Cite as: Jaguś D, Skrzypek E, Migda B, Woźniak W, Mlosek RK: Usefulness of Doppler sonography in aesthetic medicine. J Ultrason 2020; 20: e268–e272. doi: 10.15557/JoU.2020.0047.

Submitted: 27.09.2020
Accepted: 07.10.2020
Published: 18.12.2020

Usefulness of Doppler sonography in aesthetic medicine

Dominika Jaguś[1], Ewa Skrzypek[2], Bartosz Migda[1], Witold Woźniak[3], Robert Krzysztof Mlosek[1]

[1] *Ultrasound Diagnostic Department Faculty of Medical Sciences, Medical University of Warsaw, Warsaw, Poland*
[2] *Department of History of Medicine, Medical University of Warsaw, Poland*
[3] *First Department of General and Vascular Surgery, Faculty of Medicine, Medical University of Warsaw, Poland*

Correspondence: Robert Krzysztof Mlosek, Ultrasound Diagnostic Department Faculty of Medical Sciences, Medical University of Warsaw, Kondratowicza 8, 03-242 Warsaw, Poland; tel.: +48 601 355 236; e-mail: mdchris@poczta.onet.pl

DOI: 10.15557/JoU.2020.0047

Keywords
doppler, ultrasonography, skin, aesthetic medicine, complications

Abstract

Introduction: In recent years, ultrasonography has been used in an increasing number of fields, such as dermatology, aesthetic medicine and cosmetology. For skin imaging, research has shown the usefulness of both classic scanners equipped with linear transducers, and high-frequency scanners with mechanical transducers. An increasing number of reports indicating high usefulness of Doppler sonography have been published recently. The aim of this study was to assess the usefulness of high-frequency Doppler imaging in the diagnosis of vascular complications after aesthetic procedures using tissue fillers. **Materials and methods:** A total of 12 women aged 19–48 years (mean age 36.08 years) who had undergone hyaluronic acid treatment were included in the study group. Ultrasound scans were performed using standard ultrasound scanners, i.e. Philips Epiq 5 with a linear transducer and Samsung RS85 with linear transducers and Doppler Microflow Imaging option. Ultrasound scans were performed to assess the presence of blood flow using Color Power Doppler (CPA). Pulsed-Wave Doppler was used only for arteries. If no blood flow was recorded with Color Power Doppler, Microflow Imaging was used. **Results:** Doppler ultrasound showed normal blood flow despite reported symptoms in 3 cases. Vascular stenosis was found in 2 patients. In the other 7 patients, Doppler ultrasound showed no blood flow at the sites where complications developed. **Conclusions:** Skin ultrasound with Doppler options is a useful tool in the diagnosis of aesthetic medicine complications.

Introduction

Skin imaging is a relatively new, yet dynamically developing, field of ultrasonography. Advances in ultrasound are correlated with those in imaging technology. The development of aesthetic medicine and the need for safe and effective procedures, as well as the need to diagnose and treat potential complications are also important. The number of publications on the use of sonography in dermatology and aesthetic medicine has grown recently[(1)]. Their authors pointed to the usefulness of both classic scanners equipped with linear transducers, and high-frequency scanners with mechanical transducers[(1,2)]. Ultrasonography with Doppler options creates new diagnostic possibilities in evaluating both healthy and pathological skin[(3,4)]. The following modalities may be used for the evaluation of blood flow in the skin and the subcutaneous tissue: Color Doppler (CD), Color Power Angio (CPA), Pulsed Wave Doppler (PWD) and Microflow Imaging (MFI). Microflow Imaging (MFI), which is

also used for vascular assessment, is the latest option to expand the diagnostic possibilities. It is available only in high-class standard ultrasound scanners. MFI is a CPA-based Doppler imaging software for detecting ultra-fine low-energy flow patterns (microflows) at a velocity below 2 cm/s. It allows for detecting blood flow in vessels with a diameter < 1 mm. In addition to standard two-dimensional Doppler view, MFI also provides a possibility to cut out the 2D image in the Doppler gate, leaving only the vessels against a black background, which additionally improves visualization of capillaries[5,6].

