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Periorbital anatomy: avoiding complications with tear trough fillers

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ABSTRACT

Cosmetic treatments with fillers in the periorbital region are becoming more common. However, this is a complex anatomical region that must be known well to avoid complications such as chronic lymphedema, bruising, embolisms, infection, the periodontal pocket effect or nodules. The objectives when filling tear troughs are: determine the anatomical bases of the periorbital region, including fat compartments, the *septa* and lymphatic drainage; know the process of aging of the orbital region and midface (herniation of palpebral bags, loss of support, sequential atrophy of fat compartments, lower migration of these compartments and redistribution of intracompartmental volume); use the safest techniques for filling the lacrimal groove (anatomically safe, appropriate markings); determine the sequence that must be followed when applying a full facial treatment with fillers, including the lacrimal groove; and finally, determine which are the products of choice. A refined technique, a suitable product and knowledge of anatomy allow the periorbital region to be treated successfully with fillers, minimizing complications.

Keywords
tear trough, malar edema, facial lymphatic drainage, filler complication, periorbital anatomy

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Introduction

The periorbital region is one of the most affected areas by aging, with the appearance of periorbital wrinkles, deep lacrimal groove, palpebral bags, excess skin in the upper eyelid (blepharochalasis), malar bags, a loss of skin elasticity and a downwards tilt in the external canthus. In an attractive and youthful face, transitions between the pre-septal portion and the orbital portion of the orbicularis muscle, and between the eyelid fat and cheek compartments, should be smooth and not very pronounced. With the age process, these transitions become increasingly pronounced, with the appearance of grooves like the lacrimal groove (from the inner canthus to the mid-pupil line) and the palpebro-malar groove (lateral to the mid-pupil line).

Cosmetic treatments designed to improve this region combine different techniques such as botulinum toxin, fillers and surgery. However, the periorbital region presents anatomical characteristics that must be taken into account in order to achieve good results and avoid complications. This is a complex region with its own *septa* and ligaments, fat compartments, muscles, vascularization and lymphatic drainage.

Anatomy of the periorbital region

Orbicularis oculi (OO) muscle: this acts as a sphincter around the eye and allows the eyelids to close. It is responsible for periocular expression wrinkles that can be treated with botulinum toxin. The inferomedial edge of the OO muscle anatomically coincides with the lacrimal groove. The tear trough that crosses the cheek of some patients also anatomically coincides with the lower edge of the OO muscle (Figure 1).

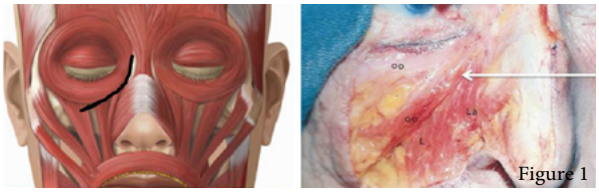

Figure 1

Figure 1 - The lacrimal groove anatomically coincides with the inferomedial edge of the *Orbicularis Oculi* muscle (OO: *orbicularis oculi muscle*; L: *levator labii superioris* muscle; La: *levator labii superioris alaeque nasi* muscle)

Deep fat compartments of the infraorbital region

-Intraorbital fat: the lower eyelid has three eye fat bags: inner, medial and outer. With age the orbital septum containing these bags weakens and the bags herniate leading to the appearance of eyelid bags. The treatment involves the excision of these bags by surgery (lower blepharoplasty). They can also be disguised by using fillers in the lacrimal groove (Figure 2). The upper eyelid has two eye fat bags (medial and inner; there is no external fat bag) that are surgically resectable together with the excess skin of the upper eyelid. This procedure is known as blepharochalasis (upper blepharoplasty).

-Suborbicularis oculi fat (SOOF): this is located behind the orbicularis oculi muscle and is divided into a medial portion and a lateral portion[1]. The medial SOOF extends from the medial limbus of the iris to the external canthus, while the lateral SOOF runs from the external canthus to the temporary fat compartment. The lower limit of the SOOF is the lacrimal groove (Figure 2 and Figure 3).

