orbit through the supraorbital foramen (Figures 1.2, 1.3), then after a short course upward, the artery divides into superficial and deep branches. The superficial one crosses the galea aponeurotica and the *frontalis* and *orbicularis oculi* muscles becoming subcutaneous. The deep one runs laterally to supply the deep orbital rim area.⁶

The supratrochlear artery (Figures 1.2, 1.3) emerges from the skull by its notch, medial to the supraorbital pedicle, accompanied by the homonymous nerve. It medially ascends the forehead and anastomoses with its contralateral counterpart. The completed notion is that after the anastomosis with its counterpart, the supratrochlear artery also anastomoses with the supraorbital artery and with the superficial temporal artery, and all these vessels supply the skin, muscles, and periosteum of the forehead and a part of the scalp.¹⁰

The dorsal nasal artery (Figure 1.2) vascularizes the lacrimal sac; it then gives off a branch to anastomose with the angular artery and after runs along the nasal *dorsum* following an imaginary line from the medial *canthus* to the nose tip. It also anastomoses with the contralateral dorsal nasal, supratrochlear, lateral nasal, and columellar arteries.^{2, 5}

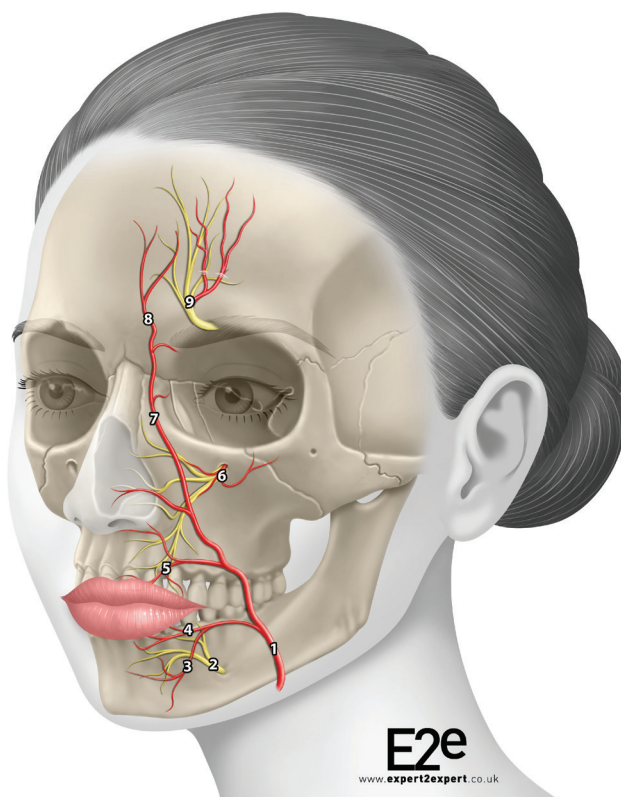


Figure 1.3. Arteries and nerves of the face (deep structures):

1) facial artery, 2) mental nerve, 3) horizontal labiomental artery, 4) inferior labial artery, 5) superior labial artery, 6) infraorbital artery and nerve, 7) angular artery, 8) supratrochlear artery, and 9) supraorbital artery and nerve.

As mentioned above, the medial *canthus* area constitutes a rich vascular region where the internal and external carotid arteries combine and blend their blood contents. An accidental intraarterial filler injection in the periorbital area or in the facial artery may lead an embolism of the product, an outcome that occludes the central retinal artery and producing blindness.^{2, 10}

Venous vasculature

The internal, external, and anterior jugular veins ensure drainage of the face and neck. Most of veins follow the arterial system but there are some exceptions, the most important of which is the facial vein. The anastomosis between the supratrochlear and supraorbital veins in the medial *canthus* area originates the angular vein that becomes the facial vein. The latter runs separately from the facial artery in an oblique course in the inferolateral direction of the face toward the antero-inferior angle of the *masseter* muscle along the midcheek groove. At this point, on the mandibular border below the *platysma* muscle, the facial vein joins its homonymous artery. Along its course through the middle third of the face, the facial vein passes under the *zygomaticus major* and *minor* muscles and over the *buccinator* muscle. It runs under the lower edge of the mandible, passes over the submaxillary gland, and follows an oblique descent path to drain into the internal jugular vein. The facial vein receives many tributary vessels, which bring venous drainage to the face and some areas of the neck.⁶ There are communications between the facial and endocranial venous networks; thus, any infection of the facial vein can trigger a craniofacial thrombophlebitis.²

Nerve anatomy

The trigeminal nerve (CN V) brings most of the sensitive innervation of the face through its three branches (**Figure 1.3**).⁶ The first one, the ophthalmic nerve (V1), innervates the nasal *dorsum*, the upper eyelids, glabella, forehead, and scalp. It divides into three branches: the nasociliary, the lacrimal, and the frontal nerves. This latter gives rise to the supraorbital and supratrochlear nerves, which emerge from the skull by their foramens. The supraorbital nerve innervates the upper lid and the forehead region, except the medial area above the nasal root, which is innervated by the supratrochlear nerve. The upper lid is also innervated by the supratrochlear nerve.

