Ultrasound in Medicine & Biology 000 (2025) 1−21

Contents lists available at ScienceDirect

Ultrasound in Medicine & Biology

journal homepage: www.elsevier.com/locate/ultrasmedbio

Guidelines

WFUMB Position Paper: Consensus on Best Practice in Aesthetic Dermatologic Ultrasound

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A R T I C L E I N F O

Keywords:
Skin
Ultrasound
Aesthetic ultrasound
Dermatologic ultrasound
Guidelines
Aesthetic procedure
Aesthetic complication
Skin ultrasound
Recommendations
Doppler ultrasound

A B S T R A C T

This position paper from the World Federation for Ultrasound in Medicine and Biology (WFUMB) reviews dermatologic ultrasound applications in the aesthetic field, providing best practices. Although dermatologic ultrasound for aesthetic applications has been demonstrated to be useful, there is little information about standardized protocols for equipment, techniques, nomenclature, reporting, documentation, training, safety, and guided procedure. To address these gaps, a group of experts consolidated the current knowledge based on published evidence and their experience. The objective is to enhance and standardize dermatologic ultrasound in the aesthetic field, facilitating accurate diagnoses and ultimately improving patient management and outcomes. Two rounds of questionnaires were developed by the steering committee co-moderators to identify key issues in aesthetic ultrasound. Authors participated in virtual voting using multiple-choice questions covering technical and procedural topics. Results were discussed in a consensus meeting. Position statements were accepted if >75% of votes supported them, categorized as broad agreement (75−95%) or strong consensus (>95%). Topics with 50−75% agreement were considered majority consensus. Statements with ≤50% agreement or repeated failure to reach consensus were excluded. Drawing on the responses to the questionnaires and the overall consensus of this panel of experts, a total of 24 recommendations were formulated. In conclusion, the recommendations in this position paper are designed to support the goal of standardizing examinations, providing a foundation for their implementation in both clinical practice and scientific research.

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https://doi.org/10.1016/j.ultrasmedbio.2025.07.003
Received 15 February 2025; Revised 1 June 2025; Accepted 1 July 2025

Introduction

Dermatologic ultrasound (US) is a non-invasive diagnostic tool that has gained significant prominence in recent years in dermatology, plastic surgery, and aesthetic medicine. It allows for detailed assessment of the skin layers, aiding in the diagnosis of various dermatologic conditions and the evaluation of aesthetic treatments [1].

In this field, dermatologic ultrasound is used to differentiate the most common cosmetic fillers, evaluate the anatomical distribution of injectable products, and monitor tissue response to rejuvenation therapies. It also helps identify potential complications and guides localized treatments [2−7].

Therefore, dermatologic ultrasound is currently a valuable tool in aesthetic applications; however, to maximize its potential, it is necessary to establish some regulations regarding equipment, techniques, nomenclature, reporting, documentation, training, safety, and guided procedures.

Standardizing these aspects improves the quality of aesthetic diagnoses and treatments and facilitates communication among professionals and the conduct of robust clinical research. Furthermore, a consensus is crucial to ensure consistency of results and guarantee a minimum quality standard for patients undergoing ultrasound examination [2].

Currently, both the literature and clinical practice reveal inconsistent information and different specialties working in this field, with varying approaches to the subject. Creating international consensus is particularly important in this area of medicine, as it provides guidance on the overall examination process and defines the minimum training requirements for medical professionals in this field.

Since the aesthetic applications of ultrasound are still emerging, the creation of guidelines needs a much higher level of evidence in multicentric studies, which is under construction. On the other hand, a position statement from an expert group from a scientific society and worldwide experts should be beneficial for physicians involved in aesthetics, providing a foundation for their current clinical practice and the generation of future evidence.

Methodology

In 2023, the Publication Committee of the World Federation for Ultrasound in Medicine and Biology (WFUMB), in collaboration with its member federations, formed a group to develop a consensus statement on best practices for professionals working in the field of Ultrasound and Dermatology, with a particular focus on aesthetic procedures and their complications.

The publication committee designated one member (MCC) to coordinate the work and to find physicians from different countries worldwide and from all the relevant specialties to contribute to the work, focusing on academic and clinical excellence in imaging, diagnosis, and treatment. In total, 15 professionals contributed to this article: six from Europe, five from Latin America, one from India, two from the United States, and one from Australia. Of the 15 authors, eight are radiologists, four are dermatologists, two are plastic surgeons and one is a cosmetic physician. Group members were chosen based on their qualifications, relevant publications, clinical experience, and absence of conflict of interest. Two co-moderators of the committee (XW and MCC) have been identified.

After the selection and acceptance of the members, virtual meetings were held to discuss the topics of this consensus between December 2023 and April 2024.

The subjects addressed in this consensus regarding dermatologic US in aesthetic applications were selected, designed, and approved by the panel members and steering committee during the initial meetings.

Two questionnaires were prepared by two members of the steering committee, designated as co-moderators of the committee (XW and MCC) based on the main sensitive issues, and were distributed to all authors to vote virtually. The initial questionnaire covered all topics broadly, while the subsequent one addressed specific issues in greater depth. Both questionnaires consisted of multiple-choice questions designed to obtain objective answers covering the chosen topics: equipment, examination technique, nomenclature, reporting, documentation, training, safety, and ultrasound-guided procedures in aesthetic ultrasound and complications.

After each questionnaire was answered, a meeting with all the authors was held to present the results and facilitate further discussion. In cases where there was a tie in responses, the decision was reached by consensus among the authors. A position statement was approved if > 75% of voting members were in agreement; (broad agreement: > 75% −95% of votes, strong consensus > 95% of the votes). The votes between > 50% and 75% on a specific topic are considered majority consensus. In the case of disagreement (≤ 50% of the votes in favor) or if the rephrased or alternative position statement again failed to gain > 75% of votes, the position statement was removed. A lack of consensus on this particular issue is recorded in the text [8,9].

Safety protocols/ disinfection

US examinations and guided procedures require proper safety protocols to minimize the risk of infection.

When conducting a diagnostic US examination on a patient with intact skin, non-sterile gel from multidose containers can be used, whereas if there is a wound present on the skin, a sterile cover is recommended, and sterile gel should be applied both under the cover and directly onto the skin [10].

While there is no consensus on the need for a completely sterile environment for filler injections, using sterile transducer covers and single-use sterile gel packets is the most effective strategy to reduce contamination and infection risks. Alternatively, disinfectants may also be applied between the sterile cover and the skin. If the transducer touches the puncture site or broken skin, a high level of disinfection is required. Sterile gloves, condoms, or occlusive dressings are suitable alternatives to transducer covers. If it is certain that the needle or cannula will not contact the ultrasound transducer, a sterile cover may not be necessary [11].

To prevent contamination, gel containers should not be refilled and must remain sealed when not in use. Additionally, the dispensing tip should avoid contact with the ultrasound transducer, other surfaces, or people to maintain hygiene and minimize cross-contamination risks [12].

RECOMMENDATION 1: US examinations and guided procedures require proper safety protocols to minimize the risk of infection (strong consensus (15/15), 100%).

Recommended scanning techniques

Aesthetic ultrasound uses the same technique reported for dermatologic ultrasound, which means that a copious amount of gel is placed on top of the skin, and a cutaneous sweep is performed in at least two perpendicular axes of the body regions.

The study needs a sequence of greyscale, color Doppler, and pulsed Doppler (spectral curve analysis) of the regional vascularity to detect the echo structure of the superficial and deep layers and their vascularity patterns.

RECOMMENDATION 2: Color Doppler ultrasound is required in all aesthetic studies (broad consensus, Pro: 80%; 12/15).

RECOMMENDATION 3: Pulsed Doppler/ spectral analysis is essential for ruling out vascular occlusion or vascular mapping (majority consensus (11/15), Pro: 73%).

Technical considerations (requirements)

There are minimum requirements for aesthetic ultrasound examinations, including linear or compact linear multifrequency transducers with a minimum upper range of 15 MHz of frequency and color or power Doppler.

The axial spatial resolution of a 15 MHz transducer (high-frequency) is 100 μm, and that of a 70 MHz transducer (ultra-high frequency) is 30 μm, which is similar to the lower magnification of histology [13]. This implies that using an ultra-high-frequency device can provide a much better discrimination of the structures. For example, small deposits (submillimeter) of fillers or thin fragments of tensor threads that are non-visible at high frequency can be detected at ultra-high frequency. Few centers around the world have these ultra-high-frequency devices. Nevertheless, the minimum requirement for an aesthetic ultrasound examination, as in any type of dermatologic ultrasound examination, is a high-frequency device [2,14]. Thus, if ultra-high frequency is available, it can add valuable information.

Ultraportable or smartphone types of devices may serve for detecting and identifying large deposits of fillers and/or biostimulators; however, these devices may present limitations in the discrimination of smaller filler deposits, the detection of low-velocity vascularity, and may show issues in their Bluetooth or WIFI connectivity and storage. Nevertheless, these devices are usually affordable compared to high-end machines and can help in clinical practice [15].

The limitations of ultrasound are the detection of lesions that measure < 0.1 mm when working at 15−18 MHz and lesions that measure < 0.03 mm when working at 70 MHz [13]. Other limitations are the detection of pigments and purely epidermal lesions. Depending on the type of machine (smartphone or ultraportable and high-end devices), other limitations, such as the definition of the images and the sensitivity of the color Doppler, may be found [1,2,16].

A time for a learning curve is expected for the operators, and its specific duration may rely on the previous imaging background and training, and the daily exposure to aesthetic patients and their conditions.

RECOMMENDATION 4: The minimum requirement of frequency for practicing aesthetic ultrasound examinations is 15 MHz (broad consensus (12/15), Pro 80%).

RECOMMENDATION 5: Ultra-high frequency transducers provide better discrimination of the structures, since the axial spatial resolution of 70 MHz is 30 μm, similar to the lower magnification of histology (broad consensus (12/15), Pro 80%).

RECOMMENDATION 6: Future work is needed to clarify the role of ultraportable devices for the identification and discrimination of fillers using different frequencies and their limitations (strong consensus (15/15), Pro 100%).

RECOMMENDATION 7: Training in this field is required to properly handle equipment used in aesthetic dermatologic ultrasound and to understand its limitations (strong consensus (15/15), Pro 100%).

RECOMMENDATION 8: The different types of ultrasound equipment used in aesthetic examinations (frequency, characteristics) should be described in the report (strong consensus (15/15), Pro 100%).

Basic image interpretation

Normal skin anatomy

The skin is made up of three layers. The most superficial layer is the epidermis, which, on ultrasound, appears as a hyperechoic line mainly due to the keratin of the stratum corneum. The dermis shows on ultrasound as a hyperechoic band that is less bright than the epidermis. The collagen component provides most of the elasticity of the dermis. The hypodermis, also called subcutaneous tissue, presents on ultrasound as a hypoechoic layer, and this echogenicity is mainly caused by the fatty lobules. In between the fat, there are hyperechoic lines that correspond to the fibrous septa.

The vascularity of the hypodermis includes slow-velocity arterial and venous vessels, with arteries commonly having a peak systolic velocity equal to or lower than 15 cm/sec. Currently, ultrasound machines can detect only one or two vessels in the dermis because the detection threshold for velocity is a minimum of 2 cm/sec. Therefore, low-velocity dermal vessels are not easily detected by ultrasonography [16−18].

In the presence of photoaging, a hypoechoic band can be detected in the upper dermis of the body regions exposed to the sun. This band corresponds to glycosaminoglycans (elastosis) deposits in the dermis. This band has been called the SLEB (subepidermal low echogenicity band) and should not be confused with inflammation (Fig. 1) [16,17,19].

RECOMMENDATION 9: Knowledge of facial anatomy and soft tissue anatomy of other regions being treated and comprehensive knowledge of color Doppler and spectral Doppler are needed to perform aesthetic medicine safely and effectively (broad agreement, (14/15), Pro: 93%).

RECOMMENDATION 10: The aesthetic ultrasound examination requires knowledge of all facial structures (head, skin layers, subaponeurotic fatty tissue, muscles, blood vessels, nerves, salivary glands, lymph nodes, ear, nose, and lip) (majority consensus (11/15), Pro 73%).

