


Identification and Complications of Cosmetic Fillers

Sonography First

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 Article includes CME test

The Sound Judgment Series consists of articles highlighting the clinical value of using ultrasound in specific clinical diagnoses where ultrasound has shown comparative or superior value. In many cases, these articles support the practice of using ultrasound first. The series is meant to serve as an educational tool for medical and sonography students and clinical practitioners and may help integrate ultrasound into clinical practice.

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Abbreviations

CaHA, calcium hydroxyapatite; CT, computed tomography; HA, hyaluronic acid; MRI, magnetic resonance imaging; PAAG, polyacrylamide gel; PMMA, polymethylmethacrylate

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Cosmetic fillers are frequently used these days for enhancing beauty and to treat wrinkles or sagging skin. However, information on the history of injections may be difficult to obtain, and there is a growing number of reports on complications with these agents. In contrast to other imaging techniques, sonography has been successfully used for detecting and identifying common types of cosmetic fillers and has become the first-line imaging modality to deal with these exogenous components.

Key Words—cosmetic fillers; cosmetic fillers, ultrasound; dermatologic ultrasound; fillers; fillers sonography; fillers ultrasound; skin ultrasound

Cosmetic fillers are composed of exogenous deposits of nanoparticles or microspheres that are used for enhancing beauty and to treat wrinkles or sagging skin.^{1,2} According to data of the American Society for Aesthetic Plastic Surgery,³ there has been a 279% increase in the total number of cosmetic procedures since 1997. Among these, nonsurgical procedures increased by 521%, and in 2013 alone, there were 9.5 million procedures. The injection of hyaluronic acid (HA) is the second most common cosmetic nonsurgical procedure and in 2013 accounted for more than 1.8 million procedures, which was a 31.5% increase in comparison with the previous year. The same data say that injectables overall (ie, all types of cosmetic fillers and botulinum toxin) saw an increase of up to 21% in 2013 and that 57% of these procedures are performed in office facilities.³ The explosive growth of the use of these agents takes place in the context of a sociological phenomenon that seeks

to avoid the devastating effects of aging in an increasingly older population. The skin and especially the face are critical for this increased use because of their great exposure. Sonography has been proven useful for detecting and identifying the most common fillers that are used in clinical practice.⁴⁻⁷ This process can be valuable in cases of complications, in which sonography can support the often difficult treatment of these patients.^{1,8}

Overview and Description of the Problem

Fillers can be divided into biodegradable and inert (non-degradable) subtypes, pure HA being the most typical representative of the degradable ones.^{1,2} The most common synthetic fillers are silicone in its pure or oily forms of presentation, polymethylmethacrylate (PMMA), calcium hydroxyapatite (CaHA), and polyacrylamide gel (PAAG), among others. Additionally, there are some new forms of HA such as high-density HA. This is more viscous and long lasting, due to the mix with some hydrophilic and synthetic molecules, which may turn the usually easily degradable HA into a long-lasting semisynthetic agent.⁹ Hyaluronic acid also has some mixed formulations with lidocaine to prevent pain.¹⁰ On the other hand, silicone oil is not approved by the US Food and Drug Administration for cosmetic practice, although its use is approved off-label in some countries,¹¹ and in other countries, there is a well-known undercover market for silicone oil injections. Polymethylmethacrylate is used in small volumes for soft tissue augmentation in some orthopedic, plastic surgery, or cosmetic procedures¹²; however, there are also some off-label uses of very high volumes of PMMA in some countries.⁴ The use of PAAG has been mostly reported in long-term treatment-induced facial lipoatrophy in patients with human immunodeficiency virus.¹³ Calcium hydroxyapatite has been frequently applied in patients for performing facial augmentation and remodeling the surface of the malar, submalar, zygoma, preauricular, and infraorbital areas.¹⁴

