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Abstract	Abstract

Objective: Dermal fillers are an important tool in the field of aesthetic dermatology. Fillers are relatively noninvasive and easy to use but are not free of secondary complications. The main complications are vascular and are due to either the compression of an artery or the direct introduction of the product into the arterial lumen. The aim of this study is to provide an overview of the vascular territories of the face to avoid many possible complications when using facial fillings. Anatomical localization of the main arterial supply to the face has been described to assess the risk of vascular injury. **Methods:** The authors dissected 17 hemifaces of embalmed adult cadavers that had previously been injected, through the common carotid artery, with latex containing a red dye. **Results:** A topographic distribution was generated by facial regions following a clinical approach from where the facial fillings were placed and related to the pathways of the arteries. Following these criteria, we established 8 topographic regions (I–VIII) that indicate the main vascular problems of each of these regions. Detailed anatomical localizations of the main arteries in these topographic regions of the face and their relationships

are described. **Conclusions:** The highest index of vascular lesions and especially visual alterations occurred for fillings of the upper third of the face. To prevent and avoid this type of lesion, it is advisable to avoid, as much as possible, treatments with filling materials in the upper third of the face, mainly including the glabellar and nasal region (III) and supraorbital region (VIII).

Abstract Second Language	

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Key Messages	
	Key Message The aim of this study is to provide an overview of the vascular territories of the face to avoid many possible complications when using facial fillings.

Body

Introduction

Aging produces significant changes that affect the facial structure, such as thinning of the epidermis, loss of skin elasticity and muscle, fat atrophy, and loss of bone tissue [1, 2]. These factors lead to a decrease in facial volume and an increase in the detachment of these structures, which leads to the appearance of furrows and wrinkles [3–5]. The convex surfaces become concave surfaces, reducing the illuminated areas and increasing the shadows.

To maintain facial rejuvenation, reduce wrinkles, improve the contour and recover lost volume, absorbable dermal fillers such as autologous fat, hyaluronic acid, calcium hydroxyapatite, polylactic acid, and collagen are used. In some cases, permanent materials such as silicone and polymethylmethacrylates are also used [6–8].

The advantages of these fillers are that they are relatively noninvasive and easy to use, but they are not exempt from secondary complications. The main complications are vascular, either due to the compression of an artery or the direct introduction of the product into the arterial lumen [9–11], causing necrosis of the affected region. The most feared complication is blindness due to the periorbital anastomosis of the vascular system of the external and internal carotid artery [12–14].

Therefore, a thorough knowledge of the anatomical structures where the filling is performed is desirable. Proper anatomical knowledge of skeletal, muscular, nervous, and main vascular structures is required to avoid the risk of complications [5, 15, 16].

The purpose of the current study is to provide useful information about the main topographic regions of the face and their anatomical structures, increasing the information of the vascular supply of the face. This description should help the professionals preventing the frequent vascular complications in aesthetic procedures.

Materials and Methods

For further details, see the online supplementary material (for all online suppl. material, see www.karger.com/doi/10.1159/000495292) (Fig. 1).

Results

According to the clinical criteria by which the fillings are made, together with the vascular territory of the main arteries, 8 topographic regions (numbered I–VIII) were established in the

region of the face (Fig. 2a, b). The limits of each of the identified regions and their vascular content are described below.

I. Masseteric Region (Fig. 3)

Cranial limit: zygomatic arch; caudal limit: lower border of the mandible; ventral limit: anterior border of the masseter muscle; dorsal limit: dorsal border of the parotid gland.

Vascular anatomical elements: transverse artery of the face and zygomatic-orbital artery.

Arterial localization: the transverse artery is situated 1 cm (range 0.85–1.1 cm) superior to the zygomatic arch. The zygomatic-orbital artery arises from the transverse artery 3 cm (range 2.85–3.17 cm) anterior to the tragus.

II. Temporal Region (Fig. 4)

Cranial limit: upper edge of the origin of the temporal muscle; caudal limit: zygomatic arch; ventral limit: external orbital rim.