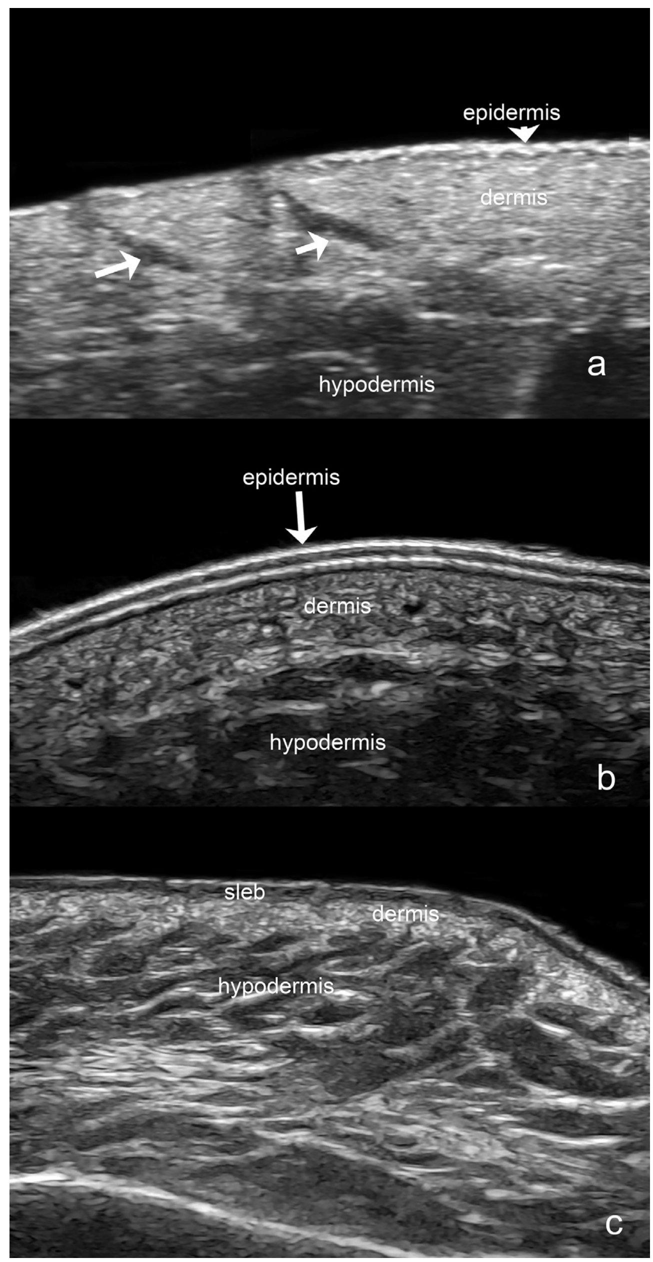

Figure 1. Ultrasound of normal skin (greyscale) shows the epidermis, dermis, and hypodermis. (a) At 70 MHz, notice the hair follicles (arrows). (b) At 24 MHz in the plantar region, there is a bilaminar epidermis. (c) At 24 MHz, in photoaged skin (face), a hypoechoic band in the upper dermis corresponds with the SLEB (subepidermal low echogenic band).

Vascular anatomy of the face

Precise knowledge of the vascular anatomy of the face is essential for different cosmetic procedures, such as the injection of fillers, tension threads, facial implants, and surgical procedures [20,21]. The ultrasonographic vascular map with color duplex Doppler US allows visualization of vascular structures in real-time, confirming their usual course or detecting anatomical variants [22].

When using color Doppler mode, it is important to understand that the blue or red colors do not represent the standard convention of arteries or veins, but instead, they identify the direction of the flow approaching or moving away from the transducer according to the color that is higher on the color scale box [22]. It is advisable to apply slight pressure to the vessel to further evaluate.

The study can be performed in amplitude Doppler mode, called Power Doppler (or Microvascularity or Echoangio software or Energy Doppler, according to the equipment brand), which is more sensitive to detect flow than color Doppler mode. Unlike color Doppler, Power Doppler does not indicate whether the flow moves toward or away from the transducer (it does not display flow direction). It is particularly useful for confirming the presence or absence of flow, especially in tissues with low flow velocities.

Compression on the vessel can be useful to differentiate arteries from veins (the latter by definition, are compressible); however, small-caliber arterial vessels such as branches of the superficial temporal arteries can be compressible, so the use of the spectral curve on the vessel evaluated is desirable if one really wants to have complete precision about the arterial or venous nature of the vessel [23].

In the case of the face, the mapping can be divided into upper, middle, and lower thirds. The order of the examination of these parts may depend on the operator and should be performed according to the objective of the examination.

In the lower third, it is recommended to study the facial artery (Fig. 2), submental artery, and inferior and superior labial arteries (Fig. 3). When evaluating the labial arteries, their complete course must be visualized and confirmed whether they are located in the submucosal, intramuscular, or superficial plane (Fig. 3) [24]. Anatomical variants of the facial artery, such as, loops, tortuosities, and supraperiosteal location, may be common and should be reported [25−27] (Fig. 4).

In the middle third of the face, the angular artery typically courses along the nasolabial fold (Fig. 5) and should be assessed carefully. The dorsal and lateral nasal arteries also require evaluation (Fig. 6). At the nasal tip, it is important to confirm the presence of the columellar artery. Additionally, the transverse facial artery should be identified as it originates from the superficial temporal artery in the preauricular region and courses through the parotid gland, often as one or two branches.

In the upper third, the origin of the supratrochlear and supraorbital arteries must be confirmed [28]. Exploring the temporal zone includes the superficial (Fig. 7a) and deep temporal (Fig. 7b) arteries and the sentinel vein (Fig. 7c), which must be described.

RECOMMENDATION 11: The sonographic grey scale and vascular mapping of the face are recommended before cosmetic procedures are performed, especially due to some patients forgetting to mention previous procedures with fillers, and threads, and because of the possibility of subclinical pathology such as granulomas, cysts, and lymph nodes (broad agreement (14/15), Pro: 93%)

Ultrasonographic evaluation of common cosmetic fillers

Ultrasound is the first-choice imaging technique to detect and identify common cosmetic fillers. These exogenous agents are identified according to their intrinsic echogenicity patterns and generated artifacts (Fig. 8a−g) [3−7,16,29−36]. It is crucial to perform ultrasound evaluation of fillers, as patients often do not recall or report the specific substances that were injected. This lack of information can complicate diagnosis and treatment, underscoring the importance of thorough imaging assessment.

Hyaluronic acid (HA)

Hyaluronic acid is the most commonly used cosmetic filler worldwide and is considered to be biodegradable. On ultrasound, HA shows as multiple round or oval-shaped anechoic pseudocystic structures that can turn hypoechoic over time due to the degradation process (Fig. 8a). In some deposits, it is possible to detect inner echoes due to the addition of lidocaine or the presence of inflammation. HA can last several years after injection but tends to decrease in size over time, usually months. Since its content is fluid, it usually generates a posterior acoustic enhancement artifact.

Polyacrylamide (PAAG)

This filler, also called hydrogel because it is embedded in a gel matrix, presents as anechoic, round, or oval-shaped structures that last for more than 18 mo without significant changes in size. Over time, some PAAG deposits can show inner echoes and appear hypoechoic (Fig. 8b).

Polycaprolactone (PCL)

This is a synthetic filler with a hypoechoic matrix containing multiple hyperechoic spots showing a mini-comet tail artifact (Fig. 8c). Over time, PCL can increase its echogenicity compared with the original deposits, but it still appears hypoechoic.

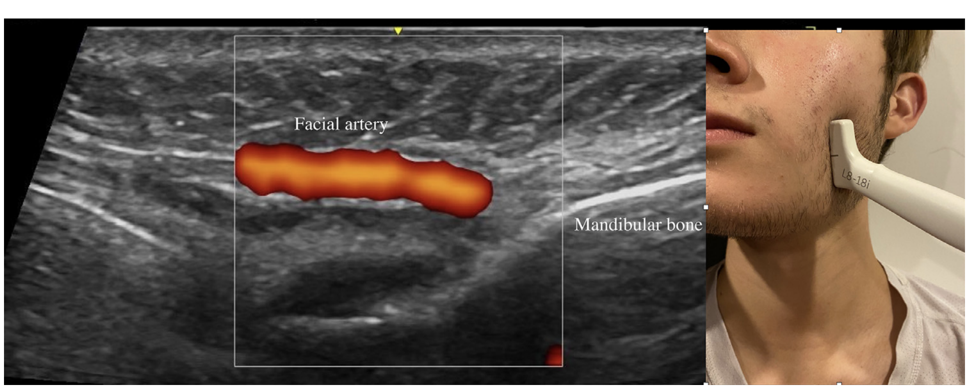

Figure 2. Longitudinal image of the facial artery in a Power Doppler ultrasound, observe the mandibular bone ridge in the proximal region. The right side shows the probe's position.

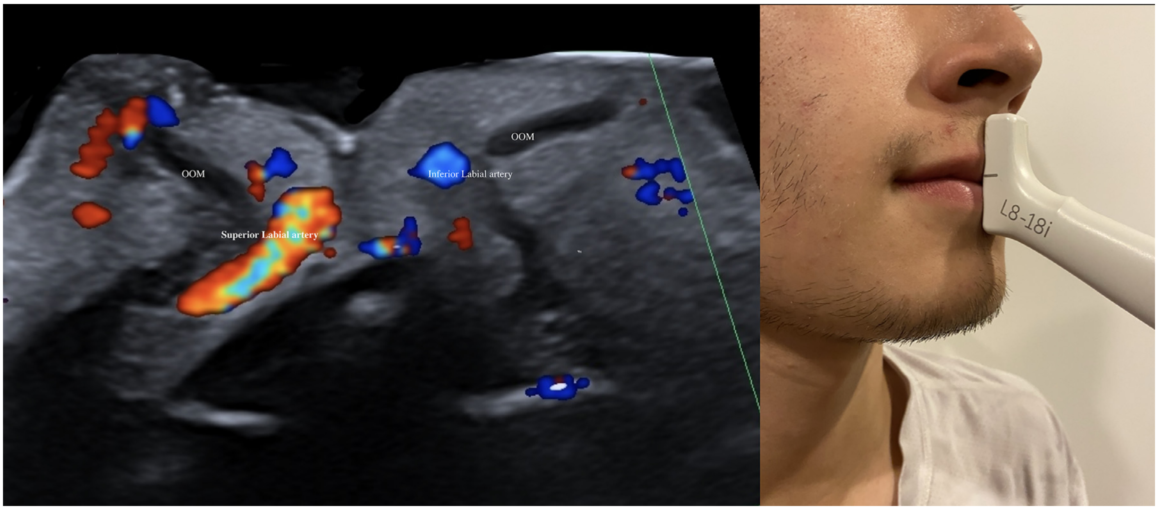

Figure 3. A longitudinal image of the lips in a color Doppler ultrasound demonstrates the location of the superior and inferior labial arteries. OOM orbicularis oris muscle. The superior labial artery is located deep in the submucosal region, and the inferior labial artery is located adjacent to the plane of the orbicularis oris muscle in a more superficial location. The right side shows the probe's position.

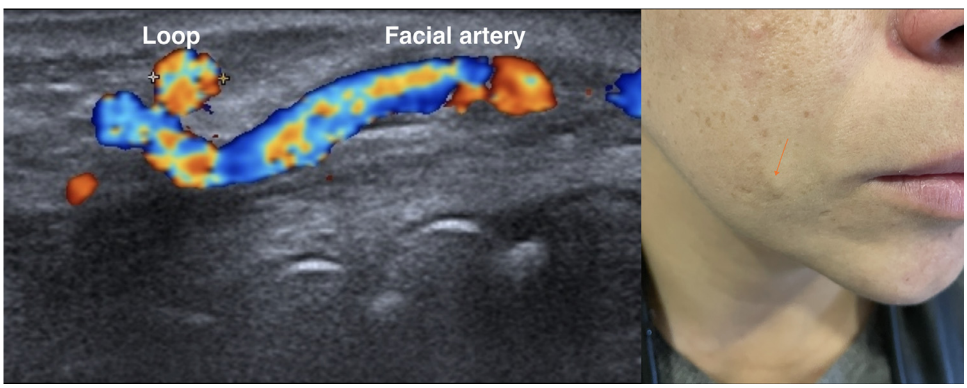

Figure 4. Patient with a palpable nodule in the right labial region, high-resolution ultrasound with color Doppler demonstrates a loop originating in the facial artery that corresponds to the clinically visualized nodule. The arrow on the right side indicates the loop position.

Calcium hydroxyapatite (CaHA)

On ultrasound, it shows as hyperechoic deposits that may vary in the intensity of their posterior acoustic shadowing artifact according to the dilution (Fig. 8f). If undiluted CaHA is used, a strong posterior acoustic shadowing artifact is commonly found. The diluted formulations show a mild or no posterior acoustic shadowing artifact. The most diluted presentations are used as biostimulators.

In the presence of mixed formulations of HA and CaHA, hyperechoic deposits with a 'cloudy pattern', are detected.

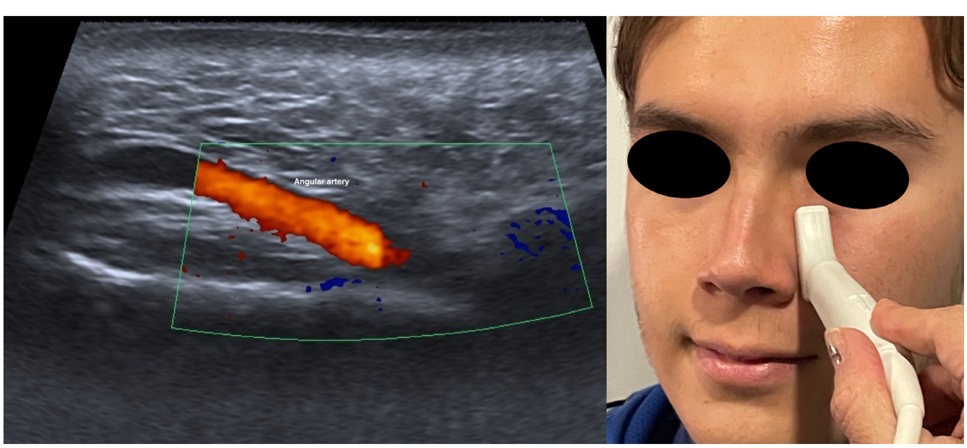

Figure 5. A longitudinal image of the left nasolabial fold, Color Doppler ultrasound, demonstrates the angular artery in its course at the level of the SMAS; this is its usual location. The right side shows the probe's position.

