

Review

SAFETY IN DERMAL FILLER INJECTION: ASPIRATION OR CONSTANT NEEDLE MOVING?

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ABSTRACT

Although dermal filler injections are extensively used worldwide, no consensus within the scientific literature determines precise guidelines for reducing the risk of vascular occlusion. This narrative review aims to distinguish whether the risk-reduction maneuvers proposed by the various authors are derived from anecdotal knowledge or based on scientific evidence. To pursue the objectives of the present study, a PubMed search was used using the search string ("aspiration" OR "needle movement" OR "needle motion") AND "filler." Articles were selected based on inclusion criteria. Twenty-five studies were chosen from 58 studies published between 1980 and 2023. Four opinion categories were compiled: 12 studies against retro-aspiration, 1 study in favor of retro-aspiration, 4 articles partially in favor of retro-aspiration, and 8 articles determined that further research is needed. The review shows no clear guidelines on vascular occlusion prevention techniques. This is due to inadequate study designs that reflect clinical reality. Therefore, further research is needed, focusing on realistic study designs applicable to everyday clinical practice.

KEYWORDS: *dermal fillers, injections, aspiration, needle motion*

INTRODUCTION

Dermal filler injections have become very popular nonsurgical facial rejuvenation procedures thanks to the excellent results they consent to achieve, the short recovery times, and their relatively low complication rate. In the past few years, the number of performed procedures has increased significantly, but unfortunately, the number of potential and reported adverse complications has also increased proportionally. These adverse events are, in most cases, mild and self-limiting (bruising, swelling, erythema), but more moderate adverse events can occur (hypercorrection, filler visibility).

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Due to too superficial injection, Tyndall effect, and granulomas), leading even to rare but extremely dangerous complications like vascular occlusion, whose most common sequelae is skin necrosis, while the most devastating one is injection-related visual impairment, which can even lead to blindness (1). This has led to practitioners' need to develop predictable techniques to prevent vascular complications. Before any injection into the body, practitioners have usually been taught to follow two main rules:

- remove the air from the syringe by priming and filling the needle with the solution that is about to be injected;
- perform the “retro aspiration test” by withdrawing the plunger before the injection to ensure the needle is not inside a vessel. The retro aspiration test consists of withdrawing the plunger for a few seconds and checking if blood flows back into the syringe (positive result) or not (negative result).

These principles can be considered valid when the injected solution is fluid, so it can easily pass back through the needle and allow blood to enter the syringe (2). But what about if the materials injected have a higher viscosity and a gel-like consistency? Due to their rheological characteristics, fillers may impede blood flow back into the syringe, giving a false sense of security with potentially devastating consequences.

The HA fillers differ in degree of crosslinking, the type of crosslinker used, hardness, viscosity, gel consistency, total HA concentration, and so forth (3).

In the past few years, some practitioners and researchers have raised many doubts and critical issues about the reliability of aspiration and have begun to investigate and develop different alternative techniques (4). Many of them have hypothesized that constant needle motion could be a safer maneuver compared to the static bolus injection (5-8) with previous retro aspiration.

The purpose of this research is to understand whether the scientific community accords reliability to the most common techniques that are routinely used and taught. The methods considered are the needle motion after insertion in the injecting site and retro aspiration before filler injection (R.A.).

MATERIALS AND METHODS

To conduct this literature review, the PubMed database was searched using the string ("aspiration" OR "needle movement" OR "needle motion") AND "filler". The titles and abstracts of each paper obtained from the results were listed, and full-text manuscripts were retrieved using online resources.

The papers were reviewed, and any study that did not relate to safety measures during tissue filling procedures was excluded. The selection did not take into account the differences between the studies' designs or the methodologies used to determine the accuracy of the scientific opinion on which risk-reducing maneuver is best suited to the tissue-filling procedure.

RESULTS

The PubMed search yielded 58 results published between 1980 and September 2023. This selection left 25 included papers, which were summarized and categorized by type. The 25 selected studies included 6 *in vitro* studies, 2 *in vivo* studies, 3 *in vitro* and *in vivo* studies, 5 literature reviews, 1 descriptive analysis, 1 systematic review and meta-analysis, 1 theoretical investigation, and 6 commentaries or editorials. All of the papers were published between the year 2015 and September 2023. The selected papers are shown in Table I (2, 3, 9-32).

After reviewing the selected papers, 4 different categories of opinions were redacted, and every paper was labeled as belonging to one unique opinion category, as follows:

- 12 papers were AGAINST R.A.
- 1 paper was IN FAVOUR of R.A.
- 4 papers were PARTIALLY IN FAVOUR of R.A. (they added specific conditions to their statement)
- 8 papers stated that FURTHER RESEARCH IS NEEDED.

Table I. Summary of selected papers.

