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Review Article

A Critical Literature Review Analysing the Evidence Base for the Efficacy of Aspiration Prior to Injection of Dermal Filler as A Safety Measure to Reduce the Risk of Vascular Complications

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Abstract

Background: A significant complication of treatment with dermal filler is "vascular occlusion". Adverse events associated with this complication can range from pain to skin necrosis and scarring. Aspiration immediately prior to the injection is often posed as a potential method for reducing the risk of vascular complications in aesthetic practice. **Aim:** This critical literary review aims to review the studies which have been conducted in this area, looking at the efficacy of the use of the aspiration technique to reduce rates of vascular complications. **Methods:** The PubMed database was reviewed for publications on the topic of aspiration when injecting dermal filler. The papers highlighted were further assessed in order to exclude any that did not study the relationship between the practice of aspiration and vascular complications. The findings of the resulting studies were then reviewed. **Results:** The studies included show a variation in the factors which can influence the risk of a vascular complication. Primed vs. unprimed needles, needle size, anatomical location, needle depth, product type, aspiration pressure and aspiration time were all highlighted as factors which ultimately influenced the effectiveness of aspiration in reducing intravascular injection. **Conclusions:** Whilst this literature review identifies some studies that have demonstrated the potential benefits of aspiration, it also highlights the need for further research in this important area. In addition, it highlights the need for a national complication reporting system within the aesthetics industry, to facilitate the development of evidence-based guidance aimed at reducing risk for those receiving such treatments.

Keywords: Aspiration; Complications; Dermal fillers; Prevention; Vascular occlusion

Introduction

When embarking on a career in aesthetics, many practitioners will cite "vascular occlusion" as their biggest worry. This uncommon, but potentially devastating, complication occurs when dermal filler is injected directly into a blood vessel, resulting in hypoperfusion of the surrounding tissues and potentially even tissue necrosis and tissue death. Undoubtedly, a good knowledge of facial anatomy, including awareness of "high risk" areas will minimise risk, along with recommended injection techniques such as the use of a cannula, or low pressure and low volume injections. However, many training providers will teach aspiring aesthetic practitioners to use the technique of "aspiration" to further reduce their complication rate. When aspirating, practitioners will pull back on the plunger of their syringe, observing for a "flash-back" of blood or "positive aspirate" of blood into the syringe. The underlying theory states that a positive aspirate would indicate that the tip of the needle is within a vessel and thus an unsafe position

for injection of the product. Much controversy exists around this issue, however, as some have labelled this safety measure as ineffective.

Methods

To conduct this literature review, the PubMed database was searched for any articles containing the key words "aspiration" and "filler". The title and abstracts of each paper were reviewed and any that did not relate to the use of the aspiration technique when administering dermal filler treatments were excluded. Any that did not consider the effectiveness of the technique in reducing intravascular injections were also excluded. From the remaining papers, the publications listed in their references were examined for any additional papers that may also be included. This left a total of four publications to include in this review.

Results - Aspiration as A Safety Test

Some of the earliest research into this area includes work by Carey et al. (2015) [1]. The authors of this study employed an experimental study design to determine if blood could be aspirated into a syringe containing filler. They began by attaching the smallest gauge of needle to the product filled syringe. The product was extruded until 0.4ml remained within the syringe. At this point the needle was pushed through a rubber stopper and into a bottle containing heparinised blood. An attempt was made to aspirate the blood using two techniques. The first technique involved the slow pulling back of the syringe for ten seconds to create a negative pressure of 0.4ml. The syringe was held in this position for a further five seconds before releasing. The second technique better represented the typical approach taken in clinical practice, whereby the syringe was rapidly pulled back by 0.4ml and released. Tests were done with both a needle primed with filler and without. Gradually wider gauged needles were attached to the syringe until a positive pullback was obtained.