The aim of this study was to assess the usefulness of high-frequency Doppler imaging in the diagnosis of vascular complications after augmentation procedures with tissue fillers.

Materials and methods

This was a retrospective study assessing 2018–2020 data of patients reporting for skin ultrasound due to symptoms occurring after aesthetic procedures with tissue fillers. We analyzed a total of 46 ultrasonographic scans, excluding patients reporting with visually evident or palpable postoperative papules or nodules, or for reasons clearly related to inappropriately administered preparation (e.g. lip or cheek asymmetry). Furthermore, some patients presented with skin redness or paleness, edema or dryness. As a result, 12 women aged 19–48 years (mean age 36.08 years) were included in the study group. The study group included 5 women who underwent lip augmentation, 3 women after tear trough filling, 2 after hand filling, 1 patient after temporal fossa correction, and 1 after nose correction (Tab. 1). Cross-linked hyaluronic acid (HA) was used as a filler in all patients. Ultrasonography was performed using classic ultrasound scanners, i.e. Philips Epiq 5 with 18–5 MHz linear transducer, as well as Samsung RS85 with linear 4–18 MHz and L 3–12 MHz transducer, which allows for microflow imaging (MFI). Ultrasonography was used to verify the presence/absence of vascular flow using CD and CPA modes. Both, venous and arterial CD and CPA were performed. PW Doppler was used for arterial and venous flow patterns. Due to the lack of spectral flow patterns (PW) within the fine arteries and veins of the face, the spectrum of flow in the contralateral face, lip or hand vessels was used for comparison. If no flow was detected in CD or CPA, MFI was used. The flow was considered normal when its spectrum was comparable to the contralateral flow spectrum.

Results

The study showed normal blood flow despite the presence of symptoms in 3 patients. Normal flow was observed in 3 patients with symptoms in the region of the tear trough, nose and temporal fossa (Tab. 1, Fig. 1, Fig. 2). Vascular compression by HA deposit was detected in CD in one patient with pain persisting for a few weeks after tear trough augmentation (Fig. 3). The compression was confirmed in PW Doppler as a comparison of flow spectrum before the site of compression and at a contralateral location showed increased blood flow resistance in the compressed artery (Tab. 1). Arterial stenosis was also found in another patient, who underwent lip augmentation, with high-resistance PW spectrum before the stenosis (Fig. 4). Doppler sonography revealed the lack of vascular flow at the sites of complications in other patients (Tab. 1, Fig. 5).

Discussion

This paper presents vascular complications after hyaluronic acid administration. The described complications affect face and body regions most commonly subject to rejuvenating procedures and relatively likely to be affected by complications. As shown above, inadequate

Tab. 1. *Characteristics of the study group supplemented by Doppler ultrasound findings*

Patient	Age	Complication site	Symptoms	Vessel type	CPA	CD	PW	MFI	PW at a synonymous site
1	46	hand	reddening, edema	vein	0	0	0	0	1
2	48	hand	reddening edema	vein	0	0	0	0	1
3	37	tear through	edema	artery	1	1	1	–	1
4	41	tear through	pain	artery	1	1	1 – increased resistance	1	1
5	43	tear through	edema	vein	0	0	0	0	1
6	38	nose	edema, pain	artery	1	1	1	–	1
7	43	temple	skin paleness	artery	1	1	1	–	1
8	19	lips, lower lip	edema	vein	0	0	0	0	1
9	22	lips, upper lip	edema, dryness	artery	0	0	0	0	1
10	25	lips, upper lip	edema	vein	0	0	0	0	1
11	31	lips, upper lip	pain, uneven skin surface	artery	1	1	1 – increased resistance	1	1
12	40	lips, upper lip	edema, pain, dryness	artery	0	0	0	0	1
0 – no flow, 1 – flow, „–" – not assessed									