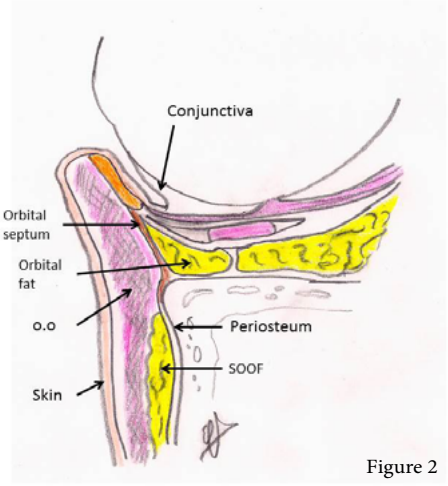

Figure 2

Figure 2 - Sagittal view of the orbit and anatomic relationships of its structures. (OO: *orbicularis oculi* muscle; SOOF: *suborbicularis oculi* fat compartment)

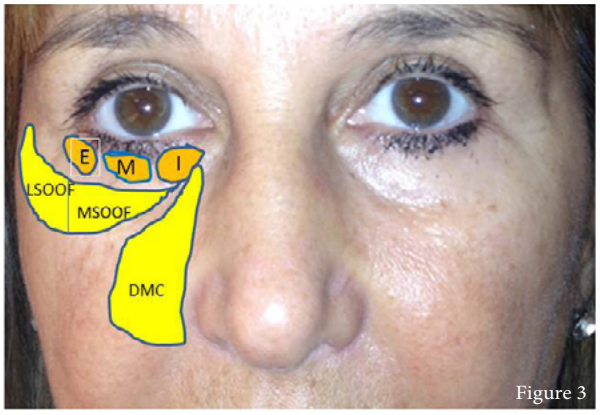

Figure 3

Figure 3 - Relationship between the internal (I), medial (M) and external (E) intraorbital eye bags with the medial (MSOOF) and lateral (LSOOF) portions of the *suborbicularis oculi* fat compartment and the deep medial fat compartment of the cheek (DMC)

-Deep medial cheek fat compartment (DMC): this corresponds to the medial edge of the SOOF. The DMC atrophies during aging[2], being more noticeable the transition between the orbital fat compartments

and the cheek fat compartments, making the lacrimal groove deeper. Restoring volume in the DMC with fillers rejuvenates the middle third of the face and reduces the transition between the lower eyelid and the cheek.

The deep infraorbital fat compartments - SOOF and DMC - can be filled to improve the lacrimal groove and rejuvenate this region.

The septum malaris: this anatomical structure was described by Pessa[3,4] and is of great relevance in lacrimal groove treatments with fillers. It is a thin facial structure that originates in the periosteum of the orbital rim and continues in the direction of the skin, dividing the SOOF into one upper portion and one lower portion. Before reaching the skin, it crosses the OO muscle and interdigitates with the fibrous septum of the surface fat in the cheek. It is inserted into the dermis at a point 3 cm below the external canthus (Figure 4). It is an impermeable membrane that prevents the diffusion of pigments and fluids from the periorbital region to the cheek. It is responsible for four different clinical conditions (malar edema, malar bag, periorbital ecchymosis and festoons), which share the same anatomical area since all of them have their lower limit approximately 2.5-3 cm below the external canthus. If the filler is placed in the area marked by the *septum malaris*, due to its impermeability, this may compress surface lymphatic vessels and cause chronic lymphedema (Figure 5). Therefore, fillers in the tear trough should preferably be introduced below the *septum malaris* to avoid chronic lymphedema, a characteristic complication of this region. If a supraperiosteal injection is performed, then the filler will be injected safely (Figure 6).