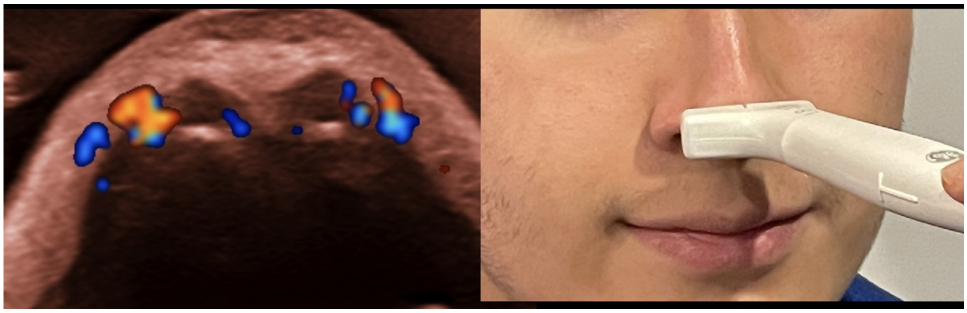

Figure 6. Axial image of the nasal tip. Color Doppler ultrasound demonstrates normal vascularity of the nose. The right side shows the probe's position.

Polymethylmethacrylate (PMMA)

This synthetic filler is shown on ultrasound as a hyperechoic deposit with mini-comet tail artifacts (Fig. 8e). Old deposits of PMMA may show a posterior acoustic shadowing artifact.

Silicone oil and pure silicone

Silicone is a non-FDA-approved substance for cosmetic uses; however, its presence has been reported in multiple countries.

Silicone oil can be detected on ultrasound as ill-defined hyperechoic deposits with posterior acoustic reverberation, called a 'snowstorm pattern' (Fig. 8d). Pure silicone is usually detected as oval, taller-than-wide anechoic deposits within the silicone oil.

Pure silicone presents a similar appearance to the silicone used in implants.

Poly L-lactic acid (PLLA)

Although it was conceived as a filler, PLLA is not used as a filler because it does not significantly modify the volume of tissues; therefore, it is injected as a biostimulator. PLLA appears as ill-defined hyperechoic deposits that become more subtle over time (Fig. 8g).

Ultrasonographic evaluation of non-filler procedures

Tensor threads

These devices are supposed to generate a lifting effect in the tissues. They can be classified into non-degradable and degradable types.

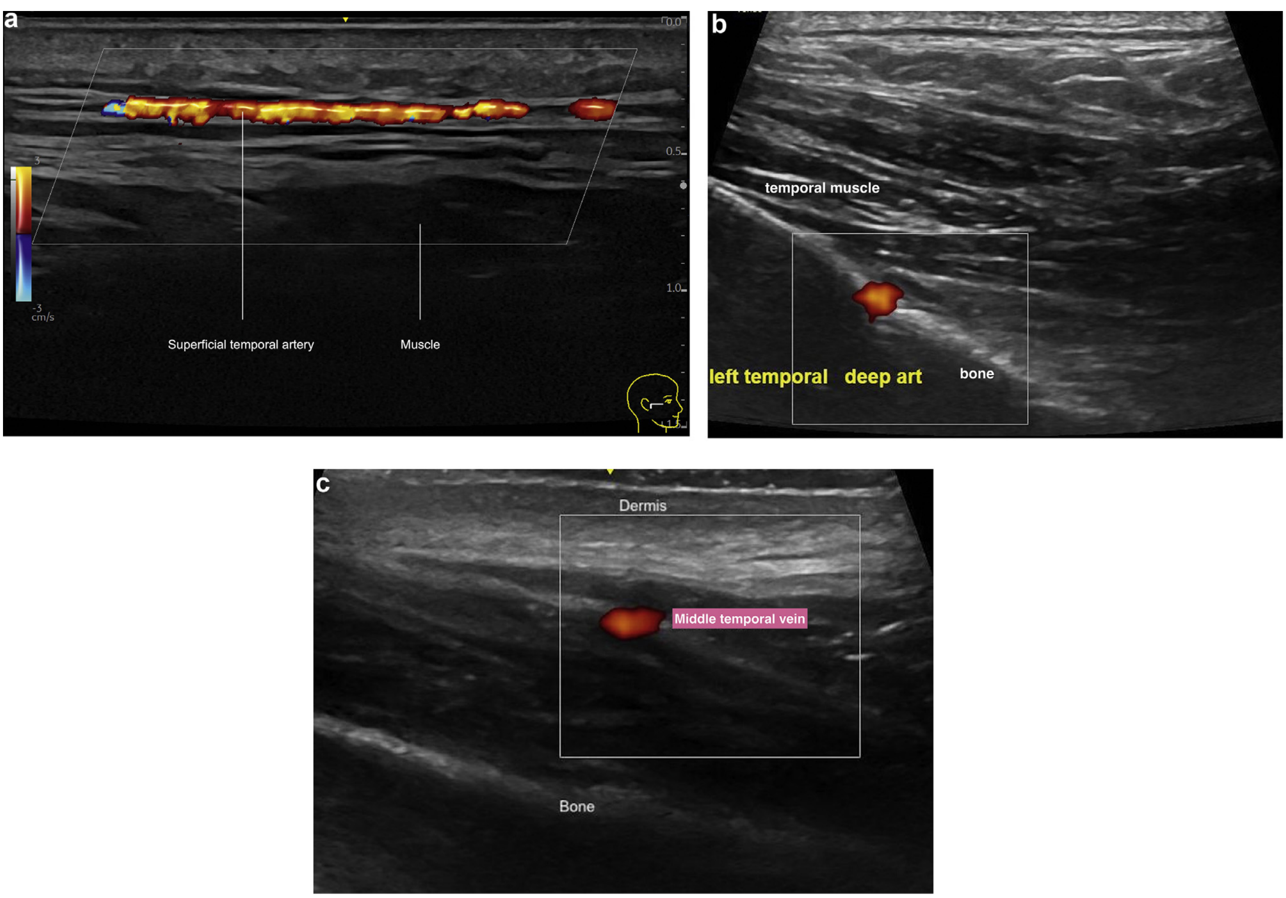

Figure 7. (a) Color Doppler ultrasound demonstrates the usual course of the superficial temporal artery. (b) Power Doppler ultrasound, demonstrates the usual position of the anterior deep temporal artery in contact with the bony ridge. (c) Power Doppler ultrasound demonstrates the middle temporal vein which is continuous with the middle temporal vein located in the superficial fat pad. It is important to establish its route since unexpected injection into this artery can cause cavernous sinus thrombosis.

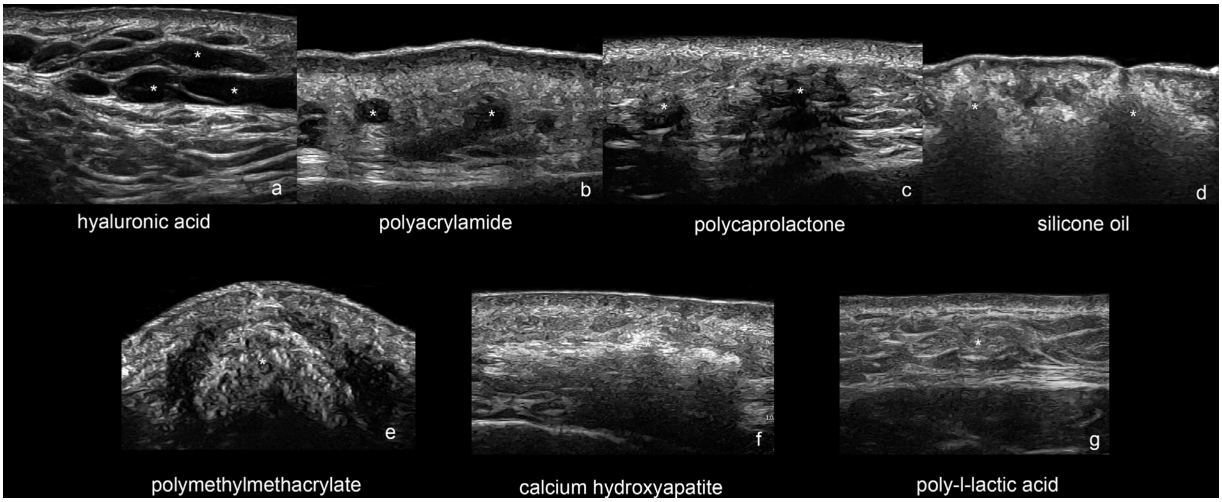

Figure 8. (a-g) Catalog of the ultrasonographic patterns of the most common cosmetic fillers.

Nowadays, the most used are the degradable types, which frequently contain polydioxanone.

Tensor threads appear as sutures; therefore, they show as bilaminar hyperechoic structures within the cutaneous layers. Some of the threads present small thorns supposedly pursuing the generation of fibrosis in the tissues [6,16,37−39] (Fig. 9).

Fat grafts (lipofilling)

Fat grafting is a procedure used to reduce facial wrinkles and increase buttock volume or breast tissue. It consists of directly injecting the patient's autologous fat, which is transferred to the subcutaneous area. On ultrasound, the autologous fat graft appears as an oval or elongated image, iso or hyperechogenic with normal subcutaneous tissue with some hyperechogenic septae. An increased echogenicity of the surrounding subcutaneous tissue and adjacent muscle can be observed. Over time, they may present some changes of anechoic cystic degeneration (fat necrosis) or hyperechoic calcifications, which should be evaluated [6,40] (Fig. 10 a, 10b).

Mesotherapy

Mesotherapy is used to supposedly correct cellulite, body contour, and hair loss, and it uses natural or synthetic lipolytic agents or tiny deposits of hyaluronic acid, among other agents.

On ultrasound, edema of the dermis and hypodermis can be observed with decreased dermal echogenicity and hyperechogenicity or heterogenous echogenicity of the hypodermis. An increase in vascularity on Doppler examination is usually found.

Occasionally, some anechoic or round structures suggestive of foci of fat liquefaction may be found in the region [41] (Fig. 11).

Cryolipolysis

Cryolipolysis consists of exposing the hypodermic fat to low temperatures to induce panniculitis, which eventually leads to the local reduction of lipocytes. However, paradoxical increases in the thickness of the hypodermis have also been reported. Ultrasound commonly shows irregular patchy areas of increased echogenicity in the hypodermal fatty tissue, which can alternate with irregular hypoechoic or anechoic areas that may represent fat necrosis [41] (Fig. 12).

Radiofrequency

Radiofrequency aims to reduce the laxity of the superficial layers through the use of heat to generate a tightening effect. The ultrasound shows thickening, a decrease in the echogenicity of the dermis, and a variable increase in the thickness of the hypodermis. There may be an increase in vascularization on Doppler examination due to the inflammatory activity generated by the procedure [42] (Fig. 13).

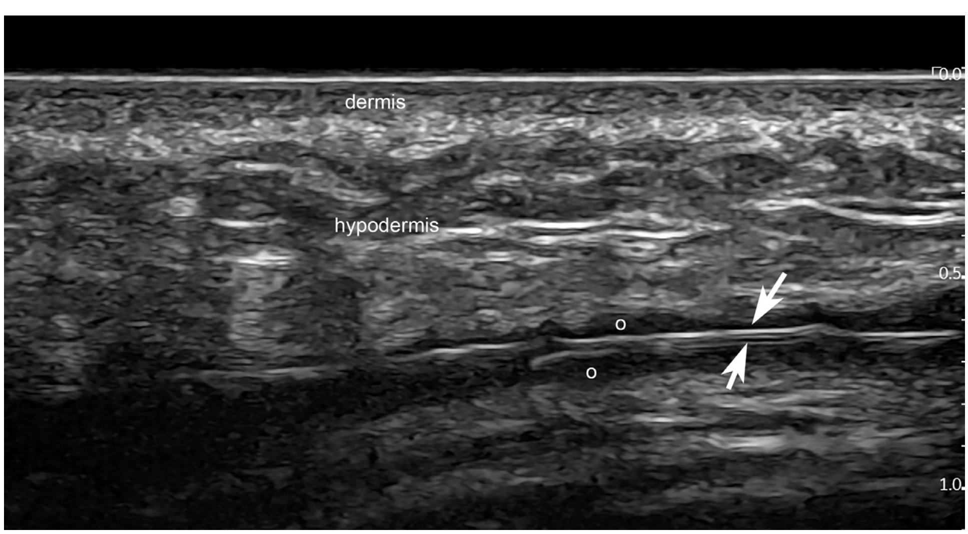

Figure 9. Tensor thread in the hypodermis. Notice the hyperechoic bilaminar structure (arrows) surrounded by hypoechoic inflammatory and granulomatous tissue (o).