Vascular anatomical elements: superficial temporal artery and its frontal and parietal terminal branches; zygomatico-orbital artery and the collateral branch of the superficial temporal artery.

Arterial localization: the superficial temporal artery division into its terminal branches is located 2.5 cm (range 2.2–2.8 cm) superior to the zygomatic arch and 2 cm (range 1.8–2.2 cm) anterior to the helix.

III. Buccinatory Region and Nasolabial Fold (Fig. 5)

Cranial limit: nasal flap; caudal limit: lower border of the jaw; ventral limit: labial commissure; dorsal limit: anterior border of masseter muscle.

Vascular anatomical elements: facial artery.

Arterial localization: the facial artery runs 2.2 cm (range 1.75–2.43) anterior to the border of the masseter muscle and 3.1 cm (range 2.85–3.2) superior to the lower border of the

mandible. Near to the mouth, this artery is located approximately between 0.9 and 1.2 cm to the labial commissure.

Lower Lip and Mentonian Region (Fig. 5)

Limits: lower lip and chin.

Vascular anatomical elements: inferior labial artery and submental artery.

Arterial localization: the inferior labial artery arises from the facial artery when this artery runs 1 cm (range 0.9–1.2 cm) to the labial commissure. The submental artery emerges from the facial artery over the lower border of the mandible.

V. Upper Lip Region (Fig. 5)

Limits: upper lip.

Vascular anatomical elements: superior labial artery, nasal septum artery, and alar artery.

Arterial localization: similar to the origin of the inferior labial artery, the facial artery divides into the superior labial artery at 1 cm to the labial commissure. The nasal septum artery arises from the superior labial artery at the level of the nasal philtrum. The alar artery emerges from the facial artery 1.2 cm (range 0.73–1.4 cm) to the ala of the nose.

VI. Infraorbital Region (Fig. 6)

Cranial limit: the lower edge of the orbital rim; caudal limit: a line that connects the nasal flap with the gullet; medial limit: corresponds to the lateral side of the nose; lateral border: limited by a vertical line joining the outer edge of the eye with the masseter muscle.

Vascular anatomical elements: facial artery, angular artery, infraorbital artery, lateral nasal artery, and alar artery.

Arterial localization: the facial artery and angular artery run 0.5 cm (range 0.3–0.6 cm) along the lateral side of the nose. The infraorbital artery was found 1.6 cm (range 1.4–1.8 cm) to the lateral nasal cartilage and 2.1 cm (range 1.8–2.3 cm) from the lower eyelid. The lateral

nasal artery emerges from the facial artery 1.5 cm (1.27–1.6 cm) superior to the lower border of the ala of the nose.

VII. Glabellar and Nasal Region (Fig. 7)

Limits: constituted by the intraciliar region, glabella, and back of the nose.

Anatomical vascular elements: supratrochlear artery (internal frontal artery) and dorsal nasal artery.

Arterial localization: supratrochlear artery leaves the orbit 1.15 cm (0.8–1.35 cm) up to the medial palpebral commissure and runs over the procerus muscle reaching the glabella. The dorsal nasal artery emerges from the angular artery at the level of the medial canthus.

VIII. Supraorbital Region (Fig. 7)

Limits: frontal region located cranial to the eyebrows.

Vascular anatomical elements: supraorbital arteries (external frontal artery).

Arterial localization: the supraorbital arteries leave the orbit through the supraorbital notch located 2.5 cm (range 2.3–2.7 cm) laterally to the glabellar midline.

Discussion

When we discuss a vascular accident, we are referring to the symptoms that can appear by:

(a) Blood vessel extravasation due to vessel injury, resulting in a simple hematoma of greater or smaller size, practically of no clinical importance

(b) Compression of the vessel due to placement of the filling material in close proximity, causing necrosis in the affected areas of the arterial pathway

(c) Injection of the product into the vessel; one of the most serious complications is the loss of immediate vision due to a retrobulbar embolism, which has a severe prognosis and requires immediate attention

A vascular accident is characterized by immediate pain at the injection site, a livedoid pattern and the appearance of scabs and necrosis of the skin a few days after the injection. This symptomatology is known as Nicolau syndrome [17].