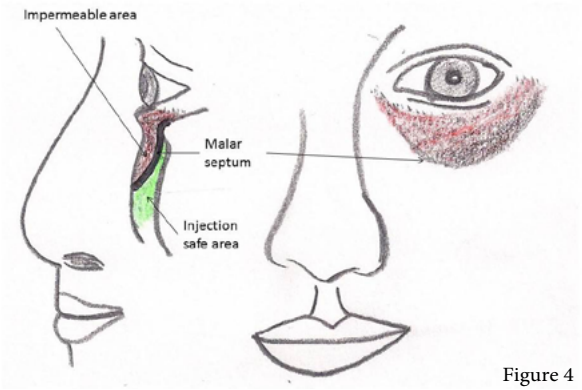

Figure 4

Figure 4 - Safe area for injecting fillers behind the *malar septum* (in green) in the supraperiosteal plane

Arterial vascularization: when filling a tear groove, consideration must be given to two main arteries: the infraorbital artery and the angular artery (Figure 7). The infraorbital foramen is easily located medial to the pupillary line and approximately 1 cm from the

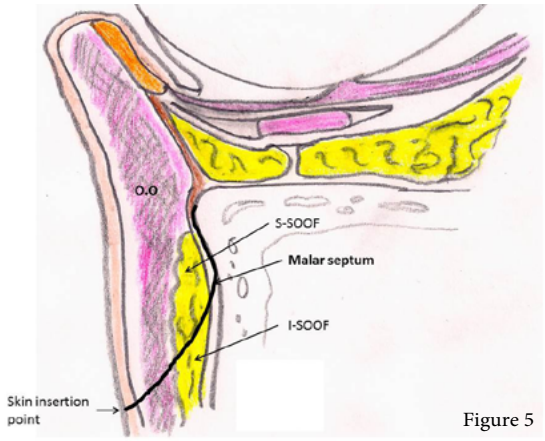

Figure 5

Figure 5 - The *malar septum* originates in the periosteum of the orbital rim and continues in the direction of the skin, through the *suborbicularis oculi* fat, and divides the latter into an upper portion (S-SOOF) and a lower portion (I-SOOF). On its way to the skin, it crosses the orbicularis oculi (OO) muscle and penetrates the dermis at a point 3 cm below the outer canthus

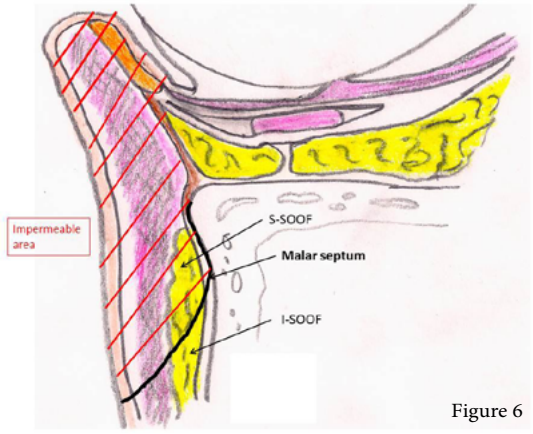

Figure 6

Figure 6 - The *malar septum* is an impermeable membrane that prevents the diffusion of pigments and fluids from the periorbital region to the cheek

infraorbital rim. The angular artery, a branch of the facial artery, runs along the inner canthus of the eye and anastomoses with the supratrochlear and supraorbital arteries; lesions to these arteries must be avoided. An infraorbital hematoma will increase pressure on soft tissue and may trigger a lymphatic insufficiency and malar lymphedema. An embolism in the angular artery could have catastrophic consequences if it causes an occlusion of the ophthalmic artery or central retinal artery, which could cause a rare but very serious complication, such as blindness.

Lymphatic system: Lymph is part of interstitial fluid. Interstitial fluid supplies nutrients to cells and eliminates waste. When this liquid passes into the lymphatic vessels, it is called lymph. The lymphatic system absorbs proteins that are too large to enter the venous capillaries and returns them together with excess interstitial fluid into the venous circulation.

