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ORIGINAL ARTICLE NON-SURGICAL AESTHETIC

Proposal of a Noninvasive Method to Reduce Injection-Related Bruising in Aesthetic Medicine: Transillumination

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Abstract

Background Hyaluronic acid (HA) injections involve a risk of vascular complications. Transillumination (TL) is a noninvasive technique that appears to allow preliminary detection of superficial vascular structures of the face to avoid intravascular HA injection. The purpose of our study was to test the efficacy of TL in terms of its sensitivity to locate vessels in the areas undergoing treatment and to reduce post-injection vascular complications.

Material and Methods We conducted a prospective study enrolling 72 patients who consulted for HA injections to treat facial wrinkles. We used TL on one side of the face to obtain a vascular mapping of the face. The area undergoing testing was randomized for the TL technique. The primary study endpoint was sensitivity for identifying subcutaneous veins and the differences in complication rates between the side of the face where TL was used to guide the injection and the side of the face where no vascular exploration method was used.

Results TL sensitivity for locating the superficial temporal vein was 100%, 91% for the supratrochlear, supraorbital and infraorbital veins, and 95% for the dorsal nasal veins ($p < 0.01$). The complication rate was higher on the side of the face where no vascular exploration method was used (22.2% vs 2.7%; $p = 0.010046$).

Conclusions Our preliminary findings validate our hypothesis concerning the advantage of using TL to identify superficial veins before performing injections. This method is simple and affordable, and the learning curve is small.

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Keywords Aesthetic medicine · Injections · Fillers · Vascular exploration methods · Transillumination

Introduction

Injections of filler are among the most commonly requested procedures in aesthetic medicine today. Currently, the most widely used dermal fillers are hyaluronic acid in aesthetic medicine and autologous fat in cosmetic surgery.

In aesthetic medicine, what patients ask for most often is injections of hyaluronic acid [1] because they are minimally invasive procedures for the treatment and prevention of wrinkles. Physicians are constantly concerned about the risk of vascular complications. The simplest adverse event is bruising caused by the puncturing of small veins. Although bruising always disappears within 3 weeks [1, 2], it may cause patients to feel unhappy or uncomfortable about their appearance.

Perforating an artery or vein may cause hematomas and extrinsic vascular or neurological compressions.

The most severe complication described in the literature is blindness [2] due to intravascular filler injection, with embolism and occlusion of the ophthalmic artery. This

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complication seems to be rare, but it is likely that the actual incidence is underestimated. While it is essential to have flawless knowledge of the vascular anatomical structure of the face, individual anatomical variation is common [3–6]. Other serious complications reported in the literature include skin embolic necrosis and vascular compromise in the injected area, which may have irreversible aesthetic and functional consequences.

Cases of partial or total necrosis of the nasolabial area of the glabella and the nose may be caused by embolization of the filler in a terminal artery as the dorsal nasal artery [7–12].

Identifying the vessels in the area undergoing treatment prior to injections could reduce the risk of bruising and of intravascular injection.

The vein structure may sometimes be visible when it is sufficiently superficial and in patients with skin phenotypes I and II on the Fitzpatrick scale [13].

At times, the arteries are palpable, depending on their size and location, and on the sensitivity of the practitioners' touch and understanding of anatomy. In most cases, the vascular structures are not visible or palpable, and even if practitioners have excellent knowledge of human anatomy, they will still have to deal with atypical anatomical variations [14].

For many years, angiologists have been using vascular exploration techniques. Among these techniques, TL could be adapted to the needs of surgeons who routinely perform filler injections. This technique could help detect vascular structures of the areas undergoing treatment to avoid effraction and accidental injections [15–19].

To date, no method to prevent filler-related complications has been described and validated.

The primary aim of this study was to evaluate whether TL represents a sensitive method for locating the vascular structures of the face, above all the superficial veins, and to assess its ease of use. Our secondary aim was to determine whether the utilization of this method reduces complications related to the injection of filler agents in aesthetic medicine.

Material and Methods

We conducted a prospective, randomized single-blind study in January and March 2017, for which we collected data over 4 days of medical consultation. For our study, we recruited 72 healthy patients who had voluntarily sought facial injections of hyaluronic acid (HA) to treat wrinkles and lines in the periocular area, cheekbones, and nasolabial folds.

