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NOSING AT NOSE JOBS

Dr Raj Thethi discusses the vascular anatomy of the external nose with relation to non-surgical rhinoplasty

The incidence of non-surgical aesthetic procedures is increasing year on year, whilst the number of cosmetic, surgical procedures continue to steadily fall. Interest in Non-Surgical Rhinoplasty (NSR) with dermal fillers over traditional surgical rhinoplasty procedures is progressively rising as some are seeing the benefit of the reduced cost and downtime.

These patients have often researched online and spent sometimes years considering their options for nasal correction. They often attend a consultation fully informed of the possibilities. Some patients attend knowing precisely which procedures are available and the advantages and disadvantages of each approach e.g., needle vs cannula. With this rise of social media and potential desensitisation of non-surgical, aesthetic procedures, we must remember that NSR is still a notoriously advanced, aesthetic procedure with many practitioners choosing not to train or provide this treatment due to the inherent risks.

One of the pertinent risks associated with this procedure is that of vascular complications. We will discuss the major anatomical principles of the external nasal vasculature that are clinically relevant to NSR, possible arterial and venous complications and how to improve your safety with some top tips from NSR expert Mr Ash Labib.

Arterial supply

Classic anatomical investigations have outlined the major vascular components of the external nose, but it was in the late 1980s and 90s that we started to truly appreciate the extensive anatomical variability and complexity of the nasal blood supply.[1] Due to the amount of variability in the blood supply we will focus on the major patterns of distribution only.

The external nose receives a blood supply from both the external and internal carotid systems. The external carotid artery gives rise to the facial artery which travels

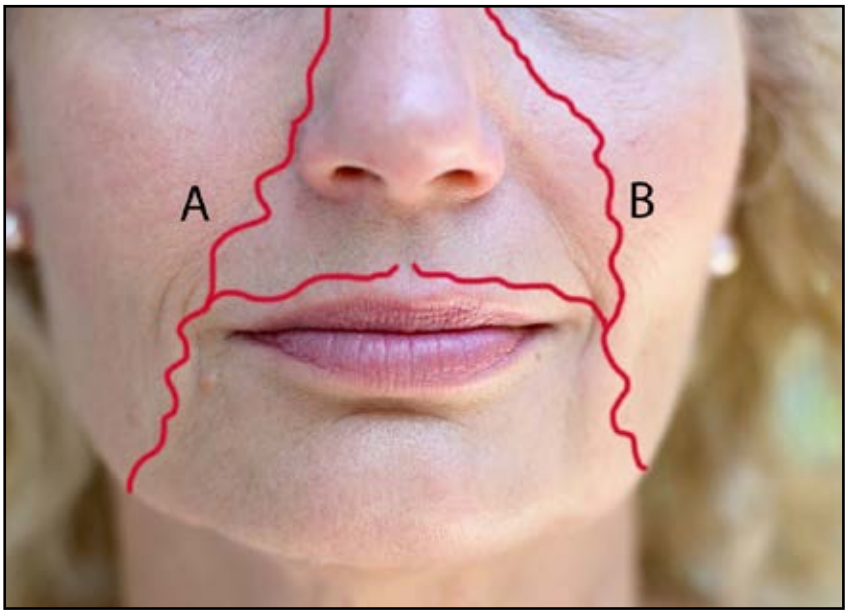


Figure 1– The two commonest paths of the facial artery. A) The Oblique Type (78%) and B) The Vertical Type (22%)[2].

tortuously over the anterior surface of mandible towards the nose. The course, anastomotic connections and point of termination of the facial artery are highly variable with some people having only a partial supply from this vessel with other arteries taking more precedence. Different ethnicities have been shown to have diverse distribution patterns but even then, many may show atypical features.

With regard to the course of the facial artery, some studies show 78% of people have an "oblique" type path which courses a medial route travelling within or in close proximity to the nasolabial fold while in 22% of cases, studies found a "vertical" type ascent of the artery running more laterally, medial to the facial vein in its septum, traversing superomedially along the inferomedial border of the orbicularis oculi muscle[2] (Figure 1).