The use of fillers can present several complexities; on one hand, there is a rapidly growing collection of multiple commercial products, and on the other hand, there are patients with often unclear histories of injections who may have consulted several specialists such as dermatologists, plastic surgeons, maxillofacial specialists, otorhinolaryngologists, dentists, or aesthetic professionals in different medical centers and sometimes in various cities or countries for diverse cosmetic procedures. Hence, it may be difficult to cross-reference the information from these various professionals. Moreover, some patients may feel

embarrassed to tell, or they simply do not remember what has been injected into them over time. This factor may be critical in cases with late adverse reactions to fillers because it can be clinically difficult to assess the cause, and furthermore, the symptoms may mimic other dermatologic diseases. Common adverse reactions to fillers include palpable lumps and bumps (nodules), erythematous or edematous regions, and morphea-like (cutaneous scleroderma) or angioedema-like signs. Less common adverse reactions include fistulous tracts or fluid collections, skin necrosis due to intravascular injection of the filler, and secondary capillary or larger-vessel thrombosis.^{1,15,16} To add more complexity to the issue, these clinical features often affect the face because it is the most common site of injection for cosmetic purposes.¹⁷

Use of Sonography to Solve the Problem

Sonography has been reported to detect and identify the most common types of cosmetic fillers.⁴⁻⁷ A multichannel ultrasound machine working with variable high-frequency probes is usually used for identifying these agents. The cases presented in this article were performed with a LOGIQE9 XD Clear machine (GE Healthcare, Milwaukee, WI) using compact linear and linear probes that range between 8 to 18 and 5 to 16 MHz, respectively. A copious amount of gel is applied on the skin to properly focus the probe on the affected skin region using the technique that has already been described for studying localized lesions of the skin on sonography.¹⁸ A grayscale, color or power Doppler, and spectral curve analysis is routinely performed. Panoramic views and 3-dimensional reconstructions (5- to 8-second sweep) are usually used to show the findings better. The settings of the machine include the lowest pulse repetition frequencies and wall filters, as well as color gain below the noise threshold.¹⁹

Under sonography, it has been reported that the term “dermal fillers” is incorrect because most of the agent is actually deposited in the hypodermis, which seems to be in part due to the length of the needles that commonly come with the injection packs.⁴ On sonography, pure HA appears as small anechoic pseudocystic structures that commonly decrease in size in a short time, usually 3 to 6 months.^{4-7,20} Hyaluronic acid mixed with lidocaine usually presents inner echoes within the pseudocystic structures and also lasts 3 to 6 months.⁴ Nevertheless, high-density HA, which is more commonly used in the restoration of the shape of the cheeks and hands, appears as small to medium-size anechoic pseudocystic structures that frequently present some echoes. These are located in the deep hypodermis or close

to the periosteum and are commonly used for volumizing the cheeks. High-density HA deposits seem to decrease in size slowly and present effects that apparently last more than 2 years.^{20,21} Well or poorly defined oval hypoechoic solid nodules may be detected in or at the vicinity of the high-density HA injection sites due to the development of granulomas and local inflammation. Pure silicone appears as oval anechoic lacunar areas that do not change in shape or size over time. In contrast, silicone oil appears as hyperechoic deposits that generate a posterior acoustic reverberation artifact.^{4–7,20} Thus, this blurry white pattern of silicone oil has been named “snowstorm.” Sometimes, mixed formulations of pure and oily forms of silicone can be traceable on sonography, which can also be the result of the merge of pure silicone with the hypodermal fatty tissue after some time. Polymethylmethacrylate appears on sonography as hyperechoic dots with a mini-comet tail posterior artifact.^{4,22} Calcium hydroxyapatite appears on sonography as hyperechoic deposits with a posterior acoustic shadowing artifact due to the presence of calcium.^{4–7,20,22} Polyacrylamide gel appears as anechoic oval pseudocystic structures that commonly do not change their size or shape for at least 18 months.^{6,23} Polyacrylamide gel has also been reported to have increased hypodermal echogenicity in the vicinity of the deposits.²³ Poly-L-lactic acid is another synthetic agent that is used in some countries. It is supposedly a biostimulator that enhances collagen production. It can be used in subcutaneous or supraperiosteal tissues for augmentation of the soft tissues. This agent is diluted in water at the time of injection, but the water is rapidly reabsorbed, usually in the first 2 weeks.^{20,24} On sonography, there is increased echogenicity and thickness at the site of the injection;

however, frequently no focal deposits can be discriminated within the area of abnormal echogenicity.²⁰ On color Doppler imaging, increased vascularity with slow flow and thin arterial vessels may be seen in the vicinity of the filler deposits, especially if there is inflammation.