Prior to performing the injections, we asked the patients whether they wished to participate in a study to test the use of transillumination for the vascularization mapping on one side of the face. No technique was used on the other side of the face. The examination was performed by the same practitioner. The study was approved by the ethics committee of our institution before the patient recruitment phase and in accordance with the 1964 Helsinki declaration. Written informed consent was obtained from all participants. Exclusion criteria were systemic disease, facial injections of HA during the previous 6 months, giant-cell arteritis (Horton disease), and facial surgery. TL was used during the injection of hyaluronic acid to reduce the risk of intravascular injection. For the purpose of randomization, patients were asked to choose a sealed envelope. Inside the envelope was a piece of paper indicating on which side of the face (right or left) the TL would be used. For each filler injection, TL was used on one side; on the other side of the face, the injection was administered without the use of any vascular exploration method. After the vessels had been located on the side chosen for the TL technique, a skin-marker pencil was used to draw the vascular mapping of the upper part of the face, which in our opinion represented the area most at risk of complications, the middle and the lower parts of the face (Video 1). Then ice was applied on both sides of the face for 15 s before to proceed with the injections in order to cause vasoconstriction and to further decrease the risk of an intravascular injection. TL sensitivity for locating the vessels of the face was assessed.

Three physicians (two plastic surgeons and one dermatologists), not aware of which side of the face the TL had been used, evaluated the occurrence of bruising and other injection-related complications the day following the procedure and two weeks later. We calculated the rate of injection-related complications without the use of TL and the rate of injection-related complications on the side of the face where the TL method had been used.

The Chi-square test was used for statistical analysis of the data. A $p < 0.05$ value was considered to be statistically significant.

All authors took responsibility for the authenticity and integrity of the reported data; analyses were carried out using PRISM software (version 7, Graph Pad, USA).

Transillumination (TL)

The TL procedure involves creating a virtual light source under the skin. Transmitted light is absorbed by deoxyhemoglobin in the blood. Depending on their diameter, subcutaneous blood vessels are visualized with a strong contrast at depths of up to 5–6 mm [14, 15]. Detection and injection can take place simultaneously [16]. The field of application for TL partially overlaps that of polarized light

(the equipment is more expensive, with a steep learning curve) and ultrasound. TL equipment is inexpensive, easy to handle, and not cumbersome. In this study, a portable transillumination device was used, measuring 1 cm (diameter) and 9 cm (length).

Results

We selected 72 patients, 3 men (4%) and 69 women (96%), with a mean age of 55.7 ± 2.3 years. Patients' skin phototypes on the Fitzpatrick scale were: Type II, 87.7%; Type III, 11.3%; and Type IV, 1%. Vascular mapping with TL was performed, targeting the superficial temporal (TS) artery, the supratrochlear (ST) artery, the supraorbital (SO) artery, the infraorbital (IO) artery, the dorsal nasal (DN) artery, and the satellite veins. TL was easy and quick to perform and well accepted by all the patients. The mean procedure time (filler injection) was 6 + 3.2 min (range 6–9.2) minutes for the side without TL, and 6 + 4.2 min (range 6–10.2) for the TL side. In 36% of cases, TL allowed visualization of the TS artery, but not the other arteries. The sensitivity of TL to identify the TS vein was 100%, 91% for the ST, SO and IO veins, and 95% for the DN veins (Table 1).

Complications (Table 2)

No major complications were observed. The only inconvenient effect observed after the injection of hyaluronic acid was the appearance of bruising, which occurred especially in the periorbital region among patients requesting treatment to remove circles under the eyes. The periorbital region contains a rich network of capillaries that are often responsible for post-injection bruising, which can be effectively visualized and avoided during an injection in this area. This complication was observed especially on the side of the face where TL was not used (22% vs 3%; $p = 0.042$) (Fig. 1).

Table 1 Visualization of veins for each patient, with and without TL

Vein identification	With TL	Without TL	*p* value
TS vein	72 (100%)	23 (31%)	0.000001 < 0.05
IO, SO, ST veins	65 (91%)	3 (4%)	0.000001 < 0.05
DN vein	68 (95%)	4 (5%)	0.000001 < 0.05

TS superficial temporal vein; *ST* supratrochlear vein; *SO* supraorbital vein; *IO* infraorbital vein; *DN* dorsal nasal vein

The overall complication rate for all areas receiving treatment was higher on the side of the face where no vascular exploration method was used (22.2% vs 2.7%; $p = 0.010046$).