The results of this study showed that in cases where withdrawal of blood is not possible with a primed needle, it is in fact possible with a product-free needle. Theoretically, therefore, we may conclude that factors such as the cohesiveness of the product, the length of needle used, and time under negative pressure etc. will all impact the clearing of the needle, and thus the ability to aspirate blood. The study therefore concluded that the most effective method for ensuring a positive aspirate would be to exchange the needle for a new one after each injection. However, the authors acknowledged that this might be impractical in clinical practice. They do, however, propose that a slow retraction technique would have more chance of clearing the needle of a product and thus would have a higher chance of giving an effective aspirate than the rapid pullback technique. Whilst this study demonstrates an extensive review of a wide range of products and needle sizes, as well as multiple aspiration techniques, it does have its limitations. The study authors list themselves as consultants and speakers for various brands such as Galderma and Allergan. This undoubtedly introduces the question of bias, particularly in a study such as this which included the use of products produced by both companies. Specific mention is made of certain named brands being superior to others, which are products with which the authors have an affiliation. In addition, the authors state that it is their own practice to not aspirate before injecting, which may also introduce an element of bias to the way the study findings are presented.

Later studies such as a 2017 study by Van Loghem et al. [2] used an experimental study design to determine the reliability of aspiration in an in vitro setting, with a view to applying this to an in vivo clinical setting. A range of twenty-four products were used (with the needle size recommended by the manufacturer) to withdraw from a bag of Ringer's Lactate solution containing blue colouring. Another arm of the study made use of an attempt to aspirate EDTA anti-coagulated blood. Similar to the study by Carey et al., the needles were primed and syringes were emptied to contain just 0.5ml of product. The time taken for blue fluid or blood to appear in the syringe after beginning to aspirate was measured. The results showed that of the 340 tests performed, 112 produced a positive aspirate within one second, 101 produced a positive aspirate between one and ten seconds, and 128 did not produce a positive aspiration. Overall, the authors concluded that the rate of false negatives for aspirating suggested that practitioners should not rely solely on aspirating to ensure a safe injection technique.

The authors of the study concluded that whilst the reliability of aspiration in detecting an intravascular position was high, this was the case only when aspirating for as long as ten seconds, which in clinical practice may be impractical. They go on the state that, in fact, specificity at one second of aspiration is low. Other features of this study bring its real-world application into question. For example, the use of saline and blood pressurised to 150mmHg, which they state is higher than the average systolic blood pressure. However, this study is applicable in other ways. For example, the use of needle size, which is recommended for each product by the manufacturer and therefore represents day-to-day practice.

Whilst the first two studies described use a purely in vitro approach to test their hypotheses, a study by Moon et al. (2021) [3] made use of animals to look in more detail at the effectiveness of aspiration. This was also an experimental study design which evaluated two different types of filler product and two different needle sizes. In the study, the needles were primed with either air, saline or product, then attached to the syringe. The needle was inserted into either a pressurised bag of blood, or into the femoral arteries of a rabbit before aspirating for a period of twenty seconds at a pressure of 0.2ml. The time taken for a positive aspirate to be seen was recorded. The results of the study showed that aspiration

with needles primed with air or saline produced immediate results, whereas the same could not be said for needles primed with filler. Furthermore, the needle size and product rheology influenced the rate of false negatives when aspirating, e.g., aspiration with a 30-G needle, produced more negative results than with a 27-G needle. Overall, the authors concluded that the use of a needle primed with dermal filler increased the risk of a false negative when carrying out an aspiration. They also went on to state that their study may facilitate further physiological studies on vascular complications.

A major strength of this study is that this is a rare example of an in vivo experiment, potentially making this much more applicable to real life practice. With this strength, however, comes the question of ethics and whether it is acceptable to carry out such experiments on animals, particularly for treatments which are typically used for cosmetic rather than medical benefits. Another strength of note in this study is the use of a 0.2ml pull-back pressure, which could also be considered applicable to real life practice where this level of pullback can be reasonably carried out, in comparison to other studies which have spoken of a 0.5ml pullback pressure, which is often unrealistic. Conversely, however, whilst a "sensible" pullback pressure has been used, a pullback time of twenty seconds was used as standard in this study, which some may consider unrealistic when translating this to a clinical setting.