The facial artery normally courses deep to the modiolus, approximately 15mm horizontally from the oral commissure[3] before becoming more superficial[1]. Before approaching the nose, it normally gives off the superior labial artery which supplies the upper lip and philtrum. The superior labial arteries can give rise to the small, columellar arteries, in over 60% of people, that run up in the philtrum and columella as end arteries to the tip of the nose[4].The facial artery can also give off small branches called the inferior allar arteries that run transversely towards the midline. The facial artery can then give off the lateral nasal branch which normally runs in the alar groove. This artery supplies the alar and nasal tip and can anastomose with the ascending columellar branches[5].

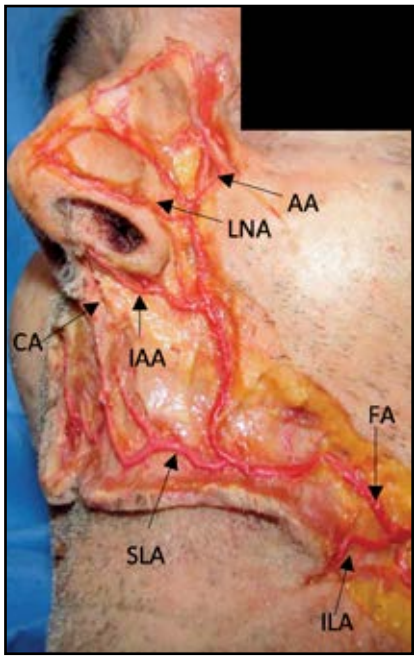


Figure 2 - Cadaveric dissection showing the route of facial artery (FA) near oral commissure and upper lip. The inferior labial (ILA) superior labial (SLA), columellar (CA), inferior alar (IAA) and lateral nasal arterial (LNA) branches can be noted. The terminal branch of the facial artery; the angular artery (AA) can be seen here traversing superiorly. (Reproduced with permission - Adapted from Saban et al., 2012[5]).

The facial artery then continues as its terminal branch called the angular artery, which traverses up either the side of the external nose (oblique type) or follows the edge of the orbicularis oculi muscle (vertical type) and is known to potentially anastomose with the infra-orbital, supratrochlear, transverse facial, dorsal nasal arteries and, or other smaller branches as can be seen in Figure 3. The arterial, anastomotic variability in this area is very high.

The internal carotid system gives rise to the ophthalmic artery just as it emerges from the cavernous sinus. The ophthalmic artery travels with the optic nerve through the optic canal before dividing and supplying branches to the orbit, forehead, nose and meninges. It branches into the supratrochlear and supraorbital arteries that can anastomose with the angular artery.