A complete understanding of the anatomical locations of vascular structures, as well as the main anatomical relationships, will aid the aesthetic provider in the identification of critical zones to avoid during the dermal filler injection process.

I. Masseteric Region (Fig. 3)

Vascular anatomical elements: transverse artery of the face and zygomatico-orbital artery.

The most common vascular accident in this region is bruising. Accidents caused by compression of the vessel are more infrequent because the skin of this area is easily distended. Injection of the product into the vessel is also unlikely.

Injury caused by the obstruction of a vessel causes necrosis of the face. The transverse artery of the face is located superficially to the masseter and cranial muscles in a line consistent with the nasal fin. This is a rare injury.

Kassir et al. [18] described the injection of hyaluronic acid in a 52-year-old male in the right cheek around acne scars. After injecting the product into the dermis and subcutaneous cellular tissue, a bluish-colored hematoma and pain developed during the first few hours. This symptomatology was attributed to the hematoma. However, 5 days after the injection, necrosis was observed in the cheek due to an intra-arterial injection that affected the transverse artery of the face, the facial artery, and the infraorbital branches.

II. Temporal Region (Fig. 4)

Vascular anatomical elements: superficial temporal artery and its frontal and parietal terminal branches; zygomatico-orbital artery and the collateral branch of the superficial temporal artery.

Vascular accidents caused by injection of products into the vessel and compression of the vessel are the most common types because the skin of this area is not distensible.

A compression injury of the superficial temporal artery occurs when the region of the temple is filled, causing necrosis of this region and the scalp. Artery injury, in addition to causing necrosis, can lead to blindness due to retinal injury. This lesion is caused by the anastomosis between the branches of the frontal artery and the periorbital artery, originating from the collateral branches of the ophthalmic artery.

Orbital zygomatic artery lesions are usually mild and cause bruising. However, due to the connections that this artery presents with the periorbital circuit, a plunger inserted into this artery could cause damage to the retina.

Although the most common lesions in this region are hematomas, which usually affect the lower eyelid [3], Kassir et al. [18] described lesions resulting in blindness produced by filling in the temporal fossa, due to the occlusion of the retinal arteries as a consequence of the anastomosis of the frontal artery and a branch of the superficial temporal artery with branches of the supraorbital artery and the ophthalmic artery. Blindness occurs because the intravascular injection pressure is greater than the intra-arterial pressure. This lesion has been described after the injection of calcium hydroxyapatite and silicone fillers in this region.

III. Buccinatory Region and Nasolabial Fold (Fig. 5)

Vascular anatomical elements: facial artery and facial vein.

In this region, the most common accidents are vascular accidents caused by injection of the product into the vessel or by the compression of the vessel. Coronary artery injury, in addition to causing necrosis, can lead to blindness due to retinal injury. This lesion is caused by anastomosis between the facial artery and the terminal branch of the ophthalmic artery.

Andre and Haneke [17] published 4 cases of facial necrosis due to intravascular injection in the angular artery as well as by compression of the facial artery when filling the nasolabial groove. According to this author, all cases were resolved without sequelae or vascular effects.

Park et al. [13] described 4 cases of blindness due to the infusion of fillers into the nasolabial sulcus. No improvement in visual acuity was observed in any of the cases, and the lesion was severer when autologous fat was used as a filler.

IV. Lower Lip and Mentonian Region (Fig. 5)

Vascular anatomical elements: inferior labial artery and submental artery.

The most common vascular accident is the formation of a hematoma, and a less common accident is the compression of the vessel.

We have not found studies of vascular lesions in this region caused by the injection of filler into the vessel.

V. Upper Lip Region (Fig. 5)

Vascular anatomical elements: superior labial artery, nasal septum artery, and alar artery.

Vascular accidents caused by compression of vessels are relatively common because the skin of this zone is in close proximity. Accidents can also be produced by injecting the product into the vessel, mainly in the upper labial artery, causing necrosis of the upper lip.