A study by Tseng et al. (2020) [4] employed a different methodology. Unlike the experimental studies described thus far, this study used a retrospective observational analysis method. The author of the paper retrospectively reviewed documentation of 213 of his own patients in whom there had been a positive aspiration when treating them with dermal filler. From his documentation, the author collected data looking at factors such as patient age and gender, injection depth and angle, needle size, needle priming, aspiration time etc. The results showed that aspirations were most likely with a 27-G needle, when injecting in the supra-periosteal plane and when aspirating through a primed needle. For almost 99% of cases, blood was visible within two seconds of aspirating. The author concluded that aspiration pre-injection of dermal filler "could be a valuable tool to prevent accidental intravascular injection of soft tissue filler".

This study was unique in its non-experimental design as its participants were all real patients. This arguably makes the results of this study more applicable to real-life practice. However, a major weakness of this study is the potential for bias. The study was designed and led by the same practitioner who performed every procedure in which there was a positive aspiration. As a result, the data collected may be influenced by experimenter bias. Furthermore, this study did not make any attempt to compare its results to that of a control group.

Conclusion

Despite the level of controversy and debate that exists surrounding this highly important topic, surprisingly little research has been conducted into the question of whether aspiration before injection of filler leads to reduced vascular complication rates. Even less work exists to validate the use of this technique outside of the laboratory setting. While some studies suggest that aspiration can reduce the risk of intravascular injections and subsequent complications, others question its reliability and practicality.

It is important to note that the effectiveness of aspiration may vary depending on factors such as the skill and experience of the practitioner, the type of filler being used, and the specific anatomical area being treated. Additionally, the limited number of publications available on this topic highlights the need for more research to provide a comprehensive understanding of the role of aspiration in aesthetic practice.

In conclusion, while aspiration may offer an additional safety measure during dermal filler injections, it should not be solely relied upon. A thorough understanding of facial anatomy, proper injection techniques, and continuous education and training are crucial in minimising the risk of vascular occlusion and other complications. Further research is needed to establish evidence-based guidance regarding the use of aspiration in aesthetic practice. Future research should focus on conducting large-scale clinical trials and implementing centralised reporting systems to gather more comprehensive data on the safety and efficacy of aspiration in reducing vascular complications.

Recommendations for Future Research

To date, the majority of evidence surrounding this topic is experimental, and has been carried out in a non-clinical setting. In order to understand fully the effectiveness of aspiration, a large-scale randomised control clinical trial would be required in which human participants receiving dermal filler treatment are allocated to a control group e.g., no aspiration performed prior to injecting, or a study group e.g., aspiration performed prior to injecting. A large sample size with a tight control over confounding variables could potentially result in a high-powered study with statistically significant results relating to frequency of complications (e.g., vascular occlusions), and adverse events directly as a result of aspirating, in each group. This, however, would be a very difficult study to put into practice for a variety of reasons. First and foremost, in a climate where aspiration is considered a necessary precaution, it may be considered unethical to allocate half of all participants to a group where no aspiration is performed, potentially exposing them to a higher risk of a negative outcome. In addition, such a study would be logistically difficult to carry out under controlled

conditions, e.g., blinding of participants, but more so, the injectors. Results may be biased as the injectors' individual belief in the technique may influence their reporting of complications. Beyond these major issues, multiple other difficulties would come into play. For example, establishing variations in complication rates between different brands of dermal filler.

One possible solution may lie in the increasing regulation of aesthetic practice whereby injectors become legally obliged to report all adverse events centrally, including factors related to the event (e.g., aspirating vs not aspirating). Such national reporting systems already exist. For example, the MHRA's "Yellow Card Scheme", which is used for the reporting of side effects or adverse drug reactions to medicines/vaccines, as well as medical device incidents. Gathered nationally, this data may begin to build up a picture of the safety and efficacy of aspirating, and other practices, when reviewed retrospectively.

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