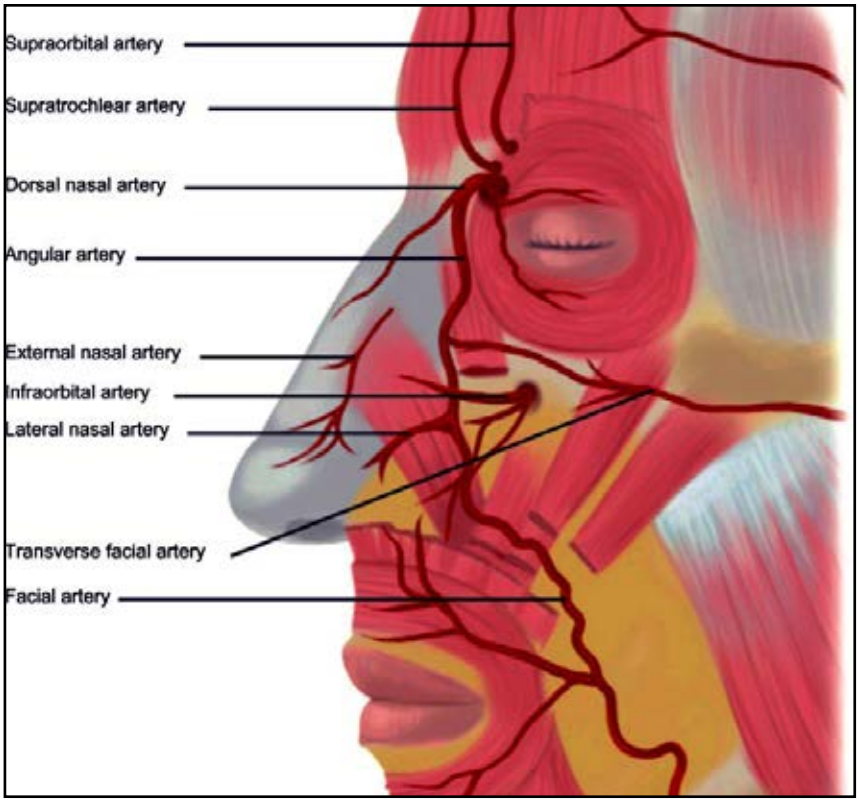


Figure 3 - Schematic diagram outlining the major arterial anatomy of the external face. Note the anastomotic relationships between the ophthalmic and facial artery branches. (Reproduced with permission - Adapted from Grunebaum et al., 2009[6]).

The supratrochlear artery frequently gives rise to a descending branch called the dorsal nasal artery which often anastomoses with the ascending, angular artery[1] (Figure 3).

The ophthalmic artery also branches into the anterior and posterior ethmoidal arteries. After supplying the frontal sinus and anterior and middle ethmoidal sinuses, the anterior ethmoidal artery can emerge on and supply the nasal dorsum between the nasal bone and upper lateral cartilages. There is variability in nomenclature, but these are generally referred to as the external nasal arteries (Figure 3).

Interestingly, studies using both traditional cadaveric dissection and in vivo, ultrasonographic doppler investigations have concluded that the external, nasal blood flow has further dimensions of complexity during its dynamic function. In vivo doppler studies assessing the residual blood flow after temporary compression of the facial artery and, or the ophthalmic artery branches, have confirmed 80% of the people (n=32) have an ipsilateral,

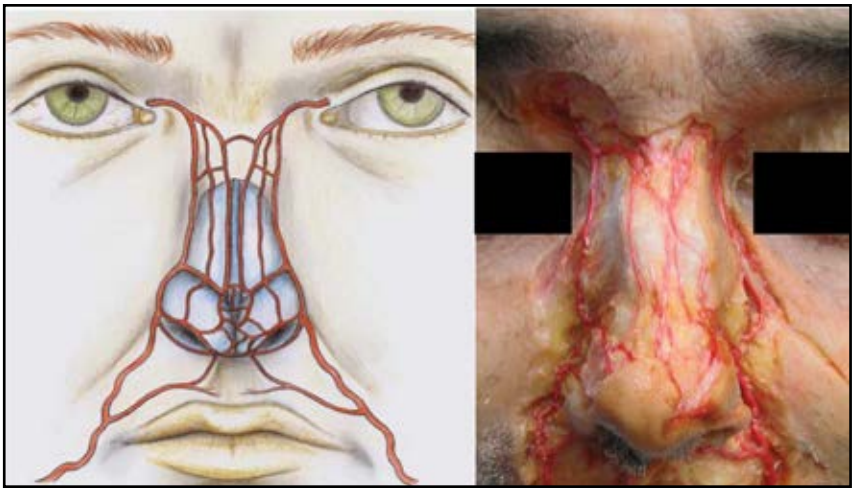
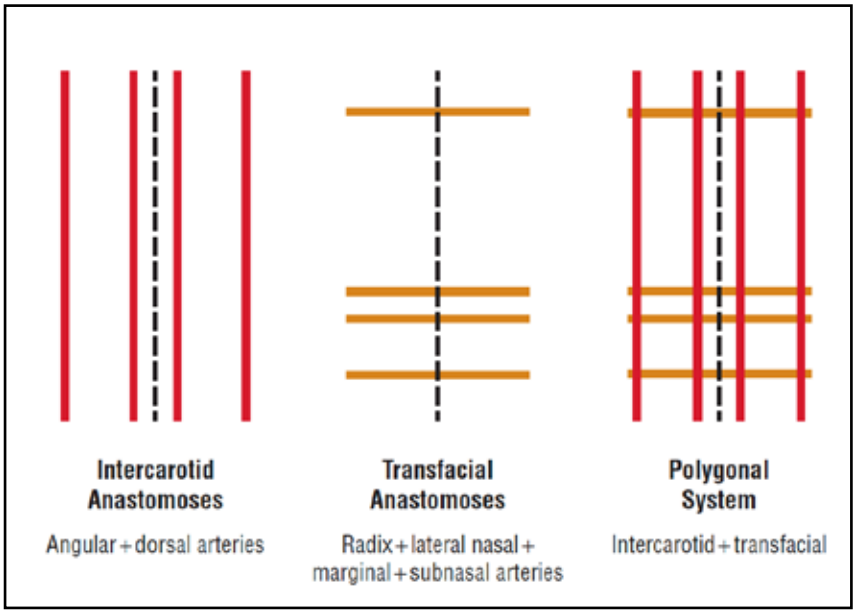