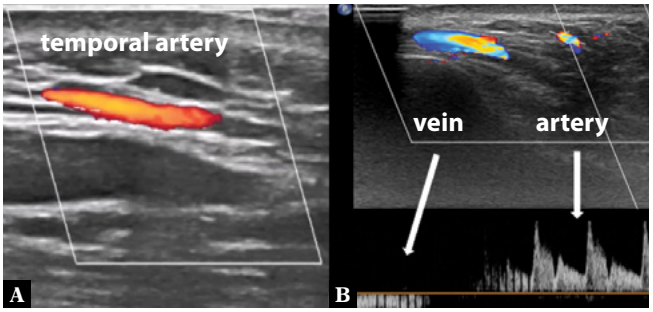

Fig. 1. *Flow assessment using Doppler ultrasound.* **A.** *The flow in the superficial temporal artery, Color Doppler.* **B.** *The flow in the angular vein and artery assessed with Color Doppler and Pulsed-Wave Spectral Doppler*

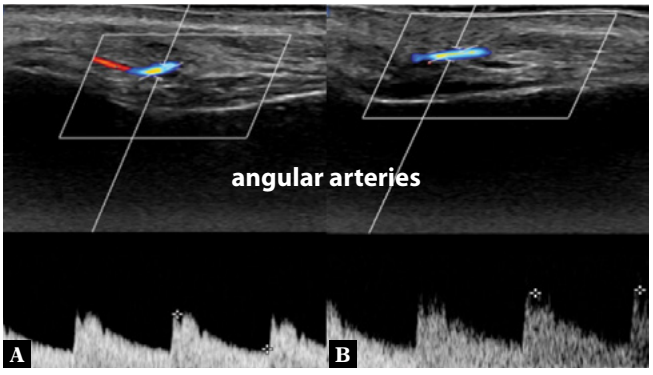

Fig. 2. *Angular arteries, Color Doppler and Pulsed Wave Doppler* **A.** *The right angular artery (on this side there was edema and pain in the patient after HA); however, the comparison with a synonymous location showed that the flow was normal.* **B.** *The left angular artery*

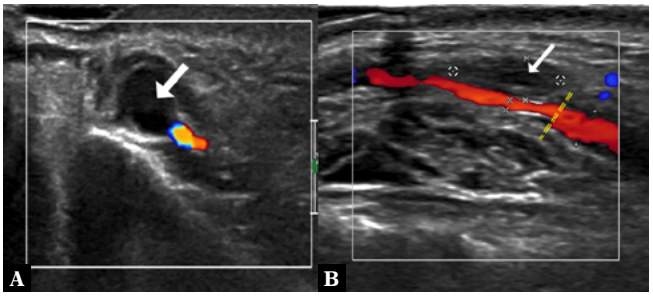

Fig. 3. *HA deposit compression (white arrow) on the arterial vessel in the zygomatic area.* **A.** *A cross-section.* **B.** *A longitudinal section (the yellow line shows the boundaries between the narrowed vessel and the vessel with normal lumen)*

filler administration is the cause of most vascular complications. Therefore, each of these body areas is discussed below.

Temporal area

The temporal fossa is a common site of aesthetic interventions. Temporal fat pad and muscles undergo atrophy with age, which is considered one of the worst signs of aging by aesthetes. Aesthetic medicine enables augmenting these defects with injectable fillers. In order to ensure safety,

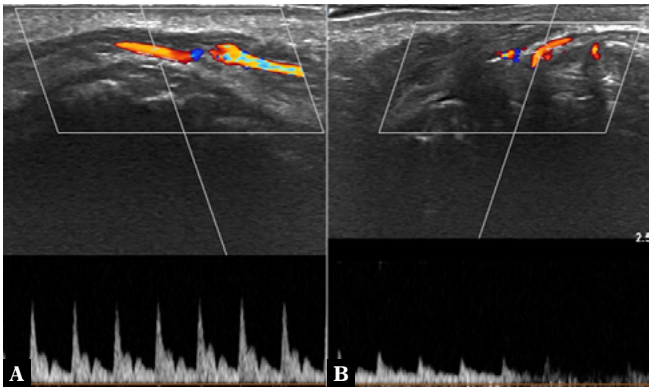

Fig. 4. *Ultrasound evaluation of the labial arteries with the use of Color and Pulsed Wave Doppler.* **A.** *Upper lip, left side, a visible stenosis of the artery in Color Doppler and high resistance spectrum before stenosis (the patient experienced pain on this side and the skin was uneven).* **B.** *A synonymous location – upper lip, right side, normal spectrum*