Discussion

Currently, no therapeutic strategy has been shown to be effective in treating blindness caused by the intravascular injection of filler agents. Prevention remains the only effective way to address this complication. There are no recent articles in the literature about the utilization of vascular exploration techniques for the prevention of complications that may arise from filler injections in facial surgery and aesthetic medicine.

Several authors have recently published studies about injection-induced complications, giving several recommendations about prevention and how to react in the event of an intra-arterial injection so that serious and irreversible situations may be avoided.

Sun et al. [7] recently presented 20 cases of skin necrosis following hyaluronic acid injections to correct or fill the back of the nose and nasolabial folds. The injection of hyaluronidase reduced ischemia in 13 patients. The authors emphasize that only early diagnosis and rapid treatment (within the first 2 days) can avoid full skin necrosis of the affected area.

The worst side effect that may be caused by filler injections is blindness.

According to the findings of dissections by Tansatit et al. [4], intra-arterial injection of filling agent provides the best explanation for the clinical picture, as compared to the theory of arterial compression. The final branch of the ophthalmic artery is the central retinal artery. The proximal branches include the supratrochlear, supraorbital, dorsal nasal, and angular artery of the nose. In the event of intra-arterial injection, the filler may flow into the central retinal artery, via an embolism path connecting the arterial system of the face to the ophthalmic artery along a number of anastomoses, which results in blindness. However, if the injection continues, the embolus reaches the internal carotid artery and may cause a stroke [3, 4].

Carruthers et al. [2] performed a review of the literature concerning cases of blindness reported after filler injections. Cases of partial recovery of vision have been reported, but for patients who had received an injection of hyaluronic acid or calcium hydroxylapatite fillers. All cases of blindness following lipofilling were irreversible. The authors explain that if a patient reports intense severe pain and blindness on the side being treated, embolism of the periocular vessels must always be suspected. Retrobulbar hyaluronidase injections may in certain cases restore blood

Table 2 Observed minor complications (bruising)

Treatment area	Side of face with TL	Side of face without TL	P
Periorbital area	1	6	0.042
27 patients			< 0.05
Nasolabial folds	1	7	0.02
32 patients			< 0.05
Cheekbones	0	3	0.65
13 patients			Not significant
All treated areas	2	16	0.010046

Fig. 1 A 35-year-old patient developed bruising following HA injection to improve tear trough deformity. Bruising occurred in the periorbital region on the right side of the face where TL was not used

circulation. Admittedly this situation is very difficult to treat, and to guarantee the survival of the retina, it is vital to restore retinal circulation within 60–90 min.

According to the findings of our study, TL unmistakably provided a great degree of comfort and safety, especially during injections to treat periorbital dark circles.

TL is a valuable technique because it reveals vein structures that most of the time are not visible to the naked eye. Because it is inexpensive and easy to use, we confirm that this method can be easily integrated into the day-to-day practice of surgeons who routinely inject filler agent, in order reduce the risk of injection-related complications. Given that the arteries are more difficult to locate, it is nonetheless essential to follow other preventive guidelines and methods. In most of the cases identifying the veins would allow to maintain a "safety distance" to avoid the arteries that are usually located deeper down, of which they are often satellites. But due to not predictable individual anatomical variations, anatomical knowledge is mandatory, as well as the respect of other established recommendations to follow during HA injection:

1. Know the anatomy, plane, and depth of each injection of filler.
2. Administer an injection of adrenaline if possible and wait at least 5 min for it to have full effect, or inject a filler with vasoconstrictor.
3. Continue to apply ice topically.
4. Use blunt cannulas or small-caliber needles and small syringes (0.5–1 cc).
5. Aspirate before injecting, keeping in mind that if the filler is highly viscous, this measure will not be effective.
6. Always inject slowly, and in small quantities.

Following these general guidelines to avoid the intra-arterial injection of fillers and the routine use of TL may significantly reduce the overall risk of complications.

Conclusions

TL may be used to identify the vascularization of the face before injecting a filler agent. In addition, it is absolutely essential to have a sound knowledge of anatomy and the standards of practice, and to exercise caution, even when making use of TL. Our preliminary findings validate our hypothesis concerning the value of using TL to identify superficial veins before performing injections. This method is simple and affordable, and the learning curve is small.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflicts of interest to disclose.

Ethical Approval Ethical approval was given, by FRENCH institutional committee and the relevant Judgement's Reference Number is 2018-A03400-56. All procedures in the study involving human participants have been performed in accordance with the ethical standards of institutional and/or national research committees and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent Written informed consent was obtained from all participants.

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