Andre and Haneke [17] described the appearance of a livedoid pattern by intravascular injection in the upper labial artery in a 30-year-old woman a few minutes after filling the upper lip vermilion with hyaluronic acid. The skin was massaged, and she was given oral treatment with aspirin (500 mg) twice daily. A total of 24 h later, a livedoid pattern developed on the soft parts of the upper lip, nose and forehead of the left side of the face due to the involvement of the superior labial artery, facial artery, and its anastomosis with the angular artery and the wing arteries.

VI. Infraorbital Region (Fig. 6)

Vascular anatomical elements: facial artery, angular artery, infraorbital artery, lateral nasal artery, and alar artery.

In this region, a vascular accident is usually caused by injection of the product into the vessel. Compression of the vessel in this region is more complicated because the skin is easily distended.

The infraorbital zone is a high-risk zone for the use of hyaluronic acid fillings and is susceptible to the appearance of irregularities, hematomas, blue discoloration, hydrophilic reactions, and potential vascular compromise by compression or direct injection of the filler inside the artery [19]; therefore, indiscriminate filling of this region is not advised.

VII. Glabellar and Nasal Region (Fig. 7)

Anatomical vascular elements: supratrochlear artery (internal frontal artery) and dorsal nasal artery.

The most common vascular accident is due to the compression of vessels because the skin of this area is not distensible. An accident can also occur by injection of the product into the vessel because this region is very vascularized.

Andre and Haneke [17] refer to the development of a livedoid pattern on the right side of the nose, cheek, and forehead after the injection of hyaluronic acid into the tip of the nose.

Park et al. [13] described 7 cases of blindness due to the injection of filling material in the glabellar region because fillings in this area are most likely to cause blindness.

VIII. Supraorbital Region (Fig. 7)

Vascular anatomical elements: supraorbital arteries (external frontal artery).

Bruising is the most common vascular accident in this region. Compression of vessels, because the skin is not distensible, as well as the injection of the product inside a vessel, because this area is a very vascularized region, are also complications that occur in this region.

Carle et al. [20] described 3 cases of blindness due to dermal fillings in the forehead region consisting of autologous fat, hyaluronic acid, and polylactic acid. The occlusion of the

central artery of the retina, which was affected in all 3 cases, was performed through the rich anastomosis in this region of the branches of the external and internal carotid arteries.

However, blindness can also be caused by embolism of the central artery of the retina. Hu et al. [21] described a case of blindness due to the involvement of the posterior ciliary arteries following filling with hyaluronic acid of the forehead.

Li et al. [22] proposed the hypothesis that for facial fillings, mainly in the glabella, back of the nose, forehead and nasolabial fold, the needle can produce a rupture of the arterial wall. The injection force could overcome the systolic blood pressure and push the small droplet of filler through the ophthalmic artery and its branches, which could reach and block the middle cerebral artery, causing a retinal lesion and visual compromise.

Beleznay et al. [23] found that the combination of larger volumes of filling material together with a deeper placement of the material increases the risk of vascular compromise. This aspect, coupled with use by physicians who are not experts in the use of these techniques and have an inadequate knowledge of facial anatomy, is leading to an increased risk of complications. Beleznay et al. [23] performed a literature review of 98 cases of ocular complications due to facial fillings and determined that eye complications most often occur due to glabella injections (38.8% of cases), followed by injections in the nasal region (25.5%), the nasogenian groove (13.3%) and the forehead (12.2% of cases). This author mentions that the most common cause of blindness is autologous fat injection.

Li et al. [22], in a review of 75 cases of patients with blindness, described the regions in which this complication occurs most frequently. These results are consistent with those of Beleznay et al. [23] and indicate that these complications arise in 45% of cases in the glabellar region, 25% in the nasal region, 19% in the nasolabial sulcus, 8% in the forehead, 4% in the scalp and 3% in the temporal region. This author also mentions that in 11% of cases, visual alterations due to an injection occur in multiple facial zones during the same treatment.

Ozturk et al. [24], after reviewing 61 cases, agreed with the previous authors and stated that blindness is more common in fillings performed in the glabellar region (50% of cases). According to this author, necrosis is more common in the nasal region (33%) and the nasolabial sulcus (32%).