Figure 4 (Above) - Conceptual schematic of the external nasal arterial system proposed by Saban et al., 2012[5]. Note the possible anastomotic networks. This is not present in all patients, but demonstrates the basic data, from which anatomic and physiological variations can occur. (Reproduced with permission - Saban et al., 2012[5]).

Figure 5 (Below) - Conceptual diagram showing the intercarotid, transfacial anastomoses. The polygonal system combines both and shows the complex possibilities for anastomotic connections. (Reproduced with permission - Saban et al., 20125).



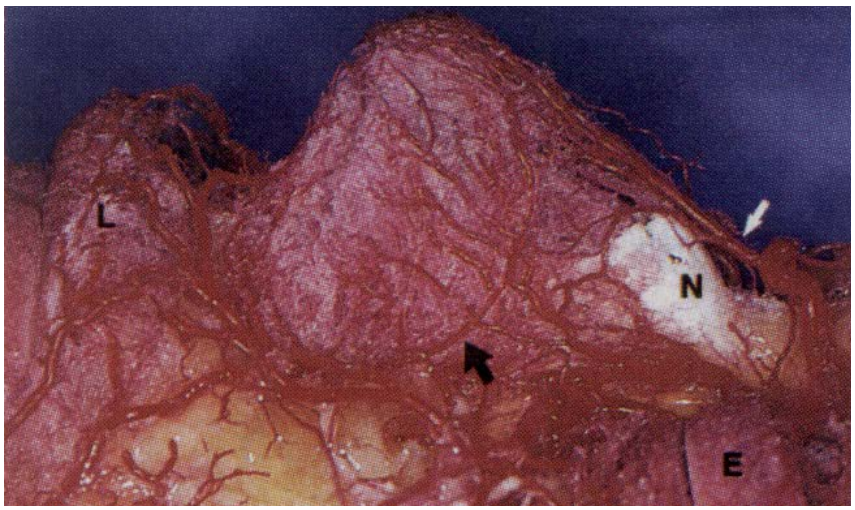


Figure 6 - Cadaver dissection with protein dissection. Note the intense vasculature of the nose. The dorsal nasal artery branches off a large artery from the medial orbit (white arrow). The lateral nasal artery (black arrow) can be seen coming off the angular artery. (N, nasal bone; L, lip; E, eyelid.) (Reproduced with permission – Toriumi et al., 1996[1])

intercarotid anastomosis[5]. Hence, if one of the carotid systems had reduced flow to the external face, the other ipsilateral, carotid system could commonly compensate, and the risk of ischaemia would be reduced.

There can also be transfacial anastomoses across the midline and the same study found that upon compression of the ipsilateral facial and ophthalmic vessels concomitantly, 20% (n=8) and 30% (n=12) of patients had residual flow from the contralateral ophthalmic and facial arteries respectively. The authors of this particular study propose a concept of a polygonal anastomotic system where the external nasal blood flow is multidirectional through a system of interconnected arterial networks (Figure 4).

