Fillers have become a popular alternative to surgical rejuvenation of the face. Nearly 8.9 million nonsurgical procedures were performed in 2014, with 1.9 million of these being filler injections. Although the results can be impressive, the complications can be even more so. Sequelae can range from slight bruising to blindness and stroke. Wide varieties of "experts" perform injections and have just as variable credentials. Compounding this with inconsistent training among practitioners, differing skill levels, and a variety of techniques, a need arises to distinguish safe practices from those that put patients at risk.

In this article, we describe general principles maximizing safety during facial filler injections, progressing to specific facial zones and pertinent anatomy. To illustrate relevant structures, a male cadaver head was procured from the University of Texas Southwestern Willed Body Program and lightly embalmed. Intraarterial and intravenous latex injections were performed.

GENERAL PRINCIPLES

Patients should receive informed consent and told when a product is being used off-label. Even though filler injections can be expedient, their results can be long-lasting. Therefore, we recommend using hyaluronic acid fillers because they can be reversed with hyaluronidase. Despite familiarity with injections, even the most experienced practitioners can have adverse events and poor aesthetic outcomes.

Always inject slowly with low pressure and in small increments (Table 1). Using small syringes (0.5 to 1 cc) allows more controlled injections. In high-risk areas, inject anterograde and retrograde in constant motion using a serial puncture technique. Blunt or small-bore needles help stay in the desired plane. Use epinephrine with filler

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A Video Discussion by Jean D. Carruthers, M.D., accompanies this article. Go to PRSJournal.com and click on “Video Discussions” in the “Videos” tab to watch.

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injections to stimulate vasoconstriction, effectively reducing the size of vessels and bruising. Use extreme caution when injecting in a previously traumatized area. The tissue planes may be scarred and the anatomy altered. Consider using dermal fillers with a low G′ in high-risk areas when trying to diminish fine wrinkles. These more effectively fill wrinkles as opposed to improving folds through volume enhancement.

Knowledge of the facial anatomy is essential. As evidenced by numerous studies, the facial vasculature has many variations and can be found in various tissue planes, depending on location within the face. Anticipating the depth and course of vessels allows practitioners to develop techniques to avoid intravascular injection, vascular injury, and/or compression.

Six facial danger zones and their relevant anatomy are described below. (See Video, Supplemental Digital Content 1, which demonstrates the facial danger zone anatomy in a cadaver, available in the “Related Videos” section of the full-text article on PRSJournal.com or, for Ovid users, available at http://links.lww.com/PRS/B963.)

### BROW AND GLABELLAR REGION

**Pertinent Anatomy**

The corrugators originate along the nasal process of the frontal bone, coursing superolateral under the frontalis, inserting dermally at the brow. Over time, contraction of this muscle creates vertical rhytides at the brow level. Likewise, procerus muscle activity leads to horizontal nasal rhytides, also referred to as “bunny lines.”

The supratrochlear artery, a branch of the ophthalmic artery, exits the superomedial orbit 17 to 22 mm lateral to midline, piercing or passing superficial to the corrugator, deep to the orbicularis and frontalis2–4 (Fig. 1). Approximately 15 to 25 mm above the orbital rim, the artery traverses the frontalis and orbicularis to enter the subcutaneous plane.2 It continues running superiorly in the subcutaneous plane 15 to 20 mm from midline in a paramedian position.3 At the level of the brow, the supratrochlear artery runs vertically in line with the medial canthus plus or minus 3 mm.5 Another study demonstrated the artery within the glabellar frown line in 50 percent of cases and an average of 3.2 mm lateral in the remaining cases.6 The

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**Table 1. General Principles for Safe Filler Injections**