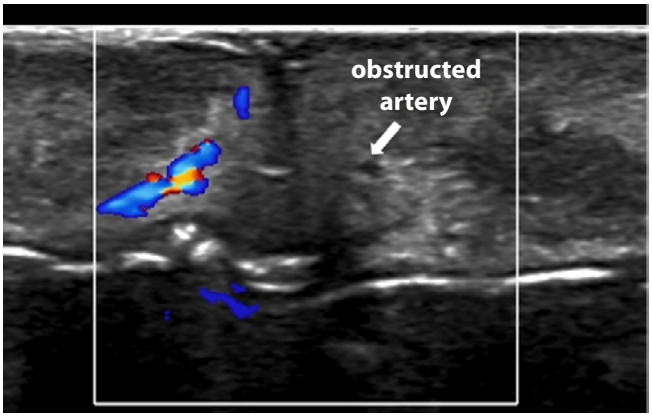

Fig. 5. *Ultrasound assessment of complications using Color Doppler: upper lip with a visible patent vessel on the right side and no flow on the left side*

temporal anatomical structures, the superficial temporal artery in particular (precisely its frontal branch), should be considered. It is a standard practice to determine the safe point for puncture empirically by measuring the appropriate distance from the zygomatic arch. Unfortunately, a vessel course other than standard one is possible. Therefore, we propose a more precise solution involving an accurate determination of the course of these vessels using Doppler ultrasound. Determination of the course of the frontal branch of the temporal artery using ultrasound poses no difficulty. It may be visualized through longitudinal application of a linear transducer 1–2 cm from the hairline[7].

Tear trough and nasolabial folds

In the case of interventions in the area of the tear trough and nasolabial folds, attention should be paid to the synonymous angular vessels and the infraorbital arteries. The angular artery, which is an extension and the terminal part of the facial artery, runs together with a synonymous vein along the lateral edge of the nose, giving

off small facial branches and connecting to the dorsal nasal artery in the medial angle of eye[8]. The infraorbital artery, a strong branch of the maxillary artery, runs through the inferior orbital fissure anteriorly, passing through the infraorbital groove and canal. The infraorbital foramen is palpable 1 cm under the inferior orbital edge in the pupil axis. There is intersubject variation in the position of the foramen, with its distance from the edge of the orbit ranging between 6.9 and 10.9 mm. We presented flow disturbances in angular vessels based on clinical cases.

Nose

The dorsal nasal artery, which is the second terminal branch of the ophthalmic artery, runs caudally from the frontal foramen to join the angular artery on the lateral nasal edge. It supplies the dorsal and lateral parts of the nose. A 43-year-old patient developed reddening and progressive bruising of the nasal and frontal region 5 hours after HA injection into the ridge and bridge of the nose. The woman reported for a medical appointment. She received 1,300 units of hyaluronidase. Also, vitamin C, dexamethason, ciprofloxacin and massage were included. The appearance of the skin improved and a follow-up ultrasound was recommended. No HA deposits were detected on ultrasound, indicating their effective dissolution. The flow in the dorsal nasal arteries was maintained.

Lips

Inferior and superior labial arteries and veins are the most important homonymous vessels of the mouth region. Both arteries usually branch off around the same region near the corner of the mouth. The inferior labial artery courses transversely and medially in the lower lip and the orbicularis oris muscle to join the contralateral artery. An analogous course is seen for the superior labial artery in the upper lip.

Compression and, consequently, embolism of the labial arteries caused by accumulation of filler deposit in the region of the vessels, is a possible complication in this facial area. We presented a case of a 43-year-old woman after lip augmentation with HA filler. After the procedure, the patient reported dry lips (the lips were wrinkled with palpable lumps) with edema persisting for 4 months. After edema resolution, no satisfactory aesthetic effect was obtained.