Conclusions

A detailed understanding of the main anatomical elements of the face is critical to avoid injury during dermal filler treatment. Based on anatomical hemiface dissections and a review of the literature in this study, we described the main complications that may occur with filler injection. The highest index of visual alterations occurs in fillings of the upper third of the face, corresponding to the temporal region (II), glabellar and nasal region (VII), and supraorbital region (VIII). These regions account for 70% of cases described by Li et al. [22] and 76.5% of cases related by Beleznay et al. [23]. The regions that present the next greatest number of complications are the buccinatory region and the nasolabial (III) sulcus, which account for 19 and 13% of the cases, respectively, in the previously mentioned studies [22, 23].

To prevent and avoid eye injuries such as blindness, it is advisable to avoid, as much as possible, treatments with filling materials in the upper third of the face, mainly the glabellar and nasal region (III) and the supraorbital region (VIII).

The treatments must at least adhere to the following guidelines to prevent accidents via the compression or filling of the vascular lumen. First, injection should be performed slowly and retrogradely after aspiration. Second, small volumes should be injected. Finally, an adequate anatomical knowledge of facial vascular structures, their route, and the most common variations is essential.

We believe that these findings will be helpful not only for dermal filler injection, but also for other injectable treatments in the facial area.

Key Message

The aim of this study is to provide an overview of the vascular territories of the face to avoid many possible complications when using facial fillings.

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Statement of Ethics

The authors have no ethical conflicts to disclose.

Disclosure Statement

The authors have no conflicts of interest to declare.

Author Contributions

Francisco Gomez-Esquer, María Angustias Palomar, and Rafael Linares García-Valdecasas conceived and designed the study. Gema Díaz-Gil, Stella Gomez, María Angustias Palomar Gallego, and Rafael Linares García-Valdecasas carried out the dissections. Stella Maris Gómez Sánchez and Antonio Gil Crujera analyzed the data; Francisco Gomez-Esquer, Gema Díaz-Gil, María Angustias Palomar, and Rafael Linares García-Valdecasas wrote the paper and gave the final approval of the version to be submitted.

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Appendix after References (Editorial Comments)

Legend(s)

Fig. 1. Flowchart of the Material and Methods.

Fig. 2. **a**, **b** Topographic regions of the face according to the clinical criteria and the vascular territory of the main arteries.

Fig. 3. Masseteric region (I): transverse facial artery (1) and zygomatico-orbital artery (2).

Fig. 4. Temporal region (II): superficial temporal artery (1), frontal branch of the superficial temporal artery (2), parietal branch of the superficial temporal artery (3), and zygomatico-orbital artery (4).

Fig. 5. Buccinatory region and nasolabial fold (III): facial artery (1) and facial vein (2). Lower lip and mentonian region (IV): inferior labial artery (3) and submental artery (4). Upper labial region (V): superior labial artery (5).

Fig. 6. Infraorbital region (VI): facial artery (1), angular artery (2), alar artery (3), and lateral nasal artery (4).

Fig. 7. Glabellar and nasal regions (VII): dorsal nasal artery branches (1) and supratrochlear arteries (2). Supraorbital region (VIII): supraorbital arteries (3).

Table(s)

Footnote(s)

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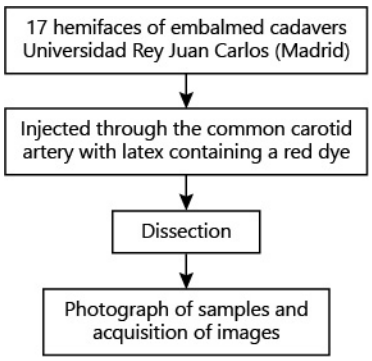