<table>
<thead>
<tr>
<th>Principle</th>
<th>Details</th>
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<tbody>
<tr>
<td>Use reversible fillers (i.e., hyaluronic acid fillers)</td>
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<td>Use small needles (i.e., 27-gauge or smaller)</td>
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<td>Use cannulas when appropriate</td>
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<tr>
<td>Use an anterograde/retrograde injection technique, keeping the needle in constant motion</td>
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<tr>
<td>Use small syringes (0.5–1 cc) and inject in small increments</td>
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<tr>
<td>Use low pressure; injections requiring high pressure signify danger and/or inappropriate location</td>
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<tr>
<td>Use extreme caution when injecting in areas of previous trauma/sca or avoid altogether</td>
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<td>Be aware of the pertinent anatomy outlined in the danger zones</td>
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<td>Have a filler rescue kit available at all times (e.g., nitroglycerin ointment, aspirin, hyaluronidase)</td>
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**Fig. 1.** The supraorbital artery (a) is shown exiting above the brow, ramifying a periosteal branch before traversing the subgaleal plane. The supratrochlear artery (b) lies medial, piercing the corrugator muscle (d), and anastomosing with the dorsal nasal artery (c) and the supraorbital artery (a).
supratrochlear artery branches anastomose with the angular, supraorbital, and dorsal nasal arteries.

The supraorbital artery, also a branch of the ophthalmic artery, exits the orbit through the supraorbital notch approximately 32 mm lateral to midline, generally corresponding to a vertical line intersecting the medial limbus of the cornea. Erdogmus and Govsa found that the artery most commonly pierced the frontalis 20 to 40 mm above the orbital rim, and then surfaced in the subcutaneous tissue between 40 and 60 mm. However, Kleintjes observed the supraorbital artery sending vertical branches entering the subcutaneous tissue as low as 15 to 20 mm above the rim after a short intramuscular course. In addition to the dorsal nasal, supratrochlear, and angular arteries, the supraorbital artery sends branches that anastomose with the frontal branch of the superficial temporal artery most often at the junction of the transverse inferior and middle thirds of the forehead.

Maximizing Safety

In the brow and glabella area, the vasculature is initially deep, quickly transitioning to the intramuscular and subcutaneous level. Therefore, we recommend using a low-G filler injected intradermally to fill glabellar frown lines and bunny lines, in the brow and glabellar area. Apply digital pressure at the supraorbital rim during injection to occlude vessels. Intravascular injection at this level can travel retrograde through the anastomoses between the supraorbital, supratrochlear, and ophthalmic arteries, leading to blindness and tissue loss (Fig. 2). In multiple reviews, the glabella was the most common filler injection site leading to visual loss.

TEMPORAL REGION

Pertinent Anatomy

Within the temporal fossa, the frontal branch of the superficial temporal artery and temporal branch of the facial nerve run within the temporoparietal fascia. In a recently published cadaver study, the origin of the frontal branch from the superficial temporal artery was on average located 17.2 mm anterior and 36.9 mm superior to the tip of the tragus. Typically, the frontal branch of the superficial temporal artery can be located coursing over the frontalis 15.8 mm superior and 14.8 mm posterior to the tragus.
the peak of the brow. A line connecting these two points delineates the most common course of the artery, although variations do exist. In the study, the authors defined their danger zone as the area starting 2.5 mm lateral and 3.0 mm superior to the peak of the brow, and thus recommended digital pressure to this area when injecting the temporal hollow. Trussler et al. histologically observed the frontal branch artery running in the temporoparietal fascia in close proximity to the temporal branch of the facial nerve 2 cm above the zygomatic arch. In our dissection, we observed similar findings; the frontal branch of the superficial temporal artery ran within the temporoparietal fascia 2 cm above the arch, transitioning to become completely subcutaneous just superior to the brow near the border of the frontalis. The frontal branch of the superficial temporal artery arborized with the supraorbital arterial system in the deep and superficial planes (Fig. 3). This presents another pathway of retrograde embolization to the arterial supply of the globe. In a cadaver study, dye injected into the superficial temporal artery was found within the ipsilateral globe, and even bilaterally in certain specimens.