As can be seen in Figure 5, people may have a combination of the ipsilateral intercarotid and transfacial anastomoses to form a complex, polygonal system. They are not all present in all patients, but this helps to formulate a basic understanding of the known, possible anastomotic relationships from which physiological and anatomic variations may occur.

This polygonal system of arterial anastomoses could, in certain instances, be beneficial to an aesthetic injector as it could mean contralateral or ipsilateral anastomotic flow could compensate and limit ischaemia in the event of intra-arterial injection of dermal filler. On the other hand, the possibility of bidirectional flow and transfacial anastomoses could also mean in the event of inadvertent intra-arterial injection, the dermal filler could, in theory, embolise more unpredictably. This can be appreciated in Figure 6 which shows the external nasal vasculature after protein dissection. The arteries and anastomoses can also vary from one facial side to the other as many cadaver studies have shown[1]. Studies have found that injections of dermal filler for NSR should be

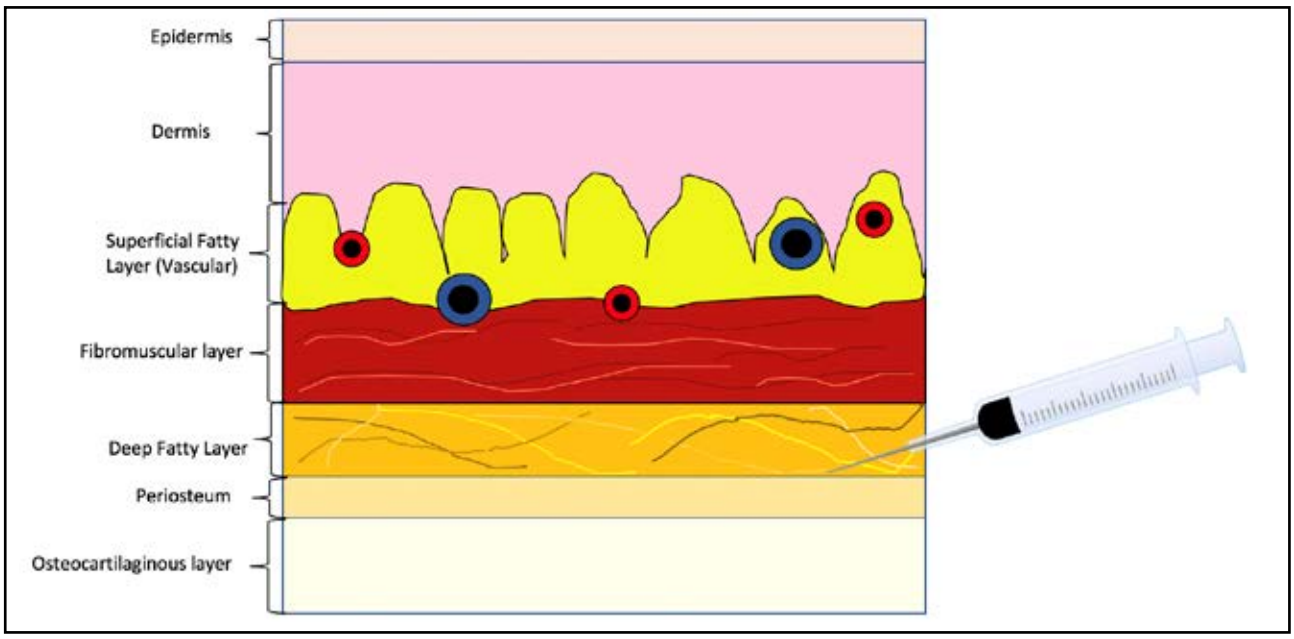


Figure 7 - Schematic diagram showing the anatomical layers of the external nose. Note the veins (blue) and arteries (red) are normally situated in the superficial fatty layer or superficially in the fibromuscular layer. Hence, as shown by the syringe, it is advisable to inject into the deep fatty layer on the level of the periosteum to reduce the risk of intravascular injection of filler.

performed on the periosteal layer lining the osteocartilaginous frame. The deep fat plane here is an avascular territory hence this space is safer for filler deposition (Figure 7). Studies have shown the vessels to travel within both the superficial fatty layer as well as the superficial portions of the fibromuscular layer; equivalent to the nasal superficial musculoaponeurotic system (SMAS)[5].