Even though there are successful reports on the use of cosmetic fillers, at the same time, the number of reports of complications has been increasing in recent years. These adverse reactions are more commonly seen when the patient has a history of injections of 1 or more types of synthetic or nondegradable fillers and is injected with a new degradable or synthetic type, especially in the same region.²⁵ With silicone oil, these adverse reactions can be extremely late in their appearance, may present 8 to 10 years after the injection, and can produce intense disfigurement, especially on the face, usually due to a severe foreign body reaction²⁶ (Table 1 and Figures 1–10).

Other Imaging Methods for Identifying Cosmetic Fillers

Other imaging modalities such as magnetic resonance imaging (MRI) and positron emission tomography–computed tomography (CT) have been used for studying fillers. However, only silicone seems to show a specific pattern on MRI that allows identification. This finding has been reported for studies of the pure silicone formulation present in breast implants and the complications following the rupture of these implants. These studies include sequences that allow differentiation between water, fat, and silicone.^{27,28} Other authors have reported the use of MRI for studying deposits of poly-L-lactic acid and CaHA in the treatment of human immunodeficiency virus–induced lipodystrophy.

Table 1. Sonographic Characteristics of Common Cosmetic Fillers

Filler	Type	Echogenicity	Duration	Comments
Pure HA	Degradable	Anechoic	3–6 mo	Decrease in size over time
HA with lidocaine	Degradable	Anechoic with prominent echoes	3–6 mo	Decrease in size over time
High-density HA	Semidegradable	Anechoic with some echoes	>2 y ^a	Commonly located in deep hypodermis of the cheeks and hands
PAAG	Semidegradable	Anechoic	Up to 18 mo ^a	Increased echogenicity of the surrounding hypodermis
Pure silicone	Nondegradable	Anechoic	No change over time	Similar echogenicity to silicone implants
Silicone oil	Nondegradable	Hyperechoic	No change over time	Snowstorm pattern
PMMA	Nondegradable	Hyperechoic	No change over time	Mini-comet tail posterior artifact
CaHA	Nondegradable	Hyperechoic	No change over time	Posterior acoustic shadowing artifact

^aReported.

However, these patterns seem to be nonspecific and are mostly described as hypointense material with no clear description of the sequences used for this statement.²⁹ Magnetic resonance imaging has also been described for studying a case that had been injected with PMMA in the face.³⁰ Even though the large deposits were visible on MRI as hypointense in this case, there was no additional description of the patterns and sequences used. Additionally, T1-weighted, T2-weighted, and contrast-enhanced sequences have been used for studying PAAG implants in breast tissue, which have shown nonspecific patterns with similar morphologic characteristics as saline implants, being hypointense on T1-weighted and hyperintense on T2-weighted images.³¹ High-density HA has also been described as hypointense on T1-weighted and bright on T2-weighted short-tau inversion recovery images.³² Thus, CT and MRI have been used for evaluating complications after PAAG injections for soft tissue augmentation and for assessing the extent of the deposits of high-density HA in orbital volume enhancement in sighted and anophthalmic orbits.^{32,33} In spite of the fact that neither CT nor MRI shows specific patterns for identifying PAAG or high-density HA deposits, the knowledge of the extent of the deposits can be useful. On the other hand, fillers can also produce hypercaptation areas on positron emission tomography–CT due to inflammation, which may generate false-positive findings or at least difficulties for the correct staging of a malignancy.³⁴

Conclusions

To date, sonography is the first-line imaging modality for dealing with cosmetic fillers. It provides reliable support in the detection, identification, and assessment of the wide range of worldwide commonly used cosmetic fillers. This imaging modality has the potential to support pre-procedure mapping, which may be useful for investigating the presence of previous cosmetic deposits that can complicate subsequent cosmetic procedures. The injection of cosmetic fillers may also have the potential to become a sonographically guided procedure. Moreover, sonography may be used for testing the longevity and anatomic effects of cosmetic fillers. It should be kept in mind that histologic analysis may be limited due to the usually deep hypodermal and sometimes periosteal locations of the deposits. Lastly, the use of sonography can be of paramount importance in the diagnosis of complications derived from the injection of cosmetic fillers that can mimic other dermatologic diseases.

Figure 1. Sonographic characteristics of common cosmetic fillers.