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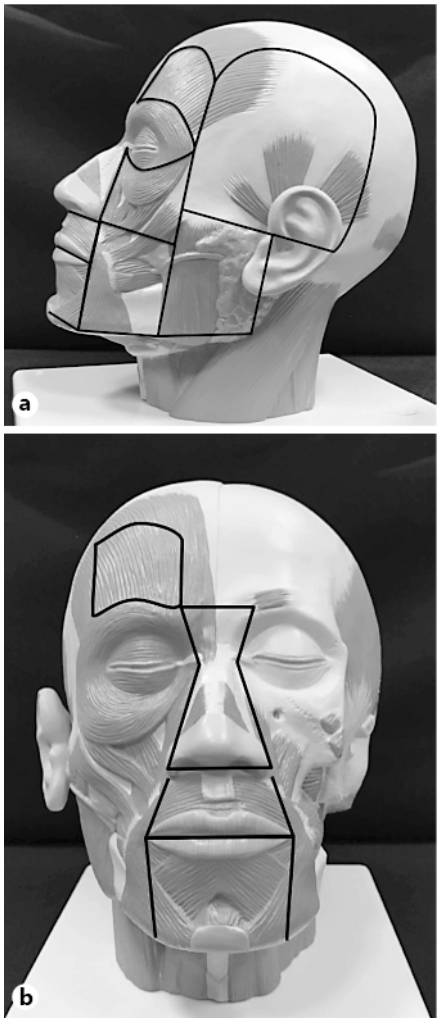

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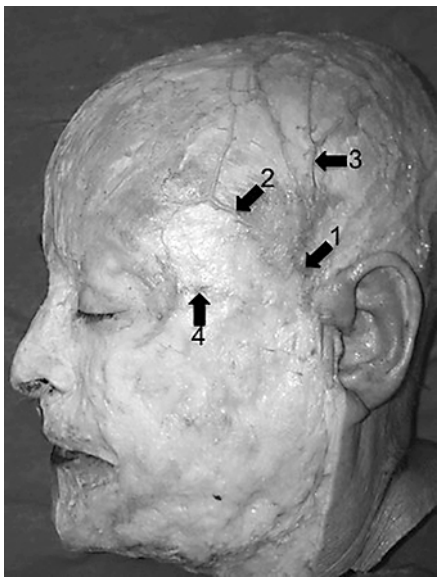

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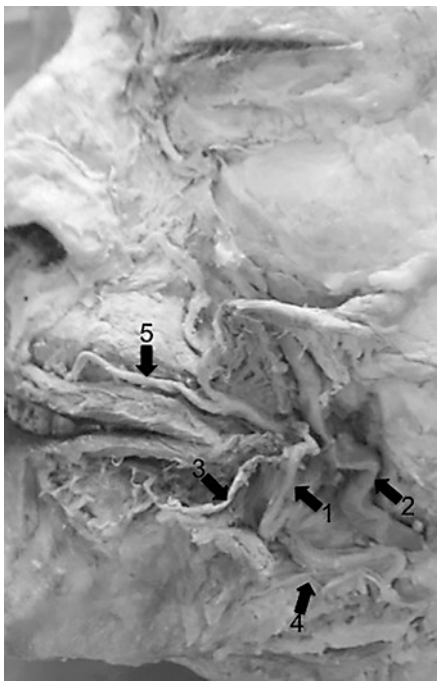

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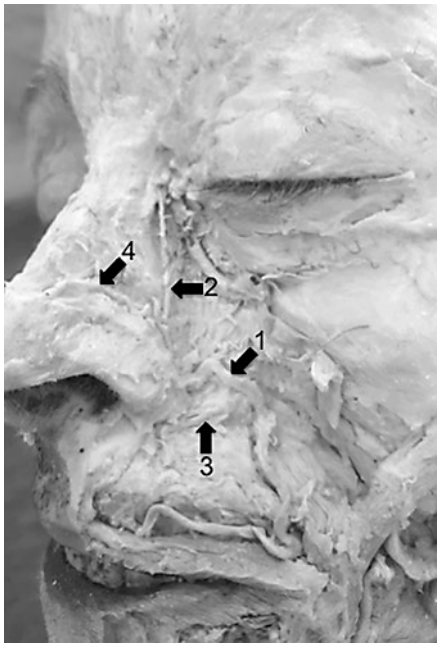

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