AUTHOR	YEAR	JOURNAL	TYPE	SUMMARY
Carey & Weinkle	2015	Dermatologic Surgery	<i>In vitro/in vivo</i>	Against RA
Casabona	2015	Dermatologic Surgery	<i>In vitro/in vivo</i>	Partially in favor of RA
Van Longhem et al.	2018	Journal of Cosmetic Dermatology	<i>In vitro</i>	Further research is needed
Torbeck et al.	2019	Dermatologic Surgery	<i>In vitro</i>	Further research is needed
Albornoz et al.	2020	Journal of Cosmetic Dermatology	Literature review	Further research is needed
Kogan et al.	2020	Journal of Cosmetic Dermatology	<i>In vitro</i>	Partially in favor of RA
Wang et al.	2020	Journal of Cutaneous Medicine and Surgery	<i>In vivo</i>	Further research is needed
Goodman et al.	2021	Aesthetic Surgery Journal	Commentary	Against RA
Jewell	2021	Aesthetic Surgery Journal	Commentary	Against RA
Kapoor et al.	2021	Dermatologic Therapy	Systematic Review and Meta-Analysis	Further research is needed
Lee et al.	2021	Aesthetic Surgery Journal	Commentary	Against RA
Moon et al.	2021	Aesthetic Surgery Journal	<i>In vitro/in vivo</i>	Further research is needed
Rivkin	2021	Journal of Cosmetic Dermatology	Literature Review	Against RA
Tseng et al.	2021	Aesthetic Surgery Journal	Descriptive Analysis	Further research is needed
DeLorenzi	2022	Aesthetic Surgery Journal	Commentary	Against RA
Goodman et al.	2022	Aesthetic Surgery Journal	Literature Review	Against RA
Jewell	2022	Aesthetic Surgery Journal	Commentary	Against RA
Lin et al.	2022	Aesthetic Surgery Journal	<i>In vitro</i>	Against RA
Rocha et al.	2022	Journal of Cosmetic Dermatology	<i>In vivo</i>	Against RA
Sezgin	2022	Aesthetic Surgery Journal	Commentary	Against RA
Wang e Huang	2022	Aesthetic Surgery Journal	Literature Review	Against RA
Gonchar	2023	Journal of Cosmetic Dermatology	Theoretical investigation	Partially in favor of RA
Peng et al.	2023	Journal of Cosmetic Dermatology	<i>In vitro</i>	In favor of RA
Zhang et al.	2023	Journal of Plastic, Reconstructive & Aesthetic Surgery	<i>In vitro</i>	Partially in favor of RA
James	2023	International Journal of Nursing and Health Care Research	Literature Review	Further research is needed

DISCUSSION

This literature review found few approaches to the topic, and most of them are not supported by precise protocols for evaluating the effectiveness of safety techniques in the context of tissue fillers.

The examined *in vitro* studies focused on reproducing operative conditions using fresh frozen cadaveric preparations or animal models, proposing imaging techniques such as Doppler ultrasonography or ultrasonography in injection assistance, and proposing needle lumen flushing maneuvers with sterile saline before each filler injection.

The examined *in vivo* studies focused on: analysing the statistical occurrence of false negatives when using a retro-aspiration prior to filler injection; analyzing the time offset between the retro-aspiration and the flashback of blood into the syringe; using ultrasonography as an imaging technique in injection assistance; and using needle lumen flushing maneuvers with sterile saline before injections.

The only examined theoretical investigation proposed a mathematical model to describe the risk of injecting into a blood vessel when doing continuous needle movement, compared to retro-aspiration before injection (28).

The only examined systematic review and metanalysis concluded that the efficacy of pre-injection aspiration as a risk-preventing technique could be improved, but only after a deep understanding of the relationship between factors such as the chosen needle gauge, the density and viscoelastic properties of the different fillers. In this review, several parameters that affect the reliability of the aspiration test came out: diameter of the needle and rheological properties of fillers, priming of the needle, speed of plunger pullback, stability of the needle, and planes injected. The needle's inner diameter is one of the main parameters determining the resistance of the filler to the backflow: needles require different strengths and times to aspirate a determined liquid with a specific density, and the smaller the gauge, the higher the strength needed (9).

Using a small gauge needle with a high-viscosity filler may impede the flow back of the filler and, consequently, the entry of the eventual blood inside the syringe, invalidating the procedure (1, 2, 16, 29).

An *in vitro* study from Kogan et al. 2020 showed that aspiration with 29G needles gave all false negatives; using 27G needles gave better results, but the minimum aspiration time was 3.5 sec.

During the aspiration procedure, the needle lumen must first be emptied to allow blood to flow into the syringe. This is straightforward when the needle is filled with air or water. In contrast, emptying the needle is complex, often incomplete, and can distort the test result when the needle is filled with filler.

One way around this problem might be to change the needle each time after a bolus injection, or to change the needle each time after a bolus injection, but with a potential risk of air embolism (since an empty needle contains air), and with definite issues of practicability in daily clinical practice.