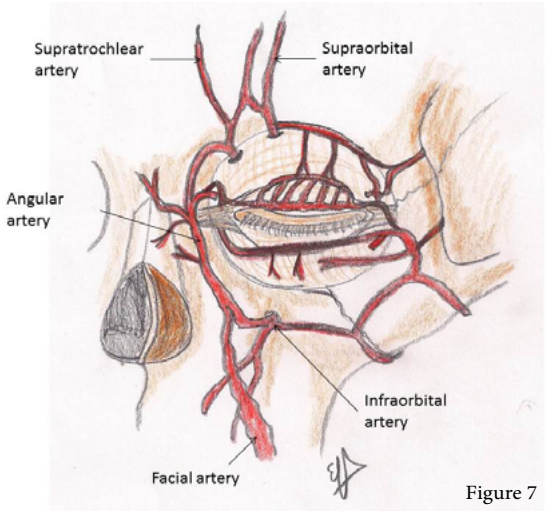

Figure 7

Figure 7 - Vascularization of the periorbital region.

Therefore, the main function of cutaneous lymphatic vessels is to maintain fluid balance and the load of lymph proteins draining interstitial fluid from the skin to the venous circulation. *Lymphatic transport capacity* is the maximum lymphatic flow per unit of time, corresponding to ten times the basal lymphatic flow. *Lymphatic insufficiency* occurs when lymphatic load exceeds transport capacity, inevitably leading to interstitial edema.

Facial lymphatic drainage occurs through different types of lymph vessels[5]:

-*Lymph vessels of the dermis:* these are approximately 0.014 to 0.15 mm and are valveless. They form a mesh-like network in the dermis and are the first to receive lymphatic drainage from the skin.

-*Pre-collector lymph vessels:* these are approximately 0.1-0.3 mm in diameter and already have valves, giving them a tubular shape resembling a *bamboo trunk*. They run from the dermis into the subcutaneous cellular tissue in search of collector vessels.

-*Collector lymph vessels:* these are approximately 0.1-2 mm in diameter, have valves and are located in the subcutaneous cellular tissue. They are tubular in shape and are classified as afferent (in the direction of the node), internodal (between nodes) and efferent (leaving the node).

So far we have described the facial lymphatic vessels. The next level of drainage is in the neck.

-*Lymphatic trunks:* these are between 1.5 and 3 mm in diameter, have valves giving them a rosary shape and are located in the deep tissues of the neck.

-*Thoracic duct:* this drains lymph into the venous system in the angle between the internal jugular vein and the left subclavian vein. It is also rosary shaped due to the presence of valves.

As can be seen, facial lymph vessels are superficially located in the dermis and in subcutaneous cellular tissue. Therefore, superficial injections of *fillers* can potentially compromise lymphatic drainage even more than deep injections. However, injections can be made superficially at other locations of the face where the risk of lymphedema is lower than in the periorbital region. This is explained by the presence of the *septum malaris*, which increases the risk of edema in the periorbital region, since it is an impermeable area at the surface, just where the lymphatic vessels that could be potentially compromised are located.

Regarding the lymphatic drainage of the upper eyelid, this generally runs to a parotid node or preauricular node and the lower eyelid and inner canthus of the eye are generally drained to a submandibular node[6] (Figure 8).