Vascular occlusion & compromise

Vascular compromise can occur secondary to either intra-vascular injection of dermal filler, embolus or rarely venous congestion. Any of these aetiologies could result in ischaemia of tissues due to an obstruction in blood flow. Due to the rich vascular supply to the nose, one must always be aware of the risk of vascular occlusion or compromise. Venous congestion can also compromise flow and increase capillary refill time; especially near the nasal tip. Hence it is advisable to treat the nasal tip with caution when treating with dermal fillers[3]. Interestingly, occlusion of the columellar artery is not believed to cause necrosis at the tip of the nose as the lateral and dorsal nasal blood supplies may compensate through anastomotic connections. However, injury of the columellar artery can cause aesthetic disadvantage as a thrombus at the base of the columellar can alter the angle of the nasal tip.[7]

As well as the risk of the vascular occlusion, there is also a threat of dermal filler embolising to distant locations. Poiseuille's law describes the resistance to blood flow within a vessel is inversely proportional to the fourth power of the radius of the vessel. Hence, if filler is inadvertently injected into an artery, the filler will most likely travel proximally in the vessel against the blood flow. This occurs as the calibre of the vessel increases proximally and thus has less resistance. The filler can easily travel against the blood flow as the plunger pressure to deposit the filler is normally greater than the mean arterial blood pressure.

However, once the hypothetical injector stops exerting force on the syringe plunger, the pressure of the filler would reduce dramatically, and the filler can then be carried as an embolus by the blood flow into more distal circulation. This is the mechanism by which dermal fillers have been proposed to cause loss of vision[8]. One can appreciate the possibility of retrograde propulsion of the filler into the angular artery and if an anastomosis with the ophthalmic branches is present, this could mean the filler moves towards the supratrochlear or supraorbital arteries or more proximal into the ophthalmic artery.

Once the plunger pressure relaxes and the filler could follow the blood flow distally into the central retinal artery, thus causing a filling defect in the retina. This could lead to a spectrum of visual disturbance symptoms including acute, monocular visual loss. Cerebral infarction has also been known to occur if the filler travels retrograde into the central cerebral circulation. Some authors advise as well as routine aspiration prior to injection in the nose, the injector should manually compress the angular artery to minimise retrograde flow risk and always avoid high-pressure injections in this area[5]. It must be noted that these events could occur with hyaluronic acid-based fillers, non-hyaluronic acid based, bio-stimulatory fillers and fat transfer.

The glabellar region, the alar and nasal tip are of course also at risk here depending on the direction of embolism. Hence, loss of vision, vascular occlusion, vascular compromise, ulceration, tissue necrosis, scar formation and possible utilisation of hyaluronidase need to be fully discussed in the pre-procedural consent[9].

Venous anatomy

The venous drainage of the external nose is more variable than its arterial counterpart. Venous drainage is also known to be multi-directional similar to the arteries. The blood from the middle and lower thirds of the nose tends to drain into the angular vein which, joins the lateral nasal vein forming the facial vein inferiorly. This joins the retromandibular vein more distally to