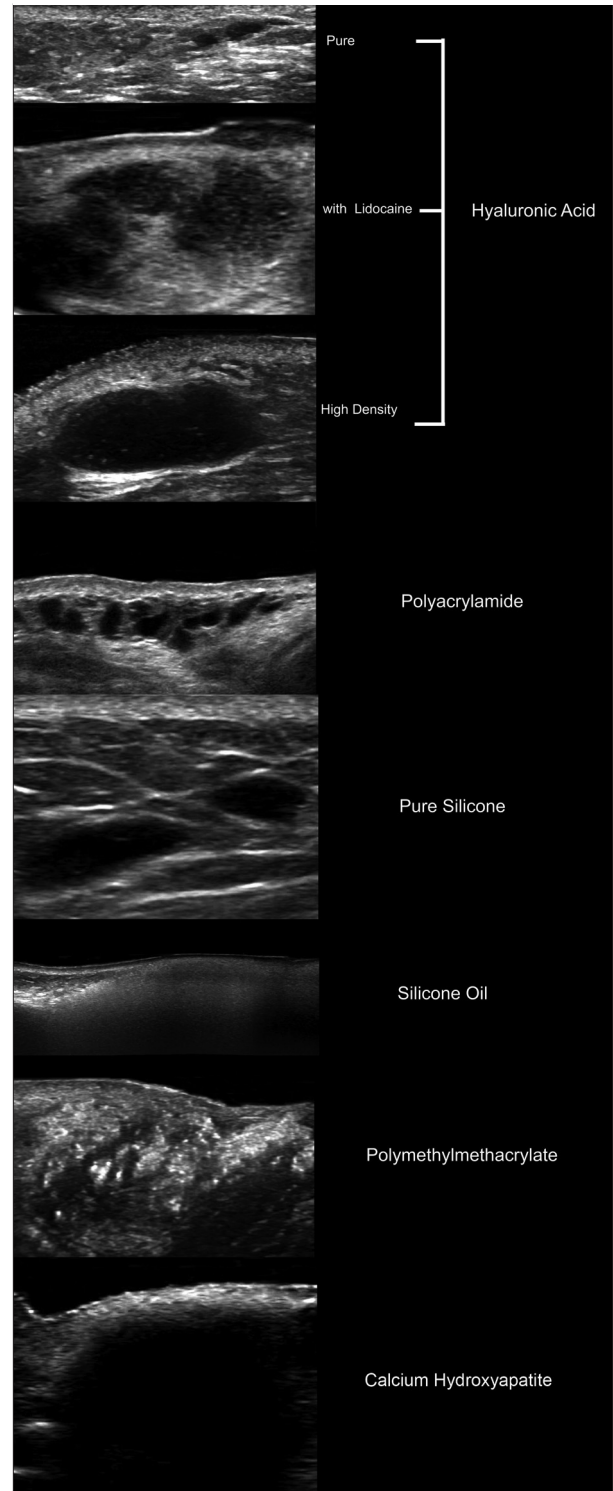


Figure 2. Drawings (A) and key sonographic features (B) of frequent cosmetic fillers.