The second branch, the maxillary nerve (V2), provides sensation to the middle third of the face: from the lower eyelid to the upper lip and from the lateral part of the nose to the anterior (hairless) temporal region. It gives off three branches: the zygomaticotemporal, zygomaticofacial, and infraorbital nerves. The latter exits by the infraorbital foramen accompanied by its artery.

The third branch, the mandibular nerve (V3), is a motor and sensory nerve. It provides sensory innervation to the *tragus*, the part of the cheek placed in front of the *tragus*, a part of the cheek mucosa, the mucosa of the floor of the mouth, the anterior two thirds of the tongue, and the gingiva of the mandibular teeth. The mental nerve, a branch of the V3, emerges from the mandible through its foramen to give sensory innervation to the skin and mucosa of the lower lip, the incisor and canine teeth, and the chin.^{2, 5}

The facial nerve (CN VII) has motor, sensory, and vegetative functions; it is the main motor nerve of the facial muscles. It supplies sensory innervation to the external auditory canal, the tympanum, and the concha of the ear. CN VII provides taste sensation to the anterior two thirds of the tongue via the chorda tympani; it regulates secretion of the lacrimal gland and of the submaxillary and sublingual

salivary glands.^{2, 6} The facial nerve gives rise to five terminal branches: the temporal, zygomatic, buccal, marginal mandibular, and cervical.

The temporal branch is the most superior branch of CN VII; it travels into the superficial temporal fascia and brings motor innervation to the *frontalis* muscle and the lateral part of the *corrugator*. The zygomatic branch innervates the *orbicularis oculi*, the *zygomaticus major*, the *levator labii superioris*, the *depressor supercilii*, and the *procerus* muscles, as well as the medial part of the *corrugator*. The buccal branch provides motor innervation to the *buccinator*, the *risorius*, the *levator anguli oris*, the *levator labii superioris alaeque nasi*, the *nasalis*, and the *depressor septi nasi* muscles.^{2, 6} The marginal mandibular branch gives motor innervation to the *orbicularis oris*, the *depressor anguli oris*, the *depressor labii inferioris*, and the *mentalis* muscles and in some cases the upper part of the *platysma* muscle. The more inferior branch of the facial nerve is the cervical branch; it innervates the *platysma* muscle.^{11, 12}

Muscles and fat compartments of the face

Upper face

This upper region of the face comprises the forehead and the temporal areas. The forehead and eyebrow zones are formed by six layers, from the superficial to deep: skin, superficial fat, *frontalis* muscle, deep fat, *galea aponeurotica*, and bone. The eyebrow area also includes the *orbicularis oculi* and *corrugator* muscles, and in the glabellar region, there is the *procerus* muscle (Table 1.I).^{1, 6, 10, 13} The retro-orbicularis oculi fat (ROOF) is located in a deep plane in the supraorbital area; it influences the appearance of the eyebrow.⁵

The temporal facial area is bordered by the temporal crest, lateral orbital rim, zygomatic arch, and the hair line. The temporal fossa is occupied by several layers as follows,^{5, 10} from superficial to deep: skin, subcutaneous cellular and fat tissue, superficial temporal fascia, fibro-adipose connective tissue, deep temporal fascia, deep temporal fat (is the temporal extension of the Bichat fat bag), *temporalis* muscle, and the temporal bone.⁵

Middle face

Also called midface, this area is placed between the level of the lateral *canthus* of the eye and a horizontal imaginary line passing through the oral commissures. The midface contains most of fat compartments of the face; they are distributed in two layers. The superficial plane includes the following fat compartments: nasolabial, medial cheek, middle cheek, infraorbital and lateral temporal cheek fat. The deep plane includes the lateral sub-orbicularis oculi fat (SOOF), medial SOOF, and deep medial cheek.⁵ The main muscles responsible for facial expression located in this region are the lower parts of the *orbicularis oculi*, *nasalis*, *levator labii superioris alaeque nasi*, and *depressor septi nasi* muscles, and the upper parts of the *orbicularis oris* muscle (Table 1.II).^{1, 4, 6, 10, 13}