Of additional concern, the middle temporal vein runs approximately 20 mm above and parallel to the zygomatic arch within the superficial temporal fat pad. Given its average size of 5.1 mm (range, 2.0 to 9.1 mm) and its connection to the cavernous sinus, Jung et al. recommended injecting within a fingerbreadth of the zygomatic arch in the preperiosteal plane. Although extremely rare, there have been reports of fatal nonthrombotic pulmonary embolism during fat injections when the middle temporal vein was cannulated. Hyaluronic acid facial injections have also been implicated as a cause of nonthrombotic pulmonary embolism. Tansatit et al. recommend pressing the pretragal area during filler injection to prevent a nonthrombotic pulmonary embolism through inadvertent cannulation of the middle temporal vein. In their cadaveric study, retrograde injections of the middle temporal vein did not fill the supraorbital, supratrochlear, or any of the medial orbital veins. However, anterograde injections drained into the internal jugular vein. Thus, middle temporal vein injections are less likely a mechanism for ocular embolism, although it has been postulated.

Despite efforts to place filler in the subcutaneous anatomical plane, cadaver studies have shown unintended deeper location of filler in the superficial temporal fascia, temporalis muscle, and encompassing a superficial muscular artery. In an attempt to obtain uniform results, some authors have heavily diluted the fillers, injecting them in the deep subcutaneous plane adjacent to the superficial temporal fascia.

Maximizing Safety

In the temporal region, fillers should be injected deeply or superficially. Deep filler injections in the temporal fossa should be in the preperiosteal plane. They should be injected within a fingerbreadth of the arch and/or greater than 25 mm above it to avoid the middle temporal vein. In the preperiosteal plane, a high-G’ filler in greater amounts will be needed to translate results superficially. Therefore, we choose to inject filler in the superficial subcutaneous tissue, staying just below the dermis while applying pressure just superior to the peak of the brow. The frontal branch of the superficial temporal artery runs one layer deeper in the temporoparietal fascia and therefore is at less risk. As the artery approaches the temporal fusion line, it transitions to the subcutaneous plane. Embolic phenomena occur when the cannulated artery propagates filler into the supraorbital system, or filler travels retrograde into the main superficial temporal artery system. Either can lead to blindness. We caution against injecting at intermediate depths because it becomes nearly impossible to discern which layer is being injected.

INFRAORBITAL REGION

Pertinent Anatomy

Midface filler injections allow augmentation without the need for an alloplastic implant. Within
this region, the infraorbital artery and nerve typically exit the infraorbital foramen. If the artery is inadvertently cannulated, this again provides another route for filler embolization. Likewise, injury to the nerve can lead to hyperesthesia/hypoesthesia and pain. Basic anatomical knowledge of the infraorbital foramen allows practitioners to better predict its location and avoid its contents.

There is great variation in the literature regarding anatomical landmarks for the vertical plane of the infraorbital foramen. In has been documented in-line with the first premolar, second premolar, and the canine teeth. Likewise, a minority of patients have multiple foramina. The average distance between the infraorbital foramen and the inferior orbital rim is 6.3 to 10.9 mm. The average distance of the infraorbital foramen from facial midline is 25.7 to 27.1 mm in men and 24.2 to 26.8 mm in women. Other authors have described it being approximately 33 to 41 percent of the total distance when measuring from the medial to the lateral canthus. Approximately 50 percent of the time, Aziz et al. found the infraorbital foramen in the same vertical plane as the supraorbital foramen.

Maximizing Safety

Overall, when injecting deep into the midface, the above measurements should be kept in mind to avoid intravascular cannulation or vascular injury. Generally, the infraorbital foramen will be located approximately one-third of the distance between the medial and lateral canthi up to 11 mm below the infraorbital rim. Clinically, the infraorbital foramen lies slightly less than a fingerbreadth below the infraorbital rim in the vertical plane of the medial limbus, or immediately lateral to it. We avoid direct deep injections into this area, choosing to inject just lateral. Injections more medial approaching the medial canthus should be avoided completely. If filler is needed in this area, it can be injected laterally and pushed medially.