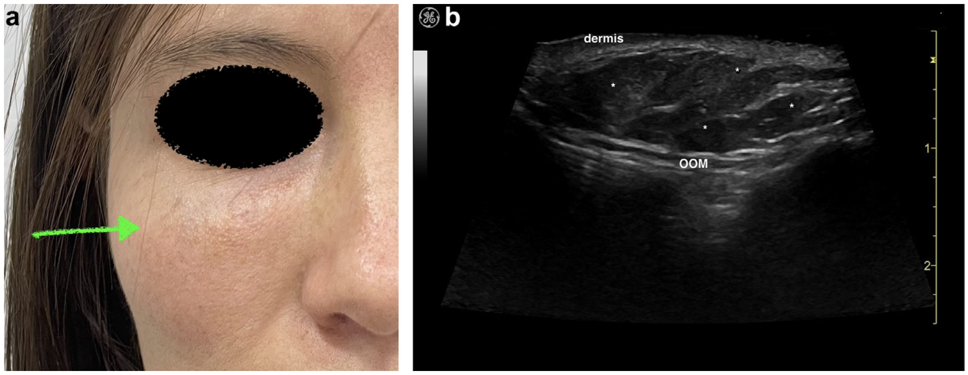

Figure 10. (a) Female patient with a history of fat transfer (lipofilling) 2 y ago in infraorbital regions, the green arrow shows asymmetry and lumpiness in the malar region after the procedure. Figure 10 (b) Gray scale ultrasound axial image demonstrates a well-defined hypoechoic mass (*) with some hyperechoic septa corresponding to a fat graft located above the orbicular oculi muscle (OOM).

Implants

The most commonly used implant in aesthetic medicine is pure silicone, although there are other types of materials, such as saline solution, cartilage, and polyethylene. Their wide range of uses can include volume restoration and reconstruction of the face, breast region, buttocks, and calves. Pure silicone implants are generally seen as oval, anechoic structures surrounded by mono, bi, or trilaminar sheets (Fig. 14). Polyethylene implants are generally used for nasal reconstructive surgery and are seen as markedly hyperechoic bands. Cartilage grafts or implants are recognized as hypoechoic bands [42] (Fig. 15).

Testosterone injection

Testosterone injection increases muscle mass, generally in the arms and legs [43]. The self-application of this substance can cause muscle tears that are visible and characterizable in the ultrasound, in the same way, the needle's path can be visualized, and it is usually surrounded by an increased echogenicity of the fatty tissue and muscular layer due to inflammation (Fig. 16).

Ultrasound evaluation of complications

Complications of fillers

High-definition ultrasound has become an indispensable tool for diagnosing and managing filler complications in aesthetic medicine. It enables the identification and localization of fillers, the detection of signs suggestive of an inflammatory process, and facilitates precise, ultrasound-guided interventions.

The classification of filler complications can be categorized based on the onset time into recent (within 4 wk) and late onset (more than 4 wk). Early onset complications can further be divided into immediate (within 24 h after the procedure) and early-onset (from 24 h to 4 wk) [44,45].

Ultrasound for diagnosis and treatment of recent filler complications

The most common immediate onset adverse reactions include injection site reactions such as erythema, transient swelling, bruising, itching, and moderate pain. In these cases, ultrasound is typically not required. However, in cases of overfilling/migration, abscess, parotiditis, neuropraxia, panniculitis, and accidental intravascular injection of the filler, ultrasound is recommended [46,47].

Overfilling clinically manifests as lumps, asymmetries, or contour deformities, particularly noticeable when there is an excessive deposit or accumulation of filler in one area (Fig. 17a, 17b).

Migration occurs when the product is observed in an area away from the application site. On ultrasound, we observe the presence of the product corresponding to the palpable area. A small tract with filler deposits may be found between the original location and the migrated deposits [41].

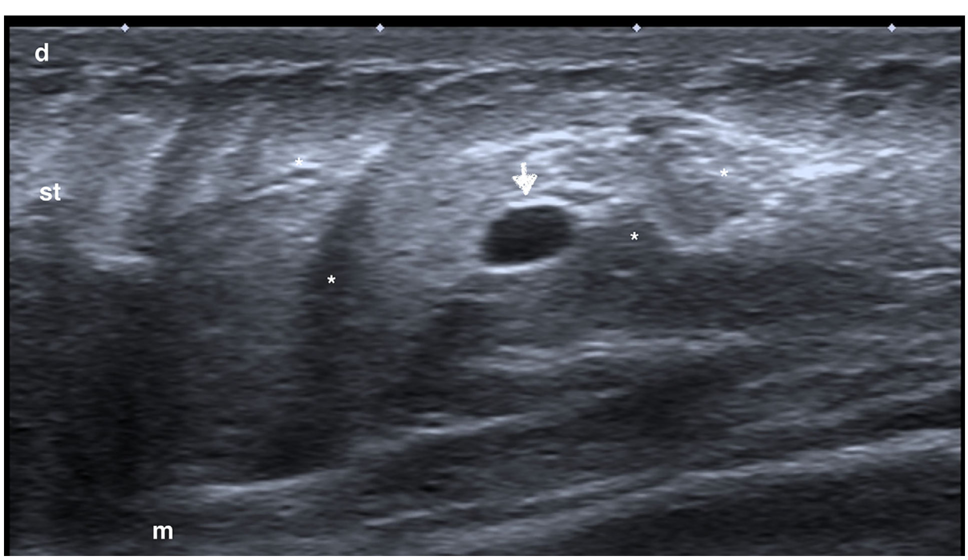

Figure 11. Axial image in gray scale ultrasound, the arrow shows a small anechoic cyst with well-defined edges corresponding to an area of fat necrosis. The asterisks (*) demonstrate heterogeneous echogenicity of the subcutaneous tissue after mesotherapy. Dermis (d), subcutaneous tissue (st), muscle (m).

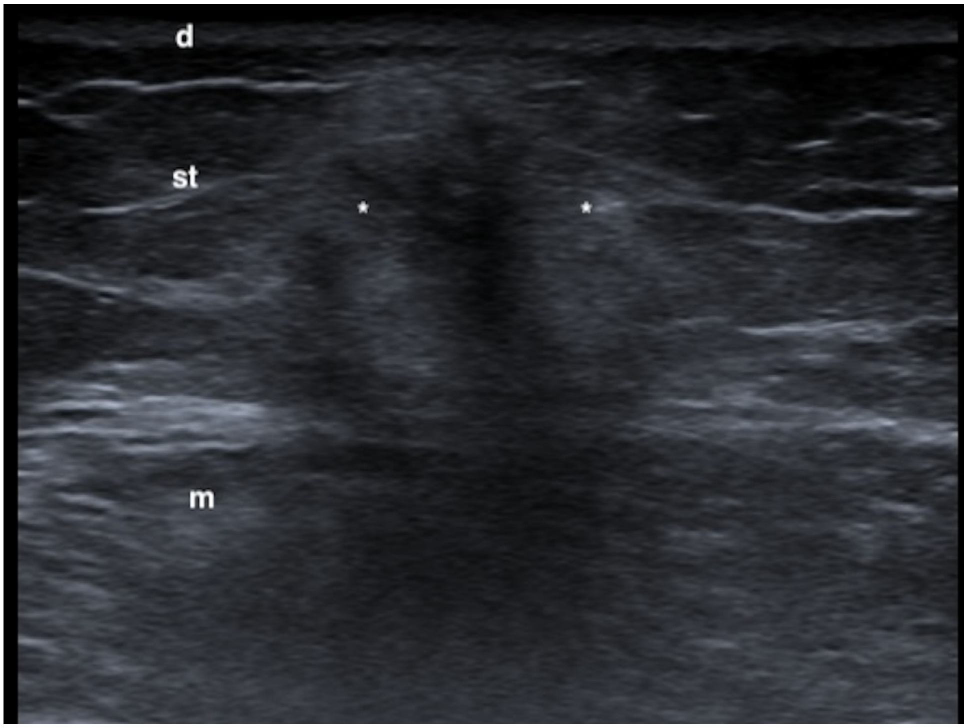

Figure 12. Axial grayscale ultrasound image of the abdominal wall area after the cryolipolysis procedure demonstrates heterogeneous areas of irregular alteration in the echogenicity of the subcutaneous tissue (st), with ill-defined irregular hypo and hyperechoic areas asterisks (*), the hypoechoic areas can correspond to incipient fat necrosis. Dermis (d), muscle (m).

Abscesses following filler procedures are typically acute infections that occur within 2 wk after treatment. Clinically, a red, tender, and painful lump is usually observed [48]. Ultrasound shows a well-defined, thick fluid collection or multiple confluent collection pockets, often with posterior enhancement that may present suspended debris at the site of the previous filler injection [49,50] (Fig. 18a, 18b).

Fillers may be injected near or into the major salivary glands, potentially resulting in inflammatory conditions such as acute parotitis. Patients can present localized swelling and pain; however, intraparotid deposits may be asymptomatic. On ultrasound examination, affected glands exhibit enlargement, parenchymal heterogeneity, discreet diffuse increase in vascularity, and the presence of intraparotid filler. In cases of intraductal injection, intraductal dilation may be observed [41].

Typically, nerve damage does not occur during filler injections. However, in rare instances, a needle or cannula may inadvertently pierce a nerve. Additionally, a filler deposit may exert pressure on a foramen, leading to nerve compression and subsequent neurapraxia. This condition often manifests as localized anaesthesia or paraesthesia [51]. Ultrasound imaging can reveal the presence of the filler product near the affected foramen and guide the treatment non-invasively (Fig. 19).

Panniculitis may be a complication caused by injected foreign material [52,53]. This inflammation presents as a palpable nodular area and can affect the fatty lobules and/or the fibrous septa. Lobular panniculitis appears as a diffuse increase in echogenicity of the fatty lobules. In septal panniculitis, there is a hypoechoic thickening of the septa between the hyperechoic fatty lobules (Fig. 20a, 20b). On color Doppler,

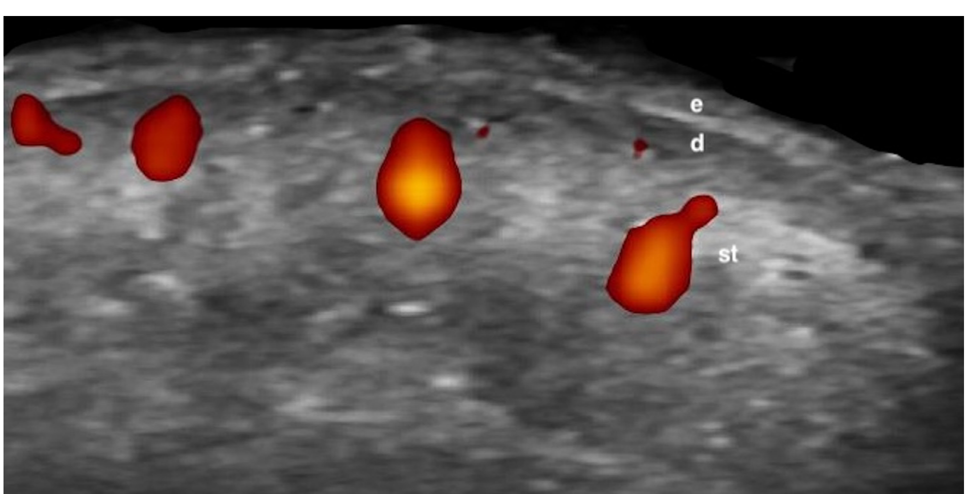

Figure 13. Power Doppler ultrasound, axial image of the cheek area after radiofrequency, there is a decrease in the echogenicity of the dermis (d), a heterogeneous echogenicity of the subcutaneous tissue (st), with hypervascularity secondary to inflammatory activity. Epidermis (e).

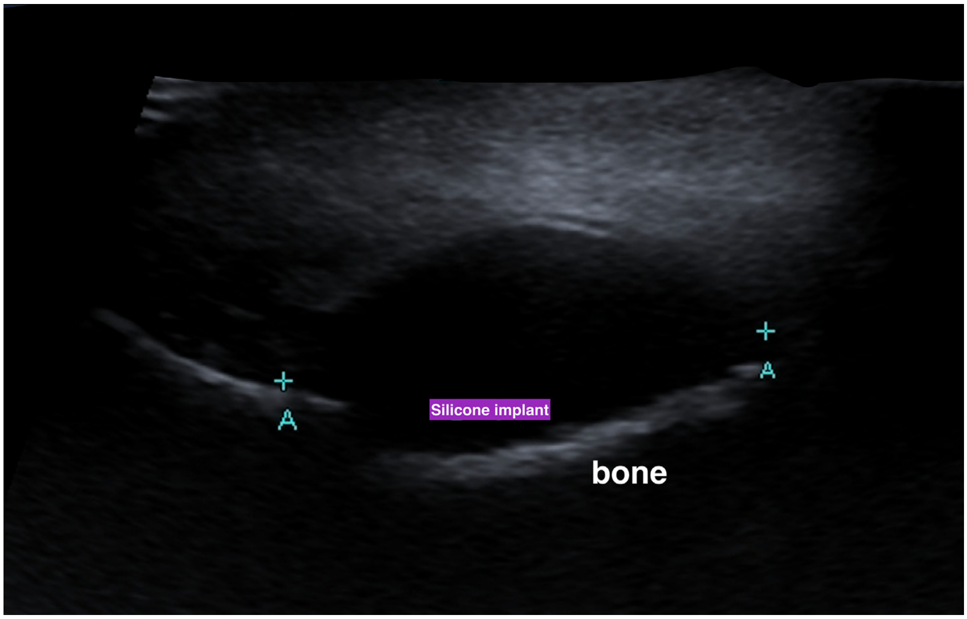

Figure 14. Longitudinal image of the chin in grayscale ultrasound demonstrating the ultrasound appearance of an oval-shaped, anechoic pure silicone implant with a well-defined monolaminar wall; there is bone remodeling underneath the implant, probably due to the long permanence of the implant. Calipers (A+) delimit the length of the implant.