Hands

Injecting fillers is an effective method of hand rejuvenation. However, it should be remembered that an extensive network of veins surrounded by a thin layer of subcutaneous tissue is located between the skin and the superficial dorsal fascia[8]. Safe injection points are located in the spaces between the tendons, distally to the wrist[9]. In the case of hands, the injection technique (a needle with a blunt tip and injection of small volumes are recommended) is important as the delicate vascular network can be easily damaged, which may result in injecting the preparation into a vessel, and thus causing complications. We included two patients with absent blood flow in Doppler ultrasound in our study.

We presented vascular complications secondary to aesthetic interventions involving filler injection. Addressing this issue is of particular importance as the number of augmentation procedures is constantly increasing, which translates into an increased incidence of complications. Furthermore, aesthetic medicine is a very young field lacking its own diagnostic methods that would allow for a reliable skin diagnosis to avoid or, if needed, treat potential complications. This gap may be filled by ultrasonography, whose advantages and possibilities have already been confirmed. The latest world literature shows that Doppler-assisted identification of facial blood vessels and assessment of flow patterns have gained an increasing importance. Unfortunately, Doppler options are not available in dermal ultrasound scanners equipped in high-frequency (30–70) MHz transducers. Therefore, classic premium class ultrasound scanners, which may be featured with Doppler options and 15–22 MHz transducers are currently used for the assessment of facial vasculature. The use of these devices allows for the imaging of small vessels within the face, located a few millimeters from the epidermis surface. The facial artery, which ends with the angular artery, is one of the most important facial vessels that can be damaged due to common administration of fillers into the nasolabial folds. Its course within the nasolabial folds is varied. However, as shown by Lee *et al*., it is possible to identify these arteries with Doppler ultrasound, which facilitates proper filler administration, i.e. bypassing the artery[10]. Iwayama *et al*.[11] compared filler administration into the nasolabial folds using a conventional method with a cannula vs ultrasound-guided identification of vessels and cannula monitoring. The authors also used both methods to assess blood supply to the skin before and after the procedure. They showed that it is much easier to bypass a blood vessel by monitoring the position of the cannulas in relation to the vessels using an ultrasound image. At the same time, they showed that in both cases the blood supply to the skin was reduced after the filler was administered; however, there were smaller changes in the area where the filler was administered with simultaneous ultrasound-assisted monitoring of cannulas[12]. A similar variance may be seen in the course of the supratrochlear artery, which may be located using Doppler ultrasound. This allows for safe correction of forehead wrinkles with fillers[12]. It is very important to identify the supratrochlear artery and the supraorbital artery before injecting fillers into the forehead as these are branches of the ophthalmic artery, as shown by Tansatit *et al*.[13]. Therefore, accidental injection of the preparation into these arteries during procedure may cause embolization of the ophthalmic artery and blindness[13]. As reported by Phumyoo *et al*., Doppler

ultrasound allows visualization of arteries with a diameter ≥ 0.3 mm. However, the authors used a linear transducer with a frequency of up to 12 MHz[14]. It seems that the use of a transducer with a higher frequency (18–22 MHz) allows for visualization of vessels with a diameter of about 0.1 mm. Therefore, it should be possible to visualize the supratrochlear or the supraorbital artery, whose mean diameters are 0.71 mm and 0.8 mm ± 0.38 mm, respectively, using such transducers[13].

Visualization of needles or cannulas also should pose no difficulty in most cases. Furthermore, it was shown in the world literature that ultrasonography may be used to detect the injected filler deposits[1,4]. Therefore, ultrasonography is also useful in the treatment of vascular complications after injection of tissue fillers. It allows for localization of a filler deposit responsible for arterial compression. Then, it provides guidance for accurate needle introduction and injection of hyaluronidase to dissolve the deposit[15]. Doppler options allow for a simultaneous assessment of positive outcomes of the intervention used, i.e. restored blood flow in a previously compressed vessel[16].