Lower face

The lower third of the face includes the *orbicularis oris*, *depressor anguli oris*, *mentalis*, *masseter* and *platysma* muscles (Table 1.III).¹ This third also includes the lower part of the superficial fat compartments⁵ and also includes superficial and deep fat in the rest of its area.¹

Table 1.I. Muscles of the upper face: the main anatomical features of the muscles are described. 3D: three-dimensional.^{1, 6, 10, 13}

Muscle	Description	Origin	Insertion	Innervation	Action	Wrinkles
<i>Frontalis</i>	Large, flat, fan-shaped muscle; not muscle in the upper midline area	<i>Galea aponeurotica</i>	Skin above the eyebrows; blends with the <i>orbicularis oculi</i> , <i>corrugator</i> , and <i>procerus</i> muscles	Temporal branch of the facial nerve	Upper portion: pulls down the hair line Lower portion: lifts the eyebrow	Horizontal forehead wrinkles
<i>Corrugator</i>	Small and thick 3D muscle, obliquely oriented in the medial part of the orbital rim	Medial portion of the <i>arcus superciliaris</i> of the frontal bone	Skin of the middle third of the eyebrow (the <i>corrugator</i> dimple)	Temporal and zygomatic branches of the facial nerve	Eyebrow adductor-depressor	Vertical glabellar wrinkles
<i>Procerus</i>	Flat and oblique oriented 3D muscle; medial borders of both <i>procerus</i> are separated, forming a V-shape	Nasal bone and aponeurosis of the <i>nasalis</i> muscle	Skin between the eyebrows	Zygomatic branch of the facial nerve	Pulls medially and down toward the medial part of the eyebrow	Transverse wrinkles of the nasal root
<i>Orbicularis oculi</i>	Thin, broad and flat muscle forming a ring; formed by two parts: <i>orbitalis</i> (peripheral portion) and <i>palpebralis</i> (lid portion)	Medial <i>canthal</i> tendon, medial upper and lower orbital rim, and lateral <i>canthal</i> tendon	<i>Pars orbitalis</i> : in the skin of the eyebrow, superior jugal, and lateral rim areas <i>Pars palpebralis</i> : directly in the skin of the lids without subcutaneous fat; the lateral inferior part is crossed by the orbital retaining ligament	Temporal and zygomatic branches of the facial nerve	Moves the eyebrow medially and downward and mediates the blink reflex	Lateral orbital wrinkles, fine lower lid lines, and tear trough

Table 1.II. Muscles of the middle face: main anatomical features of the muscles are described. In the modiolus seven perioral muscles converge: the levator anguli oris, zygomaticus major, risorius, buccinator, depressor anguli oris, platysma and orbicularis oris. 3D: three-dimensional; NLF: nasolabial fold. 1, 4, 6, 10, 13

Muscle	Description	Origin	Insertion	Innervation	Action	Wrinkles
<i>Nasalis</i>	Thin, flat, and triangular-shaped muscle; composed of two portions: <i>pars transversa</i> and <i>pars alaris</i>	Incisive fossa of the maxilla	<i>Pars transversa</i> : in the aponeurosis over the nasal bones <i>Pars alaris</i> : In the alar crease and lobule of the nose	Buccal branch of the facial nerve	<i>Pars transversa</i> : compresses the lateral nasal cartilages and closes the nostrils <i>Pars alaris</i> : opens the nostrils	
<i>Levator labii superioris alaeque nasi</i>	Long, thin, and rectangular-shaped 3D muscle	Frontal process of the maxilla bone	In the skin of the lateral part of the nostril, upper part of the NLF, and upper lip	Buccal branch of the facial nerve	Raises and dilates the nostril; elevates the upper part of the NLF and the upper lip	Hollowing out the upper third of the NLF; mainly responsible for the “gummy smile”
<i>Depressor septi nasi</i>	Short and paired muscle located between the <i>orbicularis oris</i> muscle and the mucosa; in 20% of cases, it is absent	Maxilla bone or in the <i>orbicularis oris</i> muscle	In the anterior nasal spine and in the inferior part of the medial crura of the alar cartilage	Buccal branch of the facial nerve	Pulls down the nasal tip and shortens the upper lip when smiling	
<i>Orbicularis oris</i>	Broad, flat, and elliptical muscle that forms a ring; comprises two parts: an upper and a lower that join at the <i>modiolus</i> . Each are composed of two portions: <i>marginalis</i> (free border of the lip) and <i>peripheralis</i> (cutaneous lip)	<i>Modiolus</i>	In the dermis of the vermilion border, anterior nasal spine, caudal <i>septum</i> , maxilla bone, and mandible	Marginal mandibular branch of the facial nerve; sometimes by the buccal branch	Closes and protrudes the lips forward	Perioral fine wrinkles