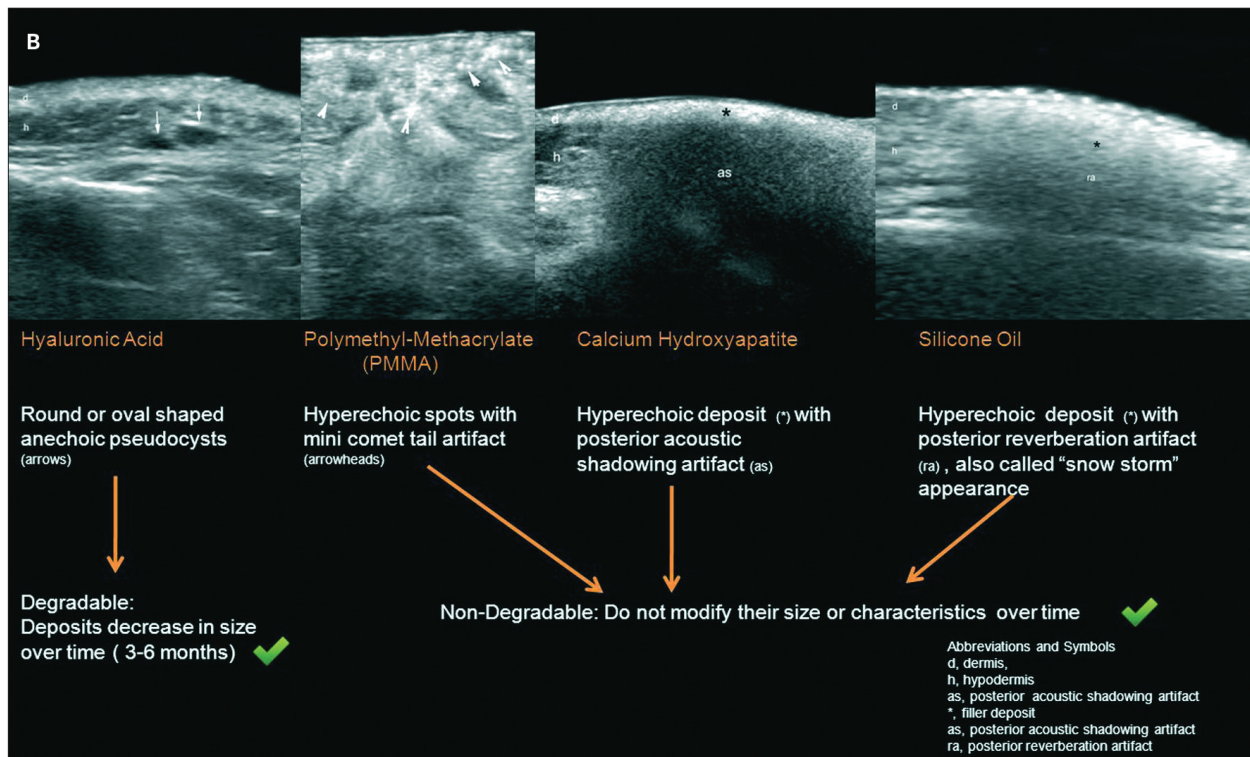
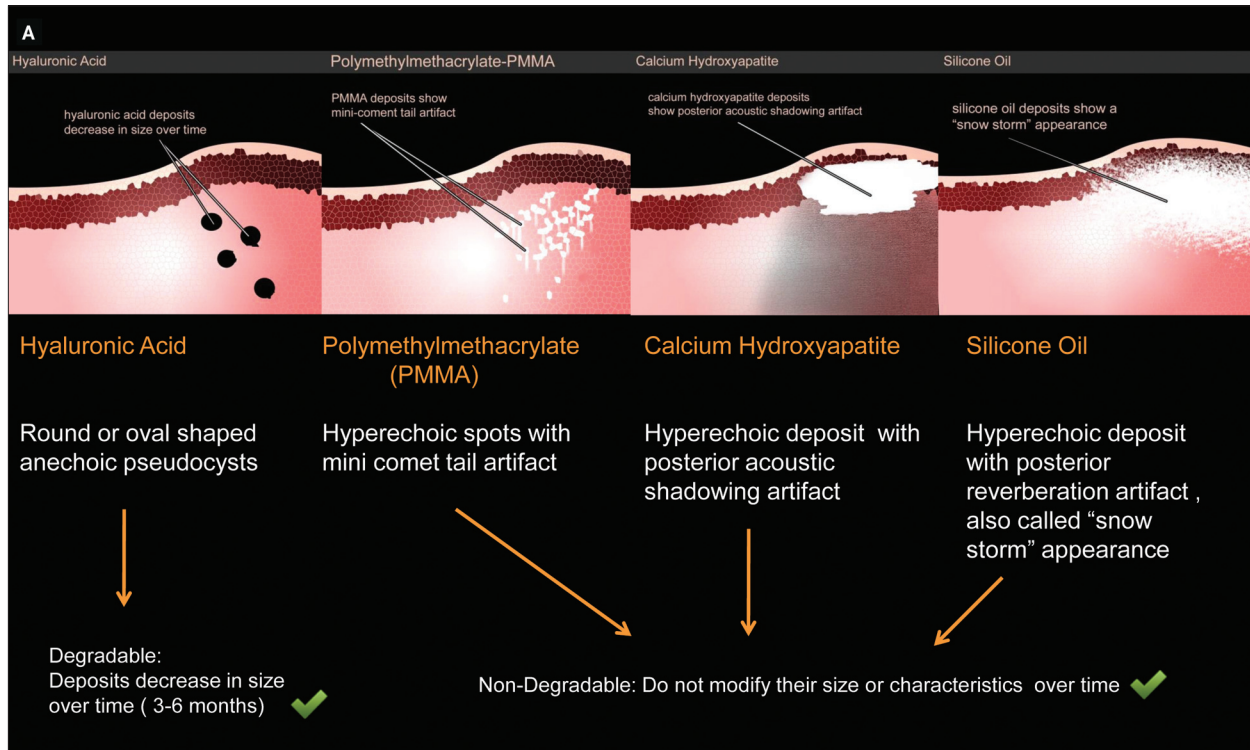