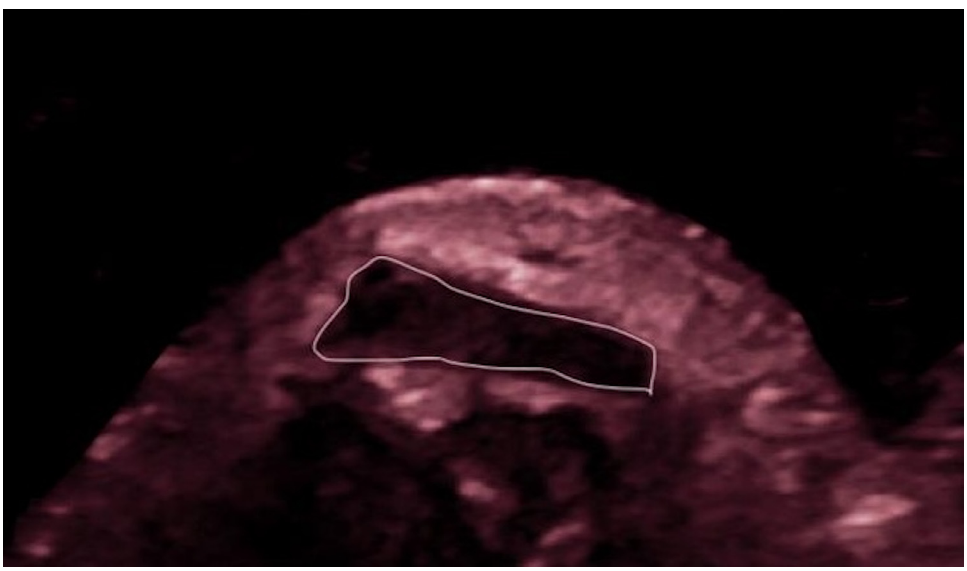

Figure 15. Axial image of the nasal tip, grayscale ultrasound (with color filter), demonstrates hypodermal hypoechoic band-like structure that correspond to a cartilage graft (outlined).

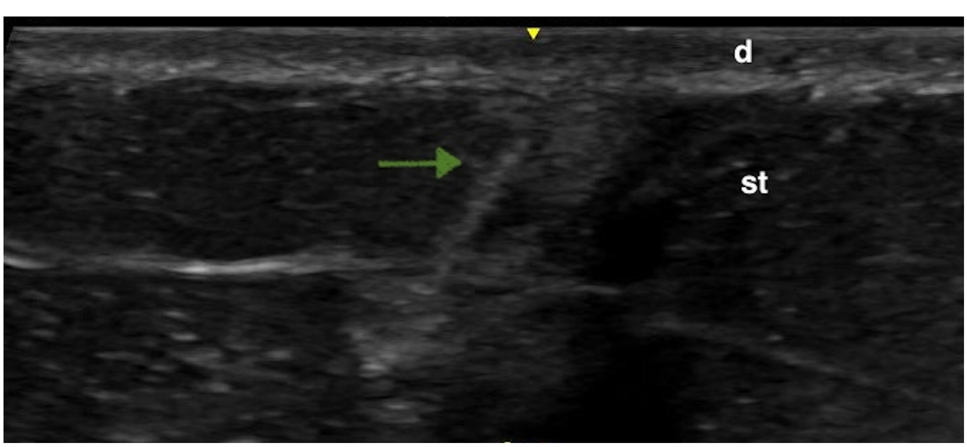

Figure 16. Axial grayscale ultrasound of the arm after testosterone injection. The green arrow shows the hyperechoic, oblique linear path of the needle, there is an increased echogenicity of the subcutaneous tissue (st) adjacent to it. Dermis (d).

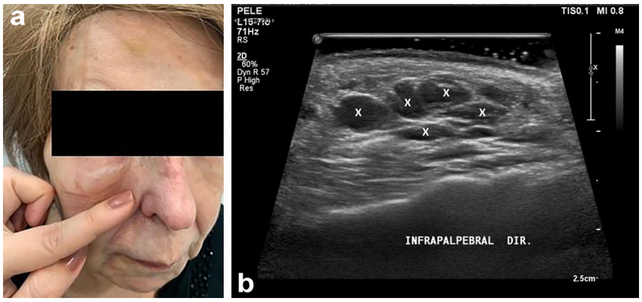

Figure 17. (a) Clinical appearance of excess filler in the right infraorbital region. (b) B-mode ultrasonography of hyaluronic acid deposits (X) in the patient's right infraorbital region, indicating an overfilling effect.

increased hypodermal vascularity can also be detected in both forms of presentation [5,41].

Clinical findings of vascular compromise may include pain disproportionate to what is typically experienced following filler treatments, and localized color changes in the affected areas. Immediate skin blanching and livedo reticularis pattern evolve over time to papules and pustules, skin breakdown, and ulceration [54]. Several conjectures regarding the pathogenesis of filler-induced necrosis have been put forward, yet the precise mechanism behind tissue ischemia remains elusive. Existing hypotheses encompass arterial or venous compression, as well as intra-arterial injection resulting in ischemia [55]. Some have argued that vasoconstriction (vasospasm) might be involved [56,57].

Most filler arterial obstructions do not constitute complete obstruction, exhibiting a spectrum from stenosis to near-complete blockage. Ultrasonographic observations in B-mode reveal irregular or serrated contours of the affected artery, and sometimes, visualization of the lumen of the affected artery becomes challenging, as hypoechoic, instead of being anechoic. On color Doppler, vascular occlusion can commonly be seen as a silent area of blood flow. In other cases, prominent or turbulent blood flow can be observed in the neighbouring regions. Additionally, occlusion attributed to hyaluronic acid may manifest as an anechoic or hypoechoic zone in the perivascular space, potentially corresponding to hyaluronic acid encasing the artery (Fig. 21).

In pulsed-wave Doppler mode, attenuated arterial flow can be observed just after the point of obstruction, suggesting reduced blood flow passage through the site of total or partial obstruction [57,58] (Fig. 22a, 22b).

Ultrasound for diagnosis and treatment of late filler complications

Late filler complications fall into two primary categories: filler malposition nodules and delayed inflammatory reactions [59].

Filler malposition nodules

Filler malposition nodules, often resulting from the inaccurate placement or overfilling hyaluronic acid fillers, manifest as aesthetic deformities due to the fillers' tendency to absorb water and expand over time. Such issues are commonly seen in the lips, nose, and infraorbital areas.

On ultrasound, we see features of the individual filler type without inflammatory changes or increased vascularity (Fig. 23). Ultrasound guidance allows targeted injection of these deposits with hyaluronidase, helping to dissolve the filler and improve the aesthetic outcome.

The infraorbital area is especially susceptible to filler malposition, nodules, and chronic edema, frequently requiring complete filler removal that can be difficult without ultrasound guidance. Some locations, such as intraorbital (usually intraorbitary extraconal) or suborbicularis fat, can only be targeted with ultrasound-guided injections [60].

Delayed inflammatory reactions (DIR)

Delayed inflammatory reactions usually present as palpable nodules with induration, edema, and redness and are challenging to diagnose and manage without ultrasound. They occur with both hyaluronic acid (HA) and non-HA fillers. Other patients may present persistent, intermittent and delayed swelling episodes [61].

Ultrasound characteristics of HA filler DIR nodules may include features of the original filler and inflammation in the nodules and the surrounding tissue. Also, it can show a nodule due to a granulomatous reaction. If the cause of the nodule is a filler, the nodule will present the intrinsic ultrasonographic of this filler. If the nodule is caused by a granulomatous reaction, it will have a mostly oval-shaped hypoechoic structure, or it will show as an ill-defined hypoechoic pseudonodule.

For these DIR nodules, treatment typically starts with ultrasound-guided hyaluronidase injections (Fig. 24) and may include oral antibiotics, steroids, or other medications. Ultrasound-guided treatments enhance precision, optimizing the therapeutic outcomes and minimizing risks, such as steroid-induced tissue atrophy.

For nodules resulting from non-HA fillers and biostimulators like PLLA, CaHA, PMMA, PCL, or silicone oil, ultrasound imaging may reveal the filler characteristics and anatomical location, the extent of

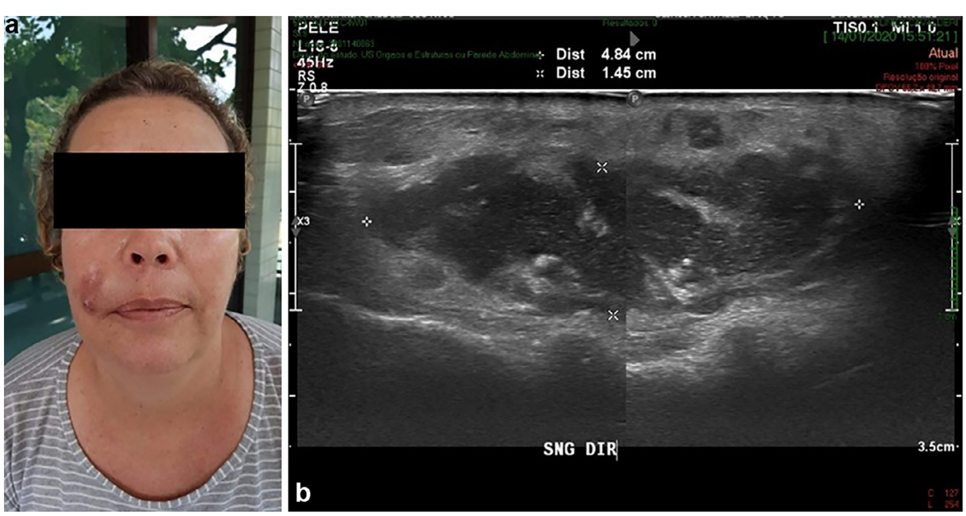

Figure 18. (a) Clinical appearance of an abscess in the right nasolabial fold region. (b) B-mode ultrasonography of the abscess (in between markers), characterized by a voluminous, thick fluid collection.

Figure 19. Hyaluronic acid deposit (between x) projecting into the infraorbital foramen (double-headed arrow).

surrounding tissue inflammation and edema, and acoustic shadowing from fibrosis and filler itself (Fig. 25) [62].

Post-treatment, ultrasound is reliable for monitoring interventions' efficacy, assessing nodule size changes, and guiding further management decisions.

Ultrasound for diagnosis of non-fillers procedures complications

The most common complications observed from cosmetic surgical procedures include fluid collections, granulomas, and fistulas [63]. Fluid collections can be seromas, hematomas, or abscesses. Seromas are a frequent complication observed, especially after abdominoplasty and body liposuction. An anechoic structure with a fusiform shape and well-defined edges, is usually found on ultrasound (Fig. 26). Hematomas in the acute phase are hyperechoic collections, and in the subacute or chronic form, they can have the classic image of the hematocrit effect, which consists of hyperechogenicity in the declining portion of the hematoma and hypoechoic or anechoic fluid above it. Abscesses are generally collections of mixed echogenicity with prominent peripheral blood flow [63].

Granulomas may appear due to the non-degradation of elements such as sutures; on ultrasound, the hyperechoic linear image of the suture is visible, surrounded by hypoechoic tissue that constitutes a granulomatous reaction: On color Doppler examination, there may be increased vascularization (Fig. 27a, 27b). Granulomas can be complicated by the development of linear tubular structures (fistulas) that are directed towards the epidermis, and they can cause the drainage of sero-hematic fluid [42] (Fig. 28a, 28B). In rhinoplasties, they are more common in the nasal tip, and in blepharoplasties, in the outer canthus [1].

Other less frequent post-surgical complications that can also be observed include infections due to atypical germs (mycobacteriosis). On the ultrasound evaluation, in these cases, it is common to find hypoechoic and heterogeneous nodules and fistulous tracts that can be

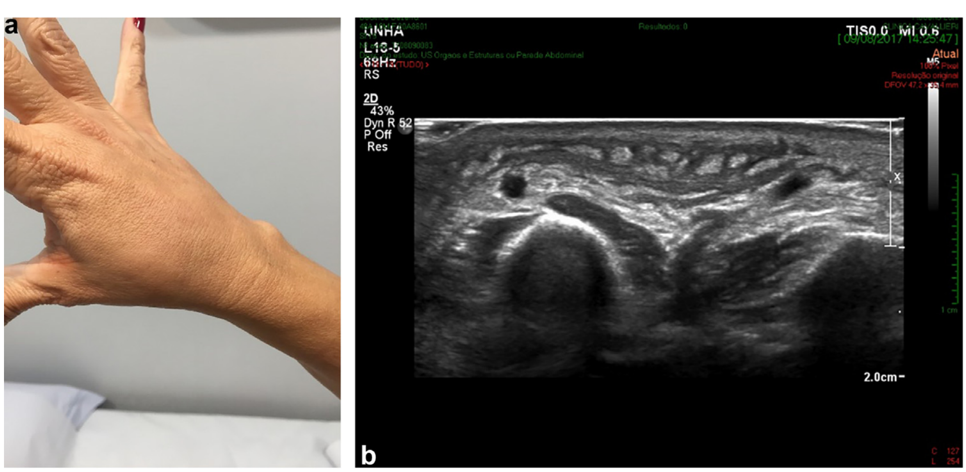

Figure 20. (a) Palpable nodular area on the dorsum of the hand following subcutaneous filling with a collagen biostimulator. (b) B-mode ultrasonographic image showing increased echogenicity of the subcutaneous tissue and hypoechoic thickening of the interlobular septa, suggestive of septal panniculitis.