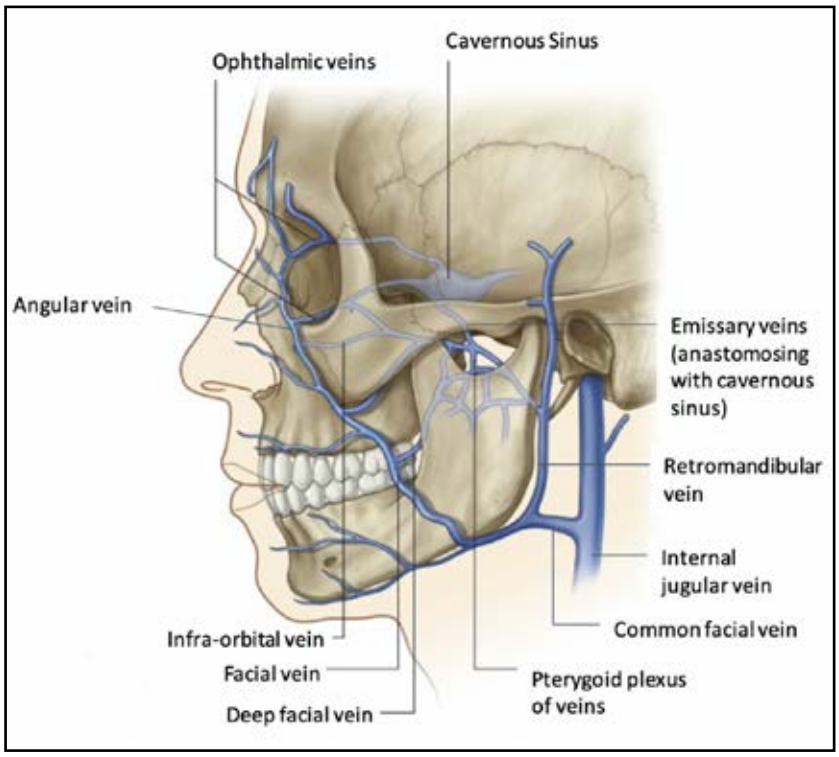


Figure 8 - Facial venous drainage and intracranial venous connections. Note the intracranial drainage of the ophthalmic and infraorbital veins. Note there are also emissary veins draining from the pterygoid plexus of veins into the cavernous sinus. (Reproduced with permission - Adapted from Drake et al., 2015[10])

form the common facial vein; a tributary of the internal jugular vein (Figure 8). There can also be anastomosis of this drainage with the pterygoid plexus of veins via the deep facial and maxillary veins.

The pterygoid plexus of veins is formed between and within the lateral pterygoid muscles bilaterally. When the lateral pterygoid muscle contracts, this forces the blood within the plexus out into the maxillary and external palatine veins which feed into the retromandibular and facial veins respectively. The pterygoid plexus also drains deeper into the cavernous sinus deep within the cranium via the emissary veins (Figure 8)[9]. In the superior portion of the nose, the tissues can also drain into the ophthalmic and infraorbital veins. These, in turn, also drain intracranially into the cavernous sinus. The cavernous sinus is a true, dural venous sinus and extends either side of the midline lateral to the sella turcica, within the sphenoid bone[9]. It is not a plexus of veins but rather a venous vault where the superior and inferior ophthalmic veins drain into. It hence, drains part of the facial blood supply deep into the cranial cavity as it feeds into the dural venous sinuses that surround the meninges[11].

Venous complications

In aesthetic medicine, we rightly spend more time considering the arterial anatomy due to the inherent risks of intra-arterial occlusion with dermal fillers. However, it is important to also consider the venous anatomy of the various structures that we inject in order to reduce the possibility of venous related complications. The most common venous complication being localised haemorrhage and haematoma formation. In rare instances, haematomas can result in extravascular compression and resultant congestion or ischaemia. Though severe dermal filler complications involving veins are rarer than their arterial counterparts, there have been rare case reports of events such as non-thrombotic pulmonary embolism after facial filler injection[12].

Figure 9 - The Danger Triangle of the Face. Within this red triangle, the venous outflow of the face can drain directly into the cavernous sinus and dural venous sinus systems.

In the nasal area, one must also appreciate the aptly named *Danger Triangle of the Face* as seen in Figure 9. This zone is bounded by the oral commissures inferiorly and by the bridge of the nose superiorly. As previously discussed, the facial venous drainage in this region can feed into the cavernous sinus and from there, drain into the dural venous sinuses. Though rare, this is clinically relevant as filler emboli or infection can potentially use this route to enter into the deep cranial structures. This can be devastating and there have been reports of cavernous sinus thrombosis post facial filler. This can in turn affect the function of the nerves travelling through the sinus as well as instigating potentially life threatening, infective, meningitic spread and intracranial infection[8,13].