LIPS/COMMISSURE

Pertinent Anatomy (Upper Lip)

Perioral filler injections are becoming more common as patients frequently request more full and voluptuous lips. The goals for the patient must be determined before injection: volume versus vermillion-cutaneous enhancement, or both. Young patients generally have adequate volume but desire enhancement of the vermillion-cutaneous border. Volume is often required in older patients and those with thin lips, occasionally along with vermillion-cutaneous enhancement.

Although many variations of the perioral vasculature are documented in the literature, a general concept of the most common anatomy increases the reproducibility of safe results. The takeoff of the superior labial artery off the facial artery is on average 10.4 to 12.1 mm lateral and approximately 43 degrees superior to the corner of the mouth, or 5 to 9 mm above this landmark. However, the origin can at times be inferior to the commissure. The superior labial artery then usually runs superior to the vermillion border, then coursing inferior to the border just before approaching Cupid’s bow. In the upper lip, the superior labial artery is 3 to 7.6 mm deep to skin, running usually between the orbicularis and the oral mucosa, or less often within the orbicularis. The superior labial artery is 3 to 7.6 mm deep to skin, running usually between the orbicularis and the oral mucosa, or less often within the orbicularis. The superior labial artery is 3 to 7.6 mm deep to skin, running usually between the orbicularis and the oral mucosa, or less often within the orbicularis. The superior labial artery is 3 to 7.6 mm deep to skin, running usually between the orbicularis and the oral mucosa, or less often within the orbicularis. The superior labial artery is 3 to 7.6 mm deep to skin, running usually between the orbicularis and the oral mucosa, or less often within the orbicularis. The superior labial artery is 3 to 7.6 mm deep to skin, running usually between the orbicularis and the oral mucosa, or less often within the orbicularis.

Maximizing Safety

Injections into the upper lip should be less than 3 mm deep, with an intermediate or low-G'...
filler either at the vermilion cutaneous border or within the dry vermilion. The superior labial artery is typically posterior at the mucosal-muscular interface and several millimeters above the inferior border of the lip. Intravascular injection can lead to tissue necrosis.

**Pertinent Anatomy (Commissure)**

Along with other authors, we observed the facial artery lying deep to the risorius and zygomaticus major and 12 to 15.5 mm lateral to the commissure. However, there are cases where the artery can be running through separate muscle bands of the zygomaticus major. Clinically, the area encompassing the facial artery and the superior labial artery origin can be estimated by placing a thumb beside the corner of the mouth.

**Maximizing Safety**

Because the facial artery and the origin of the superior labial artery generally lie deep to or within the muscle, superficial subcutaneous injections in a linear crosshatching fashion safely addresses volume deficiency and laxity in this area.

**Pertinent Anatomy (Lower Lip)**

There have been attempts to categorize all of the origins and variants of the inferior labial artery. To recapitulate each is beyond the scope of this article. However, the inferior labial artery has been observed running horizontally at the level of the vermilion-cutaneous level, and at the height of the labiomental fold perfusing the lower lip with vertically oriented branches. At the level of the vermilion-cutaneous border, the inferior labial artery lies 6.4 to 7.1, 5.9 to 9.4, and 4.4 to 4.8 mm from the anterior, superior, and posterior borders of the lower lip, respectively (Fig. 4). As the inferior labial artery branches from the facial artery, it enters the lower lip and travels between the mucosa and muscle. The numerous patterns of the inferior labial artery and its varied origins may lie in the fact that there are no universally accepted definitions distinguishing between the inferior labial artery and the labiomental artery. Although the inferior labial artery has numerous variations ranging from a common trunk with the superior labial artery to its complete absence, these patterns may overall not be as important as ascertaining the correct depth of the artery when injecting fillers. In an attempt to clarify, Lee et al. classified an artery traveling in the middle of the lower lip as a horizontal labiomental artery, regardless of the final trajectory toward the lower lip; an artery traveling along the level of the lower lip vermilion-cutaneous border with an origin near the commissure was called an inferior labial artery. When this distinction is not made, the origin of the inferior labial artery varies in the literature between just superior to the corner of the mouth, all the way to the lower margin of the mandible.