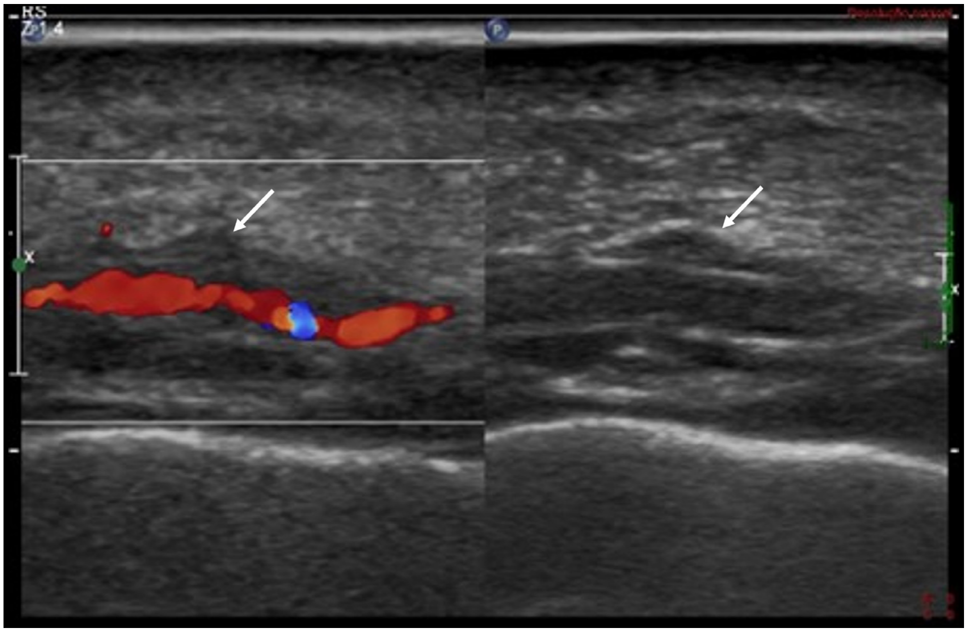

Figure 21. B-mode (right) and Color Doppler (left) ultrasound demonstrating an artery with serrated contour, and a perivascular anechoic area corresponding to the filler hyaluronic acid (arrow).

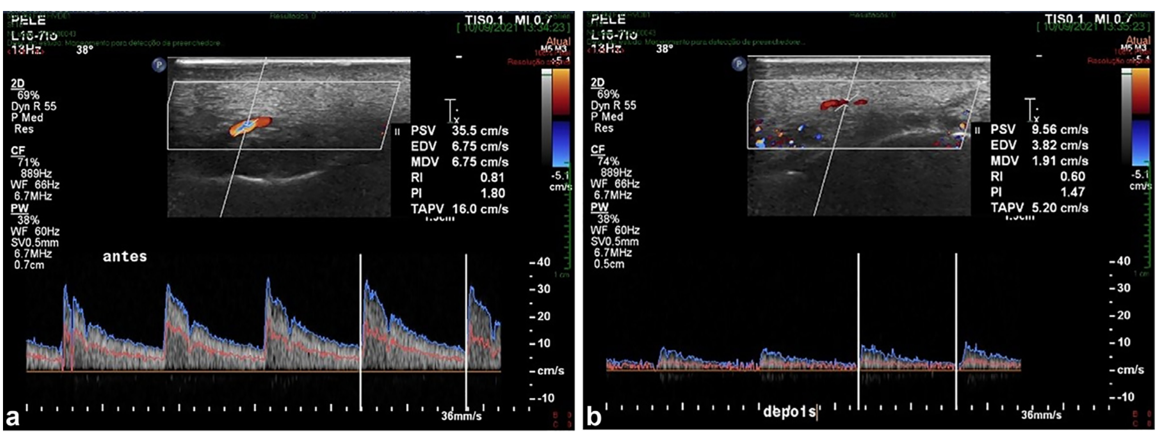

Figure 22. (a) Pulsed Doppler ultrasound demonstrating the difference in arterial systolic peak values immediately before (a) and directly at (b) the point of partial occlusion caused by the presence of hyaluronic acid filler, which leads to partial obstruction of blood flow.

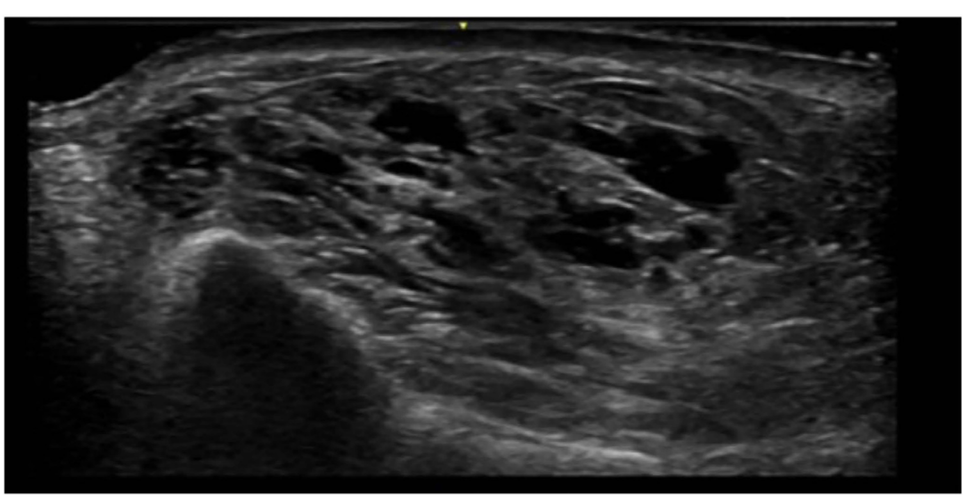

Figure 23. Overfilled midface, extensive hyaluronic acid deposits throughout (4−20 MHz linear probe).

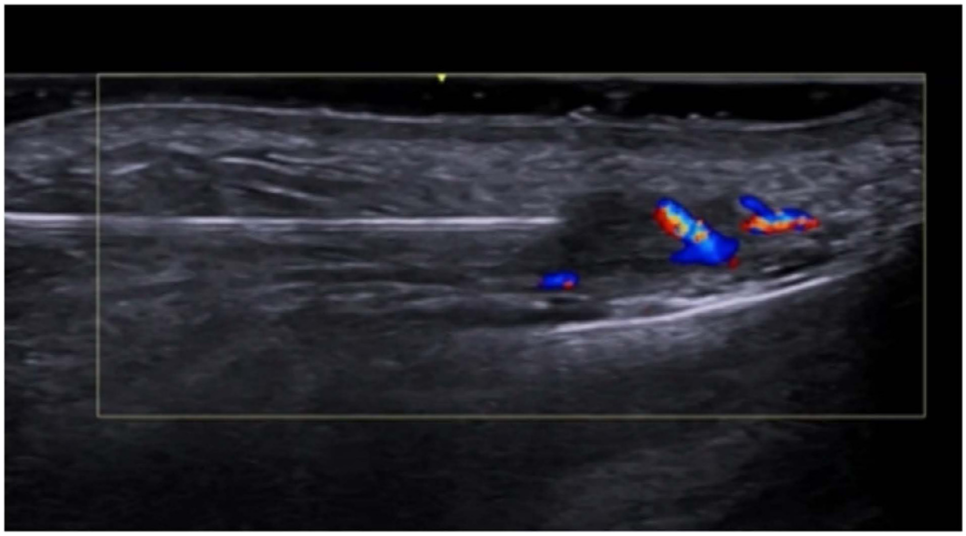

Figure 24. Ultrasound-guided injection of hyaluronidase into an inflammatory hyaluronic acid filler deposit (4−20 MHz linear probe).

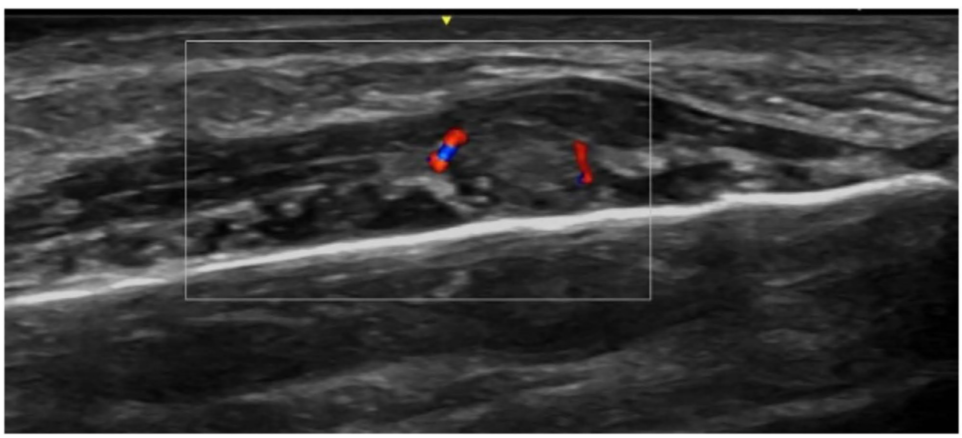

Figure 25. Granulomatous hypoechoic nodule after PLLA (poly-L-lactic acid) injection at the mandible, below depressor anguli oris (DAO) muscle, with increased vascularity (4−20 MHz linear probe).

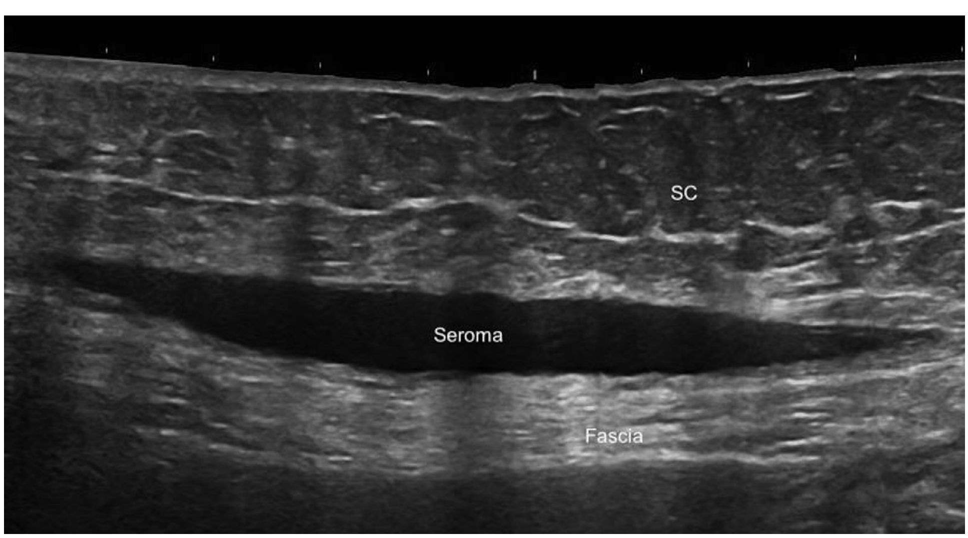

Figure 26. Transverse view grayscale ultrasound image of the abdominal wall demonstrates a seroma as a well-defined hypoechoic fusiform structure that developed after abdominoplasty. It is located deep in the subcutaneous tissue (sc).

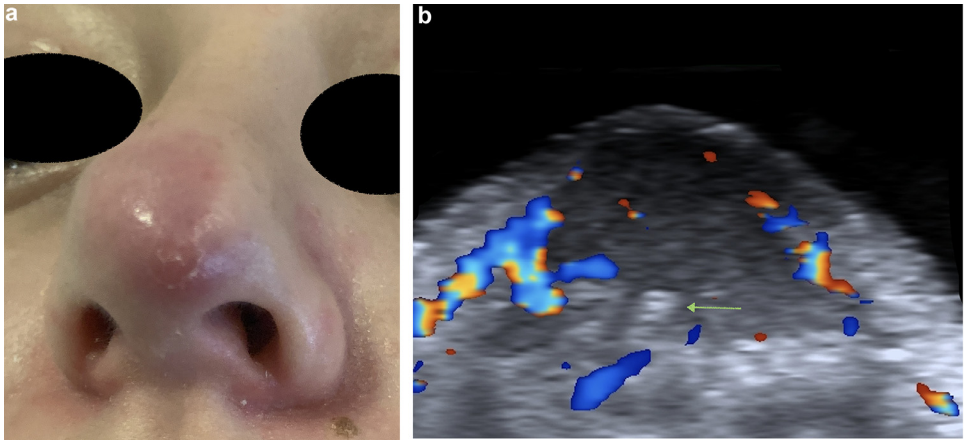

Figure 27. (a) A clinical image of a female patient with a painful, erythematous nodule on the nasal tip that developed 1 mo after rhinoplasty. (b) Color Doppler ultrasound image demonstrates a hypoechoic nodule corresponding to a foreign body granuloma with poorly defined edges at the nasal tip, the green arrow shows hyperechoic linear structures corresponding to suture fragment. On color Doppler, the periphery has increased vascularity due to inflammation.