An *in vitro* study (3) suggested the priming of the needle as a solution to this problem: the saline solution was used as a priming material because of its low viscosity, and, according to this study, 100% of the aspirations performed with this test were reliable.

Another *in vitro* study (29) from Peng et al. used lidocaine as a priming material, suggesting that it could be a better material than saline solution, as it improves the patient's comfort during the procedure.

Speed of plunger pullback

Most studies investigating the retro aspiration technique, regardless of the conclusions for or against suction, agree that it is necessary to make a slow movement in the pullback of the plunger to increase its reliability. A quick movement (usually done by practitioners) is associated with more false negative results. In addition, it raises the risk of sucking up the vessel and collapsing it, giving a false negative result and a potential intravascular filler placement.

An *in vitro* study by Peng et al. observed that holding the plunger for at least 10 seconds, even if the needle had been misinserted into the vessel, could detect 88% of these misses. They also observed that the waiting time could be shortened as the residual amount of filler in the syringe decreased. Blood appeared instantaneously in the retro aspiration tests performed with 0.1ml filler remaining in the syringe. A human study on the peripheral vein found that the mean time it took blood to appear in the syringe was 3.1 sec (13).

A retrospective case series of 213 positive blood aspiration procedures revealed that almost all positive aspirations were evident within 2 seconds, and the most frequent site was the pyriform fossa (20). The most frequent plane where aspiration was positive was the supra-periosteal plane, and this result is intuitive because this area is also the most frequent plane where aspiration is performed and considered valid since it is almost impossible to firmly maintain the position of the needle while doing aspiration in soft tissue compartments. However, this study is biased because only positive aspirations were considered, so it is impossible to evaluate the incidence of false negatives.

As needle immobility is a prerequisite for successful aspiration testing, an ultrasound study in 2022 (24) investigated the presence of micromovements during aspiration, performed by different physicians with different experiences: in all cases, there was retrograde motion along the axis of needle insertion during plunger retraction and anterograde motion during injection. The aspiration test is therefore most effective when the needle is pointed against the periosteum, thus ensuring stability of position. Any slight movement during aspiration could potentially invalidate the test.

Among the studies in favor of pre-injection aspiration, Peng et al. state that "Aspiration should be considered as a regular procedure before giving an injection", and they suggest doing aspiration "as a must no matter which equipment is used" since aspiration is a simple action that gives a "huge benefit to patients and operators". In addition, priming syringes with lidocaine is suggested to raise aspiration reliability, and tiny needles (29-30G) should be avoided because they slow down the blood flow during aspiration (29).

A different outcome came from the paper by Casabona et al., whose conclusion stated that "the aspiration test for filler application was reliable with 53% syringes and needles tested". Moreover, this paper states that the size and collapsibility of the vessels in the anatomical region of the face negatively influence the reliability of the retrograde aspiration technique as a safety maneuver.

The other safety maneuver considered among the selected papers is the continual movement of the needle or cannula during injection. The reasoning behind the adoption of this technique is that in case of unfortunate intravascular injection, it helps in reducing the chances of complete occlusion of a vessel since the filler injected is more diffused, resulting in lower pressure on the tissues rather than a single, massive static bolus.

The role of pressure in filler delivery is crucial. If the injecting pressure overcomes the patient's systolic pressure, there is a higher risk of causing an embolic bolus if the needle is positioned into a vessel. Since a still and massive bolus can easily reach and overcome the threshold of the patient's systolic pressure, continual needle movement during injection may avoid this risk. However, the theoretical model proposed by Gonchar et al. raises the issue that continual movement

could enhance the possibility of hitting a vessel. Although this finding is reasonable, the model described is far from clinical reality.

Some authors firmly take sides against aspiration and say that it should not be relied upon (14). Different authors in commentaries or editorial articles described the procedure of pre-injection aspiration as “unreliable” or “useless”, as it could give “a false sense of security” (19), as it “precludes other important safety measures – those of movement and avoidance of static bolus production”.

None of the examined papers concluded that the retro-aspiration is a recommended maneuver. Still, they all state that further research is needed to assess this technique's validity as a safety-increasing filler administration practice. Some of them suggest implementing this technique with improvements such as saline flashing and ultrasound, which may improve the sensitivity and reliability of aspiration tests. However, conclusive evidence is still lacking (3, 32). A Consensus published in 2020 states that there is no evidence in the literature that aspiration reduces the incidence of blindness or necrosis (4).

The study's limitations are represented by the fact that the only source taken into account was the search engine PubMed. Furthermore, the articles that emerged from the search have very heterogeneous study designs, so there is no comparable data to draw up statistics.

CONCLUSIONS

In conclusion, many factors can influence the reliability of pre-injection aspiration: anatomical area being treated, needle diameter and length, cohesiveness of the product, time of aspiration, and speed of retraction technique. Using air/fluid primed needles with a big diameter (>27G) with a slow pullback of the plunger is associated with fewer false negative tests (2, 10, 18, 20).

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