**Maximizing Safety**

Lower lip injections should be with an intermediate- or low-G filler either at the vermilion cutaneous border or within the dry vermilion, no greater than 3 mm deep. The inferior labial artery is typically posterior at the mucosal-muscular interface and below the superior border of the lip. Intravascular injection in the area leads to tissue necrosis.

**NASOLABIAL FOLD**

**Pertinent Anatomy**

Filling a deep nasolabial fold instantly gives the face a rejuvenated appearance. As for other areas of the face, the various naming schema and classification systems of the facial artery and its superior course have led to confusion in the literature. For our purposes, the arterial portion running from the cheek to the alar base is referred to as the facial artery until the takeoff of the lateral nasal artery. Thereafter, it is referred to as the angular artery.

After giving off the superior labial artery near the commissure, the facial artery continues superiorly adjacent to the nasolabial fold. In the cadaver study by Yang et al., the facial artery was observed in close proximity to the nasolabial fold, with its entire course being medial (42.9 percent), lateral (23.2 percent), or crossing the nasolabial fold (33.9 percent). At the transition between the upper middle third and the middle lower third of the nasolabial fold, the facial artery was on average 1.7 mm medial and 0.3 mm medial to the nasolabial fold, respectively. At the level of the ala, the facial artery branches to yield the inferior alar artery and the lateral nasal artery immediately above. It then continues as the angular artery when present. There are also “duplex” or “detouring” patterns, where an ipsilateral duplicate facial artery may branch low in the face, traveling to the infraorbital area and then crossing medially at the nasojugal groove to become the angular artery. Lastly, there are patterns where the angular artery is absent or arises in a retrograde fashion from the ophthalmic artery. This is not a comprehensive review of every branching pattern of the facial artery, but instead an illustration of the variability.

When injecting in the region of the nasolabial fold, the depth of the artery becomes all the more
pertinent to avoid an intravascular injury. Unfortunately, there is a dearth of literature illustrating the anatomical planes the artery may travel in at various levels. More recently, Lee et al. described the relationship of the facial artery with regard to the facial muscles in a cadaver dissection series. In 85.2 percent of cadavers, the facial artery was superficial to the mimetic muscles at some point between the alar base and the modiolus (Figs. 5 and 6). In 16.7 percent, the artery was completely subcutaneous from the modiolus to the alar base. In only 14.8 percent of cadavers did the facial artery remain completely beneath the mimetic muscle all the way to the alar base. In our dissection, the artery became very superficial in the upper third of the nasolabial fold as it ramified the inferior alar artery and the lateral nasal artery. It is in this area that it becomes most prone to injury during subcutaneous filler injections.

Maximizing Safety

In the lower two-thirds of the nasolabial fold, injections into the deep dermal and superficial subcutaneous plane are generally safe because most of the facial artery course lies beneath muscle and/or above it but in deeper planes; however, in the upper one-third, the artery can become very superficial. Near the alar base, we recommend injecting either intradermally or in the preperiosteal plane. Subcutaneous injections in this area can lead to alar and cheek necrosis if the facial artery or its branches are cannulated or injured. This is also a pathway for ocular embolism through propagation in the angular artery and its anastomoses with dorsal nasal branches. In one review, the nasolabial fold was the second most common injection site leading to tissue necrosis, and, in another study, the third most common site leading to visual loss.

