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**Figure 2**

While the injecting hand injects a maximum of 0.025 ml per retrograde linear thread, the fingers of the non-injecting hand press on the nasion, thereby compressing and temporarily stopping blood flow of the supratrochlear artery, the dorsal nasal artery and their connecting arteries in that area. A potential arterial embolus in one of these arteries won't be able to be pushed beyond this point of manual arterial closure.

To avoid serious vascular AEs, the most important recommendation is to inject small amounts of filler per bolus or retrograde. Even though the chance of hitting an artery increases with the number of times the needle is advanced in the tissue, the chances of devastating sequelae is reduced with smaller amounts of fillers injected into an artery. Blindness for example can occur after injecting in the supratrochlear artery. In such case, the filler travels through the vessel towards the ophthalmic artery until it reaches the bifurcation of the central retinal artery branching off the ophthalmic artery where it can embolize the retina and cause blindness. To cover that distance, the volume necessary is somewhere between 0.04 and 0.12 ml.<sup>6</sup> If a maximum injection volume of 0.025 is chosen (the so-called JVL Bolus), the chance of blinding the patient is drastically reduced to next to zero.

The number of dermal punctures is also relevant. The more the amount of needle punctures, the (exponentially) higher the risk of infection and/or biofilm formation.<sup>7</sup> Using non-traumatic cannulas, the number of dermal punctures is lower than when using needles, but a no-touch handling should be done and extra care should be taken when maneuvering the often long cannula close to the patient's hair, the non-sterile gloves or the patient's clothes, as contamination could result in the formation of biofilm as well as infections.

# needle vs. cannula

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## 1.5 Needle vs. cannula

Although the opinions differ, most clinicians nowadays agree that cannulas pose a smaller risk of complications. It was shown that higher number of skin penetrations exponentially increased the chance of biofilm formation.<sup>7</sup>

As abovementioned, fewer entry points (when using blunt cannulas) reduce the risk of infection and biofilm. Besides, in an observational cadaver study, it was shown that because of back-flow through the tunnel that was made with a needle, product was not only injected on the periosteum, which was the target depth, but also travelled retrogradely along the needle and ended up in various anatomical levels. This was a consistent finding in five facial areas and a careful conclusion can therefore be made that this is a general observation describing what happens using a needle for STF injection. When the injector uses a needle, generally, the needle is advanced (almost) perpendicularly to the skin and advanced to the periosteum. Then, when the needle is in contact with the periosteum, the injector starts injecting. The product then starts flowing out of the needle into the deep tissue and will logically start following the path of least resistance. Part of the product will flow back along the needle trajectory, as the needle has just created a pathway by being advanced. In some areas that could be exactly what the injector wants: creating pillars of filler, like in the chin or cheeks. In other areas, like the forehead, the injector wants to be certain that the filler remains in a specific anatomical level because of the depth localization of important arteries.

If an injector is more comfortable with a needle, than that is probably the safest instrument to choose. If the injector is comfortable with both, the cannula probably has lower risk of vascular events, irregularities and bruising.

## 1.6. Aspiration

Aspiration is often listed as a prevention measure, but there are many variables that contribute to the sensitivity of aspiration.<sup>8</sup> Apart from needle diameter and length, extrusion and aspiration of STFs are dependent on differences in physiochemical structure and rheological properties. The elastic quantitative measurement (elasticity) of a STF's stiffness and its ability to resist deformation under applied pressure are known as G prime ( $G'$ ).<sup>9</sup> The higher the  $G'$  of a STF, the less it will deform under pressure and the more stored energy it retains. Thickness, or viscosity of a STF in its fluid form ( $\eta^*$ ), refers to the measure of its resistance to gradual reformation by shear stress and how it flows from the needle while being injected. Therefore, elasticity and viscosity will also determine how a STF product behaves in the lumen of the needle when aspiration is applied. The higher the  $G'$  and  $\eta^*$ , the more force is needed to obtain a positive aspiration result by emptying a needle filled with STF material. Most commercial STF products have a viscosity between 7.307 centipoises (cP) (Juvederm Ultra, Allergan Inc., Irvine, CA, USA) and 349 830 cP (Radiesse, Merz Pharmaceuticals GmbH, Frankfurt, Germany).<sup>10</sup> When comparing these values to water (0.890 cP at 25°C) and blood (between 3.000 and 4.000 cP at 37°C), it becomes clear that the results of an aspiration test may not always be reliable as the high viscosity of STFs would mean that a very high suction pressure must be applied in order to obtain a positive aspiration test result.<sup>11</sup> An overview of the aspiration results are shown in [Table 3](#).<sup>8</sup>

# aspiration

**Table 3**

Aspiration test result

Courtesy of Van Loghem *et al.*<sup>8</sup>

● Positive (within 1 second)

○ Positive (between 1 and 10 seconds)

● False-negative (when still negative after 10 seconds)

RL: Ringer's Lactate; EDTA: Ethylenediaminetetraacetic acid

Digits in circles indicate seconds

Product	Agent	Needle												
		Gauge (G)	23		25		27			28	29	30		33
		Length (mm)	19	13	25	12	13	20		19		12	13	13
Control (Saline)	RL + ink		●	●			●			●			●	●
	Blood + EDTA		●	●			●			●			●	●
Belotero Hydro	RL + ink		●	●			●			●			●	⑥
	Blood + EDTA		●	●			●			●			●	⑨
Belotero Soft	RL + ink		●	●			●			●			●	⑤
	Blood + EDTA		●	●			●			●			●	④
Belotero Balance	RL + ink		●	③			●			●			●	●
	Blood + EDTA		●	③			⑤			●			⑦	●
Belotero Intense	RL + ink		⑧	⑧			③			●			●	●
	Blood + EDTA		⑨	⑥			⑤			●			●	●
Belotero Volume	RL + ink		●	●			②			●			●	●
	Blood + EDTA		●	⑤			⑧			●			●	●
Radiesse 0.8 (undiluted)	RL + ink		●	●			●			●			●	●
	Blood + EDTA		●	●			●			●			●	●
Radiesse 0.8 (diluted)	RL + ink		●	●			●			●			③	●
	Blood + EDTA		●	●			●			●			●	●
Radiesse 1.5 (undiluted)	RL + ink		④	⑥			⑧			●			●	●
	Blood + EDTA		●	●			●			●			●	●
Radiesse 1.5 (diluted)	RL + ink		●	●			●			●			⑤	●
	Blood + EDTA		⑦	③			③			●			●	●
Radiesse Plus 1.5	RL + ink		④	③			④	—		●			●	●
	Blood + EDTA		⑥	③			⑥	—		●			●	●
Etermis 2	RL + ink		●	●			●	●		●		●	●	⑤
	Blood + EDTA		●	●			●	●		●		●	●	⑧
Etermis 3	RL + ink		●	●		●	●			●			③	●
	Blood + EDTA		●	●		●	●			●			③	●

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