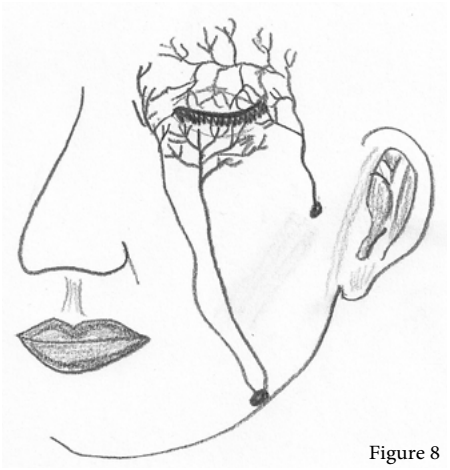

Figure 8

Figure 8 - Standard lymphatic drainage pattern of the periorbital region. The lymphatic drainage of the upper eyelid is generally performed to superficial parotid glands, and lymphatic drainage of the lower eyelid and the inner canthus of the eye to the submandibular glands. *(Based on the book illustration: The McGraw-Hill Companies from Lemke BN, Della Rocca RC. Upper facial anatomy. in: Lemke BN, ed. Surgery of the Eyelids and Orbit. An Anatomical Approach. Norwalk, Connecticut: Appleton and Lange; 1990).*

Factors leading to the appearance of malar lymphedema after filler injection

-*Location of injections:* a surface injection in the *septum malaris* increases its impermeability, and may compress the lymphatic vessels, obstruct lymphatic drainage and cause malar edema.

-*Volume of injected material:* excessive volumes put pressure directly on the lymphatic vessels if the material is injected either superficially or deep in the *septum malaris*.

-*Elasticity (G') properties of the filler:* elasticity is the capacity of a material to return the force applied

to it. An example of material with high G' is gelatin, which deforms slightly when force is applied to it, and a material with low G' is cocoa spread, which deforms easily and permanently when force is applied to it. It is preferable to use *fillers* with low G' because they offer less resistance to applied force, less extrusion force, less tissue stretching, a softer feel and are less palpable. The greater the elasticity of the *filler*, the greater the risk of compression of lymphatic vessels and edema formation.

-Patient propensity: patients with previous malar bags, a history of malar edema after excessive intake of salt or alcohol or when getting up in the morning, are patients with diminished lymphatic transport capacity so they are more at risk of presenting malar lymphedema after treatment.

Recommendations in the treatment of tear troughs

It is recommendable to make a supraperiosteal injection (avascular space) to reduce the risk of compression of lymphatic vessels, lymphedema, ecchymosis, visible material and embolism, as mentioned previously. Injection of small *bolus* of 0.05 cc of product prevents the appearance of lymphedema and nodules. The nodules in this region are more visible and palpable because the skin of the lower eyelid is extremely thin, so it is important to prevent their appearance.

Moreover, it is not advisable to vigorously massage the area after injection because massaging can move the *filler* superficially through the needle tracts and lead to inappropriate placement of the product even though it was initially injected correctly.

Correct patient selection is also important. Patients suspected of being at greater risk of lymphatic insufficiency in this region should not be candidates for treatment. Nevertheless, if the decision is taken to treat these patients, the safest approach would be to perform the procedure with a small volume of product and in various sessions to avoid saturating lymphatic transport capacity due to lymphatic vessel compression.

It is also necessary to choose the right products, which must offer low elasticity and be resorbable, such as hyaluronic acid with low cross-linkage or semi cross-linked, or collagen. Permanent products must be avoided in this region because they increase the risk of complications such as granulomas, product migration, chronic reaction to a foreign body and visible or palpable material.

The choice between cannula or needle depends on the physician preference, but generally less bruising and ecchymosis occur with cannula. Bruising may also cause lymphatic vessel compression and greater risk of edema, so the technique should be as atraumatic as possible. Cannula also minimizes the risk of intravascular injection and embolism. It is also advisable not to inject medially in the inner canthus to avoid lesions to the angular vessels.

Whenever the purpose of treatment is to restore volume in the midface together with treatment of the tear trough, it is recommendable to start by treating the midface. With aging, facial fat compartments atrophy and lower migration of facial fat occurs, increasing the distance between the eyelid and cheek fat compartments, leading to the appearance of the tear trough. Restoring volume in the midface rejuvenates the face and reduces the distance between the eyelid and cheek fat compartments, thus partially correcting the tear trough. This reduces the amount of product required to treat tear troughs, and also reduces the risk of complications, which are difficult to treat; hence, the most important thing is to prevent their occurrence[7].