Fig. 5. The nasolabial portion of the facial artery is seen running beneath subcutaneous tissue (a) until its upper third, where it becomes more superficial (b) and at greater risk for injury during injections.

Fig. 6. With the subcutaneous tissue (e) reflected, the facial artery (a) is seen running in the nasolabial fold sporadically within the muscle but mostly in the plane between the subcutaneous tissue and muscle. The artery becomes superficial (b) in the upper third of the nasolabial fold and is at risk during superficial injections. The transition of the facial artery into the angular artery (c), and its anastomosis with the dorsal nasal artery (d) is demonstrated. Of note, the facial artery lies approximately 1.5 cm lateral to the commissure.

NOSE

Pertinent Anatomy

In general, the layers of the nose are as follows: epidermis, dermis, subcutaneous fat, muscle and fascia (musculoaponeurotic layer), areolar tissue, perichondrium/periosteum, and cartilage/bone. As discussed previously, the facial artery gives rise to the lateral nasal artery and angular artery through a variety of patterns. The facial artery is on average 3.2 mm lateral to the most lateral point of the ala. More importantly, the facial artery gives rise to the inferior alar branch traveling along the inferior margin of the nostril and lateral nasal artery, which runs in the subdermal plexus 2 to 3 mm superior to the alar groove over the cephalic margin of the lower lateral cartilage. After this branching point, the facial artery now continues toward the medial canthus as the angular artery while anastomosing with the dorsal nasal arterial system running over the nasal dorsum (Fig. 7). Toriumi et al. illustrated a subdermal vascular plexus that was most prominent in the nasal tip and a larger arterial and venous system of the nasal skin found superficial to the nasal musculature (superficial musculoaponeurotic system layer).
in the subcutaneous plane. There is sparse vasculature within the areolar layer beneath the muscular layer aside from what they termed the “deep” or “lateral nasal veins” running cephalic to the lateral crura. Saban et al. described a “marginal artery” coursing over the lower lateral cartilage caudal border toward the tip after branching from either the facial artery or the lateral nasal artery. The dorsal nasal artery (a terminal branch of the ophthalmic artery) emerges from the medial orb and courses over the dorsum above the muscular layer to contribute to the subdermal plexus at the tip.

Maximizing Safety

Given the shallow nature of the vasculature located within the nose, a misplaced injection can lead to disastrous results. Superficial injections compressing or injuring the superficial vasculature in the tip and alar facial groove can lead to tip and alar necrosis, respectively. Likewise, given the tip, dorsal, and sidewall vessel anastomoses with the ophthalmic artery, intravascular injections in these areas can cause retrograde propagation of filler, leading to ocular ischemia and blindness. Therefore, all lateral injections should be greater than 3 mm above the alar groove and deep. Injections to the tip and dorsum should be deep in the preperichondrial and preperiosteal planes. In several reviews analyzing facial danger zones, nasal filler injections were documented as the leading cause of tissue necrosis and the second leading cause of visual loss after the glabella.

CONCLUSIONS

Facial filler injections continue to grow in popularity given the limited recovery time and the immediate results. However, their complications can be even more impressive than their aesthetic results. Therefore, we have reviewed the pertinent anatomy in the six danger zones of the face so that practitioners can tailor their injection techniques to maximize safety. Despite detailed published descriptions of the facial vasculature, the anatomy can be quite variable, and vascular injuries can occur even after the best precautions are taken. Likewise, actual needle depth can be difficult to track and at times unpredictable. Most importantly, practitioners need to recognize complications in a timely manner and take the appropriate measures to minimize what can be a devastating result.

REFERENCES


Fig. 7. The facial artery (a) ramifies the inferior alar branch (b) and the lateral nasal artery (d) before becoming the angular artery (c). The dorsal nasal artery (f), lateral nasal arteries (d), and columellar artery (not pictured) form a rich vascular network at the nasal tip in the subdermal layer (e).