Figure 3. Cyanosis immediately after pure HA injection in a 59 year-old patient. **A**, Clinical appearance. **B**, Three-dimensional grayscale sonogram (longitudinal view, color filter, examination performed 2 weeks after the procedure) showing 2 types of fillers in the same patient: HA (h; outlined) and silicone oil (s) involving the dermis and the orbicularis oris muscles of the upper and lower lips. The presence of silicone oil was clinically unknown at the moment of HA injection.

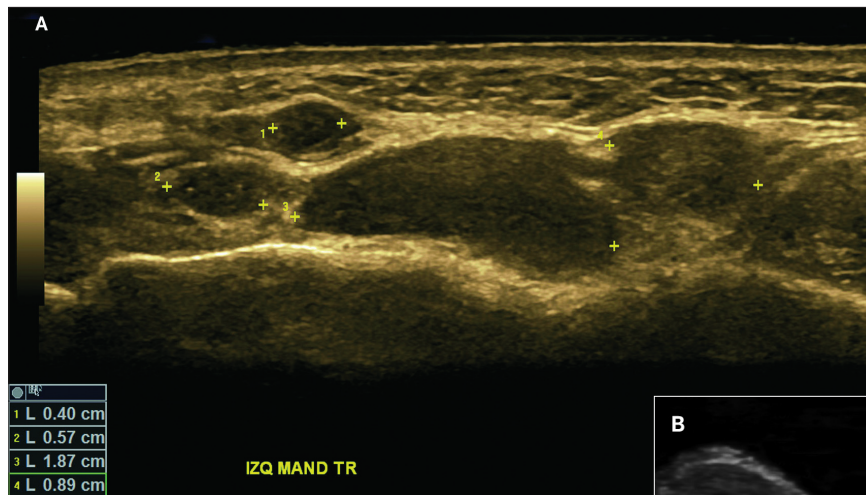
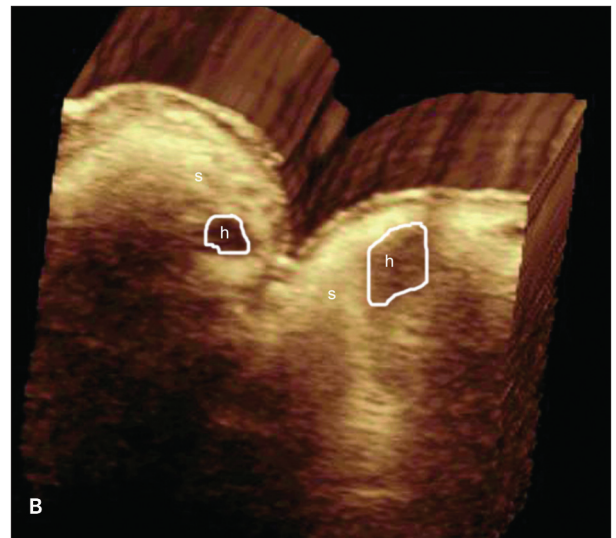


Figure 4. Sonograms of granulomas after high-density HA injection. **A** and **B**, Grayscale sonograms (**A**, transverse view, left mandibular region, color filter, examination performed 8 months after injection; **B**, longitudinal view, lips region, examination performed 1 year after injection) showing 4.0- to 18.7-mm (between markers) hypoechoic oval solid nodules in the hypodermis (**A**) and the dermis and orbicularis oris muscle of the lower lip (**B**).

Figure 5. Panniculitis after injection of high-density HA in a 61-year-old patient. **A.** Clinical appearance showing erythema and edema in the dorsum of the left hand. **B.** Grayscale sonogram (panoramic transverse view, dorsum of the left hand, examination performed 6 months after injection) showing increased echogenicity of the hypodermis (star) with thickening of the septa (o) between the hypodermal fatty lobules.