Malar edema is a complication poorly tolerated by patients that can last months or even become permanent and cause disfiguration. There is no effective treatment, but it can be improved with postural measures (sleeping with the head elevated), lymphatic drainage, radiofrequency, restricting salt and alcohol intake, administration of oral corticosteroids or intralesional hyaluronidase. Injecting intralesional corticosteroids in the lower eyelid is not recommended because, given the thinness of the skin in this region, a skin atrophy can occur.

Personal technique

The personal technique recommended for filling *tear trough* and palpebromalar groove would be the use of a 25G x 38 mm cannula. The cannula is inserted through a puncture hole made with a 23G needle into the skin. The entry point of the cannula is located at the intersection between the line passing through the lateral *limbus* of the iris and the line marked by the tear trough. From this point of entry, both the tear trough and the palpebromalar groove can be filled. After introducing the cannula, resistance to the passage of the cannula should be noted; the cannula should pass through this resistant layer until it reaches the safe supraperiosteal layer. Once the cannula has been inserted into the deep layer, it should be moved medially, injecting small amounts in a fan shape, in the form of *bolus* or using the retro-tracing technique. From the same entry point, the cannula is removed and inserted laterally at supraperiosteal level to fill the palpebromalar groove in a similar way (Figure 9). It is not advisable to inject more than 0.5 cc per side in the same session; it is preferable to repeat the treatment after one month if more volume is needed. Natural results can be achieved with good technique (Figure 10 and Figure 11). Another technique is to make the entry point of the 25G x 40 mm cannula from the nasolabial folds, at a point located one cm to one side and one

cm below the nasal ala, injecting the *filler* in vertical strokes, perpendicularly to the tear trough (Beut-Jelks technique)[8]. This technique can be used to correct the tear trough and restore volume in the deep medial fat compartment of the cheek from the same point of entry.

Figure 9 - Female patient aged 59 before (top) and after (bottom) filling of the tear trough with Teosyal Redensity II (Teoxane laboratoires, Geneva, Switzerland)

Figure 10 - Female patient aged 42 before (top) and after (bottom) filling of the tear trough with Teosyal Redensity II (Teoxane laboratoires, Geneva, Switzerland)

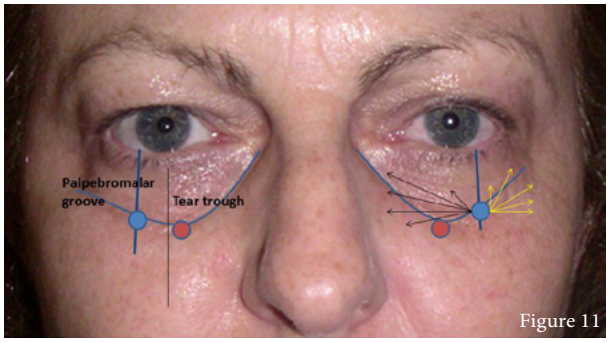

Figure 11 - Marking used in the personal technique for filling the tear trough. The entry point (blue circle) is at the intersection between the line of the lateral *limbus* of the iris and the line of the tear trough. The red circle indicates the location of the infraorbital *foramen*. The black arrows indicate the direction of the material deposits in the tear trough. The yellow arrows indicate the direction of the deposits of the material in the palpebromalar groove. The lacrimal groove or tear trough goes from the inner canthus to the mid-pupil line and the palpebromalar groove is lateral to the mid-pupil line

Summary

The anatomical features of the tear trough make it a particularly delicate area when injecting *fillers*. The injection technique must be based on good anatomical knowledge of the region, a refined and atraumatic technique with supraperiosteal injection of resorbable products with low elasticity, in moderate volumes and adequate selection of patients not prone to lymphatic insufficiency. If these principles are followed, satisfactory results will be achieved by minimizing the occurrence of complications.

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