Conclusions

There is a growing interest in dermal ultrasonography among both doctors specialized in dermatology and aesthetic medicine, as well as patients. This creates a need to constantly incorporate new imaging techniques and functions featured by modern ultrasound scanners into dermal ultrasonography. In addition to standard assessment of the epidermis, dermis and subcutaneous tissue, imaging of the vascularity of the examined area should be a crucial element of each examination. Imaging of skin vessels is currently rare, although it has been shown to be extremely useful. A scarce number of publications on this subject encourages further research.

Conflict of interest

Authors do not report any financial or personal connections with other persons or organizations, which might negatively affect the contents of this publication and/or claim authorship rights to this publication.

References

1. Polańska A, Dańczak-Pazdrowska A, Jałowska M, Żaba R, Adamski Z: Current applications of high-frequency ultrasonography in dermatology. Postepy Dermatol Alergol 2017; 34: 535–542.
2. Mlosek RK: Ultrasonograficzny obraz skóry zdrowej. Ultrasonogr 2014; 47: 63–66.
3. di Santolo MS, Sagnelli M, Mancini M, Scalvenzi M, Delfino M, Schonauer F *et al*.: High-resolution color-Doppler ultrasound for the study of skin growths. Arch Dermatol Res 2015; 307: 559–566.
4. Barcaui E, Carvalho A, Lopes F, Piñeiro-Maceira J, Barcaui C: High frequency ultrasound with color Doppler in dermatology. An Bras Dermatol 2016; 91: 262–273.
5. MicroFlow Imaging [online], https://www.usa.philips.com/healthcare/resources/feature-detail/ultrasound-microflow-imaging, access: 20.10.2020.
6. Bae JS, Lee JM, Jeon SK, Jang S: Comparison of MicroFlow Imaging with color and power Doppler imaging for detecting and characterizing blood flow signals in hepatocellular carcinoma. Ultrasonography 2020; 39: 85–93.
7. Alessandrini A: Anatomia twarzy dla lekarzy praktykujących medycynę estetyczną. 2017: Wydawnictwo Medycyna Estetyczna.
8. Bochenek A, Reicher M: Anatomia człowieka. T. 3 Układ naczyniowy. VIII ed. Wydawnicwo Lekarskie PZWL, Warszawa 2007.
9. Goisis M, Di Petrillo: Ręce. In: Goisis M: Iniekcje w medycynie estetycznej. Atlas pełnych zabiegów w rejonie twarzy i ciała. Medipage 2020: 153–162.
10. Lee W, Kim JS, Moon HJ, Yang EJ: A safe Doppler ultrasound-guided method for nasolabial fold correction with hyaluronic acid filler. Aesthet Surg J 2020; sjaa153. Online ahead of print.
11. Iwayama T, Hashikawa K, Osaki T, Yamashiro K, Horita N, Fukumoto T: Ultrasonography-guided Cannula Method for Hyaluronic Acid Filler Injection with Evaluation using Laser Speckle Flowgraphy. Plast Reconstr Surg Glob Open 2018; 6: e1776.
12. Lee W, Moon HJ, Kim JS, Yang EJ: Safe glabellar wrinkle correction with soft tissue filler using Doppler ultrasound. Aesthet Surg J 2020: sjaa197. Online ahead of print.
13. Tansatit T, Phumyoo T, Jitaree B, Sawatwong W, Rungsawang C, Jirasutat N *et al*.: Ultrasound evaluation of arterial anastomosis of the forehead. J Cosmet Dermatol 2018; 17: 1031–1036.
14. Phumyoo T, Jiirasutat N, Jitaree B, Rungsawang C, Uruwan S, Tansatit T: Anatomical and ultrasonography-based investigation to localize the arteries on the central forehead region during the glabellar augmentation procedure. Clin Anat 2020; 33: 370–382.
15. Schelke LW, Decates TS, Velthuis PJ: Ultrasound to improve the safety of hyaluronic acid filler treatments. J Cosmet Dermatol 2018; 17: 1019–1024.
16. Habib SM, Schelke LW, Velthuis PJ: Management of dermal filler (vascular) complications using duplex ultrasound. Dermatol Ther 2020; e13461. Online ahead of print.