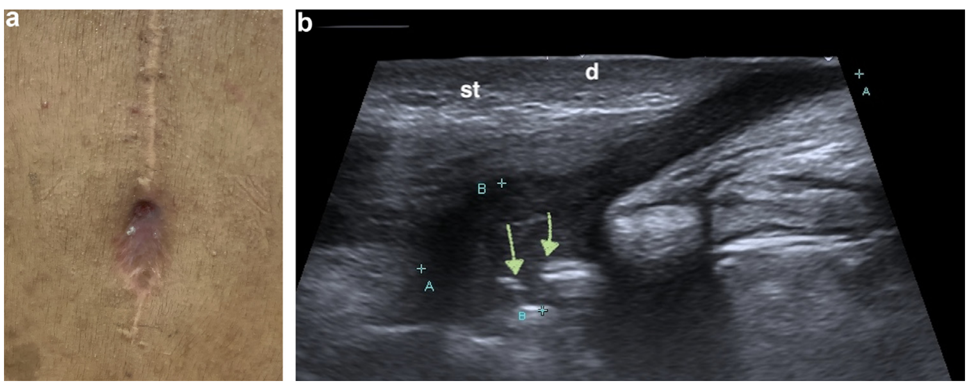

Figure 28. (a) Clinical image of a patient after abdominoplasty, in the periumbilical region, there is an erythematous lesion with continuous serohematic drainage.(b) Longitudinal grayscale ultrasound demonstrates a tubular, hypoechoic structure compatible with a fistula with partially defined edges. Its length is delimited by the calipers (A+) and its thickness by the calipers (B+). Inside, there are hyperechoic linear structures (green arrows) corresponding to non-degraded fragments of sutures and a foreign body granulomatous reaction in the periumbilical region.

interconnected, with irregular distribution, and increased vascularity on color Doppler (Fig. 29a, 29b).

Post-abdominoplasty and liposuction, fibrosis, morphea and keloids may also appear (Fig. 30).

The transferred autologous fat may not degrade and may form solid masses with an extensive calcified component [40] (Fig. 31a, 31b).

Among the complications of non-surgical aesthetic procedures, is, for example, paradoxical lipodystrophy following cryolipolysis with an increase in fat volume, contrary to the desired aesthetic effect [64] (Fig. 32a, 32b).

RECOMMENDATION 12: It is recommended that specific intrinsic patterns and anatomical features should be reported in facial fillers and complications (majority consensus (11/15), Pro: 73%).

RECOMMENDATION 13: A report detailing complications should always be written (strong consensus (15/15), Pro: 100%).

Report and storage recommendations

A detailed written report of the findings is essential following a dermatologic ultrasound (US) in aesthetic applications. The images should

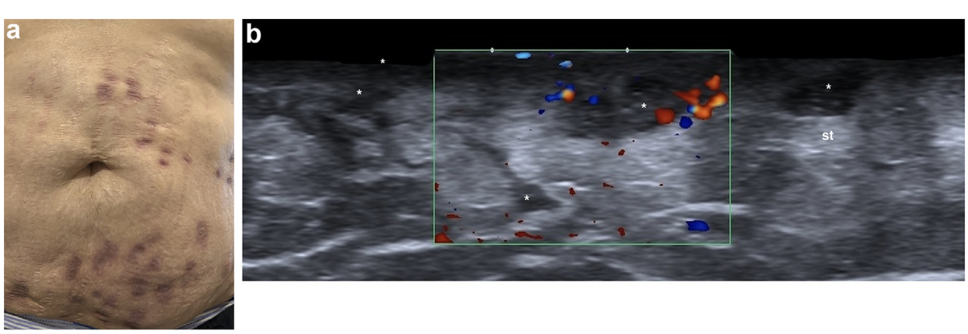

Figure 29. (a) Clinical image of a female patient after abdominoplasty, she is developing multiple painful erythematous lesions one month after the procedure. (b) Color Doppler ultrasound, axial image shows multiple nodular and anfractuous structures (*) located in the dermis and subcutaneous tissue (st). They have poorly irregular edges and present increased vascularity in the vicinity.

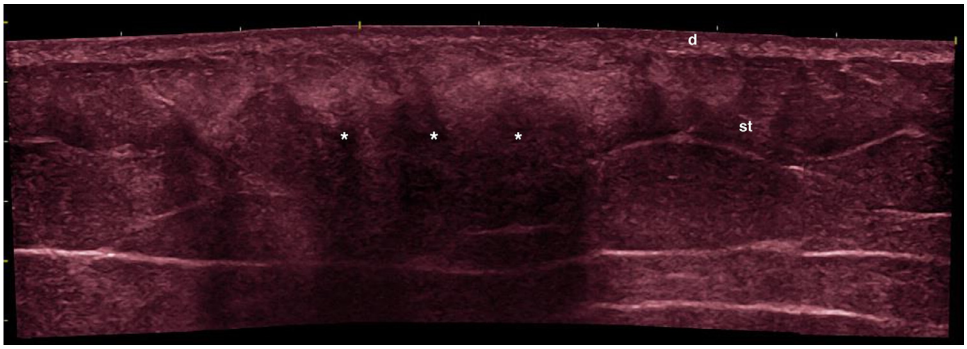

Figure 30. Transverse view image, grayscale ultrasound (with color filter) in the extended field of view of the abdominal wall after abdominoplasty. There are irregular heterogeneous, hyperechoic and hypoechoic areas (*) along the subcutaneous tissue (st) corresponding to areas of fibrosis.

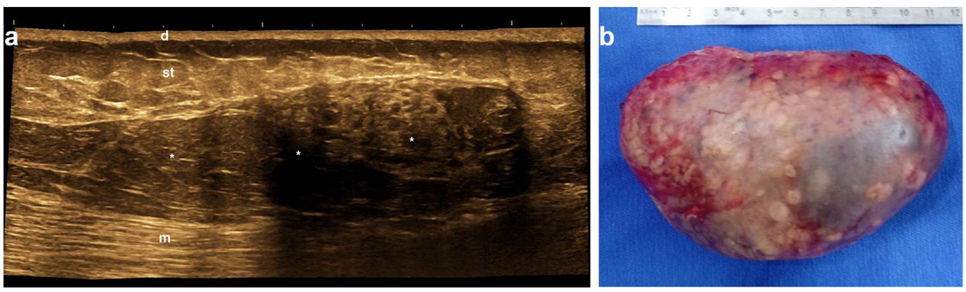

Figure 31. (a) Gray scale (with color filter) ultrasound, transverse view of the gluteal region shows a subaponeurotic mixed- echogenicity mass, predominantly hypoechoic, and elongated. (*) The structure presents some hyperechoic septa and oval-shaped anechoic areas and zones with posterior acoustic shadowing artifact that suggests the development of fat necrosis with calcifications. This palpable mass appeared after an autologous fat transfer. Subcutaneous tissue (st); muscular plane (m); dermis (d). (b) The macroscopic piece of the surgically removed mass, you can see the multiple calcified foci inside it and the similarity with the ultrasound findings.

be stored together with the report, preferably in a computer-based picture archiving and communication system (PACS) and electronic patient records (EPR). It is also essential to document the precise anatomical location of the US findings, using anatomical position markers or text annotations within the images to indicate the location of the findings.

Dermatologic US examinations should be correlated with clinical and histologic results. Interdisciplinary collaboration among physicians involved in dermatological diagnosis and treatment — such as radiologists, dermatologists, plastic surgeons, and pathologists — is highly recommended [1].

Ultrasound report — dermatologic aesthetic application

An ultrasound report should always be issued. However, given the lack of consensus on formatting ultrasound reports in aesthetic medicine, the following suggestion is offered as a potential reporting model.

Indication/clinical complaint: (*e.g.,* Pre-procedure mapping, filler evaluation, post-procedure complication, nodule, fibrosis, inflammation)

Technical details:

- Ultrasound system
- Transducer Type and Frequency
- Mode(s) Used: B-mode, Color Doppler, Power Doppler, Spectral Doppler
- Region(s) Examined: (Specify side and area — *e.g.,* right nasolabial fold, upper lip, glabellar region, zygomatic area, etc.)

Findings (B-mode):

- Epidermis + dermis in mm — specify by region if relevant
- Subcutaneous Tissue: (Normal, increased echogenicity, edema, fibrosis, calcifications, etc.)

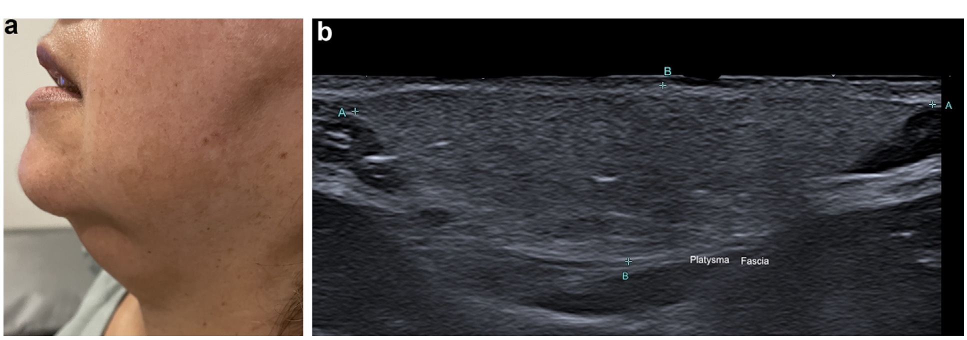

Figure 32. (a) Clinical image of the submental region of a female patient who developed a lump in this area after cryolipolysis. (b) Axial grayscale ultrasound of the submental region demonstrates an isoechogenic structure compared to the subcutaneous fat of the submental region, extending from the hypodermis to the platysmal fascia. Calipers (A +) show its anteroposterior diameter, Calipers (B +) delimit its transverse diameter. The lesion is a paradoxical lipodystrophy.

- Filler/biostimulator Presence:
  - Not detected
  - Hypoechoic / anechoic/ heterogeneous deposits
  - Artifacts: comet tail, posterior acoustic shadowing, posterior reverberance
  - Size variation (minor and major diameters)
  - Layer: (*e.g.,* dermal, superficial or deep subcutaneous fat tissue, SMAS, supraperiosteal)
  - Region: (*e.g.*: glabella, temple)
- Complications (if relevant *e.g.* Nodules, panniculitis, fluid collections):
  - Size: __ x __ x ___mm
  - Echogenicity and echotexture
  - Margins: (well-defined / poorly defined/ undefined)
  - Surrounding alterations
- Other Findings: (*e.g.,* fibrosis, granulomas, vascular complications, relevant anatomical variations)

Doppler assessment:

- Vascularity:
  - Normal
  - Increased vascular signal
  - Absent flow
- Vascular Mapping (if performed):
  - Arteries and veins visualized in relation to anatomical landmarks
  - No signs of compression or obstruction
  - Suspected vascular compromise (describe)

Impression:
Summarize key findings using standard terminology. For example:

- Presence of filler/biostimulators/threads (indicate which, layer, and region).
- Type of Complication (if relevant)
- Other findings

Comments: (*e.g.*: Clinical follow-up, referral to dermatology or plastic surgery, follow-up ultrasound, intervention under US guidance, etc.)

Standardized scanning planes

Facial regions

- **Forehead:**
  - Transverse Plane: Probe oriented horizontally above the eyebrows.
  - Sagittal Plane: Probe oriented vertically along the midline.
- **Glabella:**
  - Transverse Plane: Probe placed horizontally between the eyebrows.
  - Sagittal Plane: Probe aligned vertically over the glabellar region.
- **Temple:**
  - Transverse Plane: Probe positioned horizontally over the temporal fossa.
  - Coronal Plane: Probe aligned vertically over the temporal fossa
- **Cheeks (midface):**
  - Transverse Plane: Probe placed horizontally over the zygomatic arch.
  - Sagittal Plane: Probe aligned vertically from the infraorbital rim to the mandible.
- **Nasolabial fold:**
  - Oblique Plane: Probe oriented along the nasolabial fold from the nose's ala to the mouth's corner.
- **Lips:**
  - Transverse Plane: Probe placed horizontally across the upper and lower lips.
  - Sagittal Plane: Probe aligned vertically at the midline of the lips.
- **Chin:**
  - Transverse Plane: Probe positioned horizontally over the mental protuberance.
  - Sagittal Plane: Probe aligned vertically along the midline of the chin.

Neck region

- Transverse Plane: Probe placed horizontally at various levels to assess structures like the submandibular gland and submental region.
- Sagittal Plane: Probe aligned vertically along the submandibular gland and the midline.

Body regions (*e.g.*, abdomen, buttocks, limbs)

- Transverse Plane: Probe placed horizontally over the area of interest.
- Sagittal Plane: Probe aligned vertically over the area of interest.
- Oblique Plane: Probe oriented at a 45-degree angle to assess structures not aligned with standard planes.

Documentation and reporting

- Image Storage: Save representative images of each scanned plane, ensuring the inclusion of any pathological findings.
- Annotations:
  - Indicate the scanning plane and anatomical landmarks.
  - Note the depth and size of any fillers or complications.

RECOMMENDATION 14: A report should always be issued whenever ultrasound is used in aesthetic medicine (majority consensus (11/15), Pro: 73%).

RECOMMENDATION 15: The indication for carrying out aesthetic US should be added to the report; for example, diagnostic ultrasound pre-filler injection, a vascular map identifying anatomical variants, ultrasound for the guidance of hyaluronidase, etc (strong consensus (15/15), Pro:100%).