We are well versed in the risk of arterial occlusion with dermal fillers, but authors have also postulated that venous infiltration of dermal filler or compression of a venous drainage system may also indirectly cause vascular compromise. This concept is called "the roundabout theory" of dermal fillers and has been postulated by Dr Patrick Treacy[14]. If you imagine an artery (entry route) feeding into a capillary bed (the roundabout) and eventually draining into the vein (the exit route), the constant drainage of the venous outflow is required in order for the blood to perfuse appropriately. If the vein (exit route) became blocked or compressed, this could block the entire system and stop blood entering on the arterial side; hence leading to congestion and vascular compromise. This may be a delayed onset presentation hence the practitioner must be alert to this possibility[14].

Signs of vascular compromise

In the event of vascular compromise there are several signs and symptoms that may become apparent; though all are certainly not necessary.

1. **PAIN** - If pain occurs either initially or as a delayed onset symptom after dermal filler injection; the injector should be cautious and always suspect a possible complication. However, there is often no pain at all until much later in the natural history of events.
2. **BLANCHING** - Sudden onset blanching of the skin upon injection. This can be a sign on intra-vascular injection. However, if using a cannula, it is common practice to use a small quantity of local anaesthetic at the nasal entry point. Most practitioners either inject in the glabella or the nasal tip for their cannula entry point. It is advised to not use local anaesthetic with adrenaline for this reason on the nose, as the vasoconstrictive effect can often complicate the post-procedural picture at the nasal tip.
3. **CRT** - Capillary Refill Time can be increased from the normal two seconds. Firm consistent compression of the tissues with the thumb or index finger is required for at least five seconds and then quickly release and observe the refill time. If the refill time is slower than two seconds, this could be a sign of possible vascular compromise or congestion.
4. **COLOUR** - The skin can appear blue, grey or red and mottled in the areas of compromise. This is often called the Livedo Reticularis Phase.
5. **DAYS LATER** - After a few days of ischaemia, blister formation is possible in the areas of ischaemia.
6. **NECROSIS** - Ischaemia can lead to ulceration, necrosis and ultimately scar formation. The skin can slough off in the affected areas leaving a cavity which would require tertiary, plastic surgical input or be allowed to heal naturally by secondary intention.

If you are concerned about the possible risk of ischaemia to the tissues the *Aesthetic Complications Expert Group* have published thorough guidelines on the necessary steps to attempt resolution of this emergency scenario[15].

Expert Input

I have had the honour of being taught by one the UK's leading NSR experts, ENT Surgeon and senior *Allergan Medical Institute Faculty* member, Mr Ash Labib. Mr Labib's vast knowledge and experience in both the surgical and non-surgical aspects of this field really help him to tackle even the most challenging nose.

Mr Labib's top tips

Injecting fillers for NSR is always risky and needs to be carried out by experienced injectors only. It also needs separate training due to complex nature of the nose.

7. Use the right product – Mr Labib does not recommend any products except hyaluronic acid fillers for NSR for the simple reason that if you run into trouble, you need a product that can be dissolved immediately.
8. Inject slowly with low pressure. Inject with precision on the periosteal plane to avoid vascular complications.
9. Always stay in the midline whilst injecting. This is the safest place to inject as most of the blood vessels are lateral to the midline.
10. Mr Labib personally prefers using a needle on the nose for accuracy. Cannulae can be used to fill the nose but he does not believe they are significantly safer than needles in the nose.
11. Always be cautious treating patients after surgical rhinoplasty or serious, nasal trauma as they can have altered vasculature, neovascularisation or adherent vessels within scar tissue that can be more susceptible to vascular complications.

Ultimately there is no completely safe way to inject anywhere in the nose. Always be cautious in this area and utilise your anatomical knowledge to stay as safe as possible.

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