RECOMMENDATION 16: The reports for US aesthetic guidance procedures should always be done and delivered to patients according to country regulations (broad consensus (12/15), Pro: 80%).

RECOMMENDATION 17: The key images (pictures and/or clips) should be recorded and saved if used as a diagnostic tool for US aesthetic guidance procedures. They should always be delivered to patients and maintained on the institutions' platforms according to the country's regulations (strong consensus (15/15), Pro: 100%).

RECOMMENDATION 18: A signed consent form should always be required for invasive procedures (majority consensus (11/15), Pro: 73%).

RECOMMENDATION 19: In the report, it is essential to specify whether the procedure is an ultrasound-assisted examination or an ultrasound-guided injection (strong consensus (15/15), Pro: 100%).

Training (basic and CME) and future accreditation processes

Continuing Medical Education (CME) in ultrasound of aesthetics is strongly needed; for that, mixed theoretical and hands-on courses are required.

The existence of accredited programs for that purpose remains a challenge that needs to be filled.

In the future, the performance of aesthetic ultrasound studies should be more standardized and regulated. This includes the recommended and accredited professionals for performing these examinations, the methodology of the exams, the minimum requirements, and the levels of complexities in the curricula of the operators in charge of the examinations.

According to our results, only physicians should perform ultrasound examinations in aesthetic medicine (majority consensus (11/15), Pro: 73%). However, this will vary according to each country's formal regulations (majority consensus (11/15), Pro: 73%).

RECOMMENDATION 20: only physicians should perform ultrasound examinations in aesthetic medicine (majority consensus (11/15), Pro: 73%). However, there are differences in regulations depending on each country's policies.

RECOMMENDATION 21: specific recommendations for different personnel performing US-guided procedures should be established (majority consensus (11/15), Pro: 73%).

Concerning training, we recommend the type of training and qualifications the physician requires to demonstrate competence in using ultrasound in aesthetic examinations with continuing medical education, at least once a year CME, and 100 studies per year to maintain competence in US guidance procedures.

RECOMMENDATION 22: physicians must demonstrate competence in using ultrasound for aesthetic examinations through specific qualifications and training, supplemented by annual Continuing Medical Education (CME) (broad consensus (11/13), Pro: 85%).

RECOMMENDATION 23: a minimum of 100 studies per year to maintain proficiency in guidance procedures (majority consensus (9/12), Pro: 75%).

Many courses with various levels of training are required to standardize the education and training in aesthetic US. As well as basic B-mode US knowledge of facial and other corporal regions anatomy and its anatomical variants, and a comprehensive knowledge of color Doppler and spectral Doppler, the ultrasonographic patterns of fillers, implants, and other aesthetic agents are also required.

Additionally, there is a need for standardizing training and knowledge to carry out ultrasound-guided aesthetic invasive studies such as diagnostic ultrasound pre-filler injection and ultrasound for guidance of hyaluronidase.

RECOMMENDATION 24: Percutaneous ultrasound guidance training could be acquired through hands-on courses and then, a local practice of the operator (broad consensus (14/15), Pro: 93%).

MAIN recommendations for the use of ultrasound in aesthetic procedures

1. Pre-procedural assessment

- Detection and identification of previously injected common cosmetic fillers or the performance of other cosmetic procedures [2,6,7,65].
- Vascular mapping: Utilize Doppler ultrasound to identify and map facial arteries and veins prior to filler injections to reduce the risk of intravascular complications [16].
- Anatomical evaluation: Assess skin thickness and subcutaneous tissue for appropriate injection depths and techniques [66].

2. Intra-procedural guidance

- Real-time monitoring: Employ ultrasound to guide needle placement during filler injections, ensuring accurate delivery and avoiding critical structures [67].
- Immediate Complication Detection: Detect inadvertent intravascular injections or tissue anomalies promptly during procedures [41,68].

3. Post-procedural evaluation

- Complication assessment: Use ultrasound to identify and characterize post-injection complications such as overfilling, edema, inflammation, granulomas, or vascular occlusions [16,69,70].
- Treatment Monitoring: Monitor the efficacy of interventions like hyaluronidase injections in dissolving unwanted filler material [41,69,70].

4. Management of complications

- Vascular occlusion: In cases of suspected vascular compromise, ultrasound aids in confirming the diagnosis and guiding targeted treatment [57,66,71−73].
- Infection and Inflammation: Differentiate between infectious and inflammatory processes in post-procedural complications using ultrasound imaging [16].

5. Patient selection and education

- Risk stratification: Identify patients with anatomical variations or pre-existing conditions that may increase procedural risks [66]. Identify previous fillers, such as permanent fillers, before starting a new treatment, as it increases the risk of complications [74].
- Informed Consent: Use ultrasound findings to educate patients about potential risks and expected outcomes, enhancing informed consent processes [66,75].

Discussion of controversial points and limitations

This paper explores the basic knowledge, challenges, and perspectives of establishing standardized practices for using ultrasound in aesthetic procedures. Given the increasing application of ultrasound in aesthetic medicine, clear guidelines are imperative to ensure the quality and safety of treatments. However, as our discussions and research findings demonstrate, there are significant areas where consensus is yet to be reached. Some discrepancies were also present in this group, addressing the lack of uniformity in reporting practices, the specificity of ultrasound-guided procedures, the scope of examinations conducted, and the training requirements for practitioners. The issues raised reflect both the complexity of clinical applications and the variety of approaches among experts that come from different subspecialties, highlighting the importance of ongoing dialogue and collaborative research for advancing standards in aesthetic ultrasonography.

Although it is agreed that a report should always be issued when ultrasound is utilized in aesthetic medicine, there is no consensus on whether a standardized reporting template is necessary, with opinions split evenly (50% in favor).

There is a broad consensus (11/13 − 85% agreement) that reports for ultrasound-guided procedures in aesthetics should always be issued. However, there is no agreement on the recipient of these reports, whether they should be provided to patients or primary care physicians, which can be affected by the country's regulations. Additionally, there is no consensus on the level of detail required in these reports, whether they should offer a general overview of the procedure, including essential information such as the name (generic or brand) of the product injected, its dosage, and injection area, and the patient's condition upon discharge, or if they should include comprehensive details like the type of ultrasound machine, transducer frequency, use of color Doppler, the needle or cannula used, detailed product information (name and dosage), injection or drainage area, and the patient's condition upon discharge. Opinion on this matter is evenly divided (50% for each).

The discussion also covered whether operators should limit their procedures exclusively to the target area when addressing complications in facial treatments. Although there was a majority consensus (10/15-66.7%) favored this approach.

Another point of discussion was whether operators should perform a full-face ultrasound scan or if a regional focus is sufficient. This topic was equally divided (50% x 50%) and remains unresolved, even after being included in the questionnaire for a second round. This can be explained by the multidisciplinary composition of this group, which gathers dermatologists, plastic surgeons, and radiologists. Presumably, radiologists would be more prone to perform a full-face study than clinicians.

Regarding training for the diagnostic use of ultrasound in aesthetics, there was no consensus on the number of studies required annually. The majority opinion supports 300 exams per year (7/12, 58.3%). However, there was a majority agreement (11/15, 73.3%) that a minimum of 100 per year is necessary for ultrasound-guided procedures in aesthetic ultrasound. The numbers are similar to the ones reported in the dermatologic and other ultrasound field guidelines reported in the official journal of scientific societies [2].

Despite the aesthetic ultrasound field's growth, it is still necessary to have stronger empirical evidence, refine training and competency guidelines, address inter-operator variability, explore AI-driven advancements, and expand the discussion on safety and ethical considerations. Thus, the consensus might be a way to start building solid evidence in this field.

Future perspectives

The integration of artificial intelligence (AI) into aesthetic ultrasound represents an emerging frontier with significant potential to reshape clinical practice. Although peer-reviewed literature specifically addressing this topic remains limited, early studies suggest that AI can enhance diagnostic accuracy, standardize imaging protocols, automate image analysis, and support real-time clinical decision-making. In facial aesthetics, where anatomical variability and operator dependence are common challenges, AI offers promising solutions. Recent advancements include algorithms for image enhancement, real-time procedural guidance, post-procedural complication assessment, and personalized treatment planning. These applications improve procedural precision and safety and contribute to workflow optimization and clinical training support [76].

Nonetheless, significant challenges remain, including data variability, ethical considerations, and the need for practitioner training. The successful integration of AI into aesthetic ultrasound will require collaborative efforts to develop standardized guidelines, validate AI tools across diverse clinical settings, and ensure equitable access to emerging technologies.

In summary, the convergence of AI and aesthetic ultrasound can potentially set new diagnostic and therapeutic outcomes standards, offering more precise, safer, and personalized care. Continued investment in research and innovation will be essential to fully realize the clinical impact of this technology.

Conclusion

In conclusion, there is a significant need for guidelines to standardize the application of dermatologic ultrasound in aesthetics to ensure the quality and proper utilization of this technique. The recommendations provided in this position paper aim to support this objective and offer a foundation for conducting these examinations in both clinical practice and scientific research.

Summary of recommendations

	Recommendation
Safety protocols/ disinfection	1. US examinations and guided procedures require proper safety protocols to minimize the risk of infection (strong consensus (15/15), 100%)
Scanning techniques	2. Color Doppler is required in all aesthetic studies (broad consensus, Pro: 80%; 12/15). 3. Pulsed Doppler/ spectral analysis is essential for ruling out vascular occlusion or vascular mapping (majority consensus (11/15), Pro: 73%).
Technical considerations (requirements)	4. The minimum requirement of frequency for practicing aesthetic ultrasound examinations is 15 MHz. (broad consensus (12/15), Pro 80%) 5. Ultra-high frequency transducers provide better discrimination of the structures, since the axial spatial resolution of 70 MHz is 30 μm, similar to the lower magnification of histology. (broad consensus (12/15), Pro 80%). 6. Future work is needed to clarify the role of ultraportable devices for the identification and discrimination of fillers using different frequencies and their limitations (strong consensus (15/15), Pro 100%). 7. Training in this field is required to properly handle equipment used in aesthetic dermatologic ultrasound and to understand its limitations. (strong consensus (15/15), Pro 100%). 8. The different types of ultrasound equipment used in aesthetic examinations (frequency, characteristics) should be described in the report. (strong consensus (15/15), Pro 100%).
Basic image interpretation	9. Knowledge of facial anatomy and soft tissue anatomy of other regions being treated and comprehensive knowledge of color Doppler and spectral Doppler are needed to perform aesthetic medicine safely and effectively (broad agreement, (14/15), Pro: 93%) 10. The aesthetic ultrasound examination requires knowledge of all facial structures (head, skin layers, subaponeurotic fatty tissue, muscles, blood vessels, nerves, salivary glands, lymph nodes, ear, nose, and lip) (majority consensus (11/15), Pro 73%)
Vascular anatomy of the face	11. The sonographic grey scale and vascular mapping of the face is recommended before cosmetic procedures are performed, especially due to some patients forgetting to mention previous procedures with fillers, threads, and because of the possibility of subclinical pathology such as granulomas, cysts, and lymph nodes. (broad agreement (14/15), Pro: 93%)
Ultrasound evaluation of complications	12. It's recommended that specific intrinsic patterns and anatomical features should be reported in facial fillers and complications (majority consensus (11/15), Pro: 73%) 13. A report detailing complications should always be written (strong consensus (15/15), Pro: 100%)
Report and storage recommendations	14. A report should always be issued whenever ultrasound is used in aesthetic medicine (majority consensus (11/15), Pro: 73%). 15. The indication for carrying out aesthetic US should be added to the report; for example, diagnostic ultrasound pre-filler injection, a vascular map identifying anatomical variants, ultrasound for the guidance of hyaluronidase, etc. (strong consensus (15/15), Pro:100%). 16. The reports for US aesthetic guidance procedures should always be done and delivered to patients according to country regulations (broad consensus (12/15), Pro: 80%). 17. The key images (pictures and/or clips) should be recorded and saved if used as a diagnostic tool for US aesthetic guidance procedures. They should always be delivered to patients and maintained on the institutions' platforms according to the country's regulations (strong consensus (15/15), Pro: 100%). 18. A signed consent form should always be required for invasive procedures (majority consensus (11/15), Pro: 73%). 19. In the report, it is essential to specify whether the procedure is an ultrasound-assisted examination or an ultrasound-guided injection (strong consensus (15/15), Pro: 100%).
Training (basic and CME) and future accreditation processes	20. Only physicians should perform ultrasound examinations in aesthetic medicine (majority consensus (11/15), Pro: 73%). However, there are differences in regulations depending on each country's policies. 21. Specific recommendations for different personnel

(*continued*)

performing US-guided procedures should be established (majority consensus (11/15), Pro: 73%).
22. Physicians must demonstrate competence in using ultrasound for aesthetic examinations through specific qualifications and training, supplemented by annual Continuing Medical Education (CME) (broad consensus (11/13), Pro: 75%)
23. A minimum of 100 studies per year to maintain proficiency in guidance procedures (majority consensus (9/12; three declined), Pro: 75%).
24. Percutaneous ultrasound guidance training could be acquired through hands-on courses and then, a local practice of the operator (broad consensus (14/15), Pro: 93%).

Conflict of interest

The authors declare no competing interests.

Acknowledgments

We kindly acknowledge Mrs. Lynne Rudd for her continuous help and motivation. We thank Dr. Anthony Rudd for his review of the text.

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