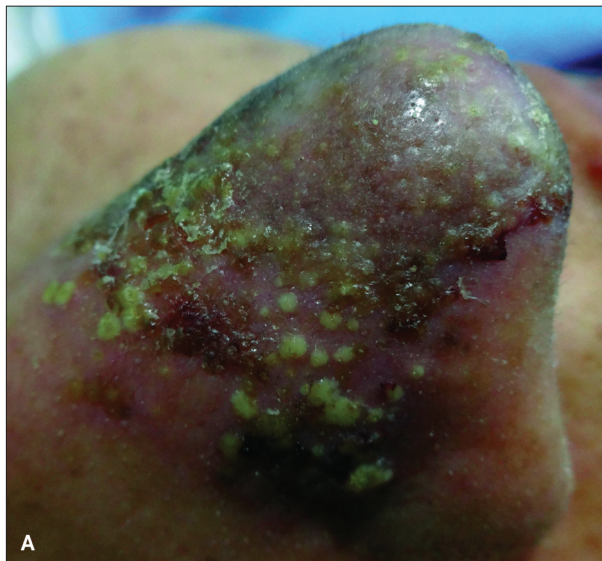
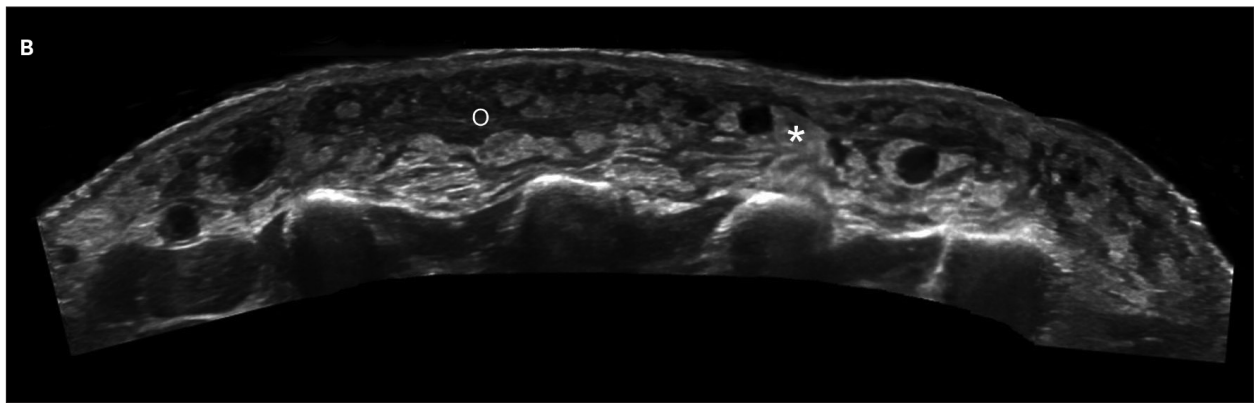


Figure 6. Skin necrosis after HA injection in a 35 year-old patient. **A.** Clinical appearance after a second injection of pure HA. **B.** Color Doppler sonogram (transverse view, examination performed 3 days after injection) showing a subclinical hypoechoic solid nodule that corresponds to a granuloma secondary to a previous HA injection (6 months before). Notice the thickening, hypoechoogenicity, and hypovascularity of the dermis (star) in the mid anterior aspect of the tip of the nose; c indicates cartilage; and g, granuloma.

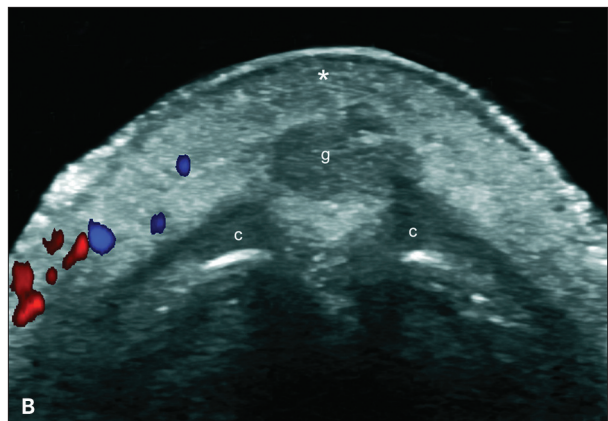


Figure 7. Clinical and sonographic correlations in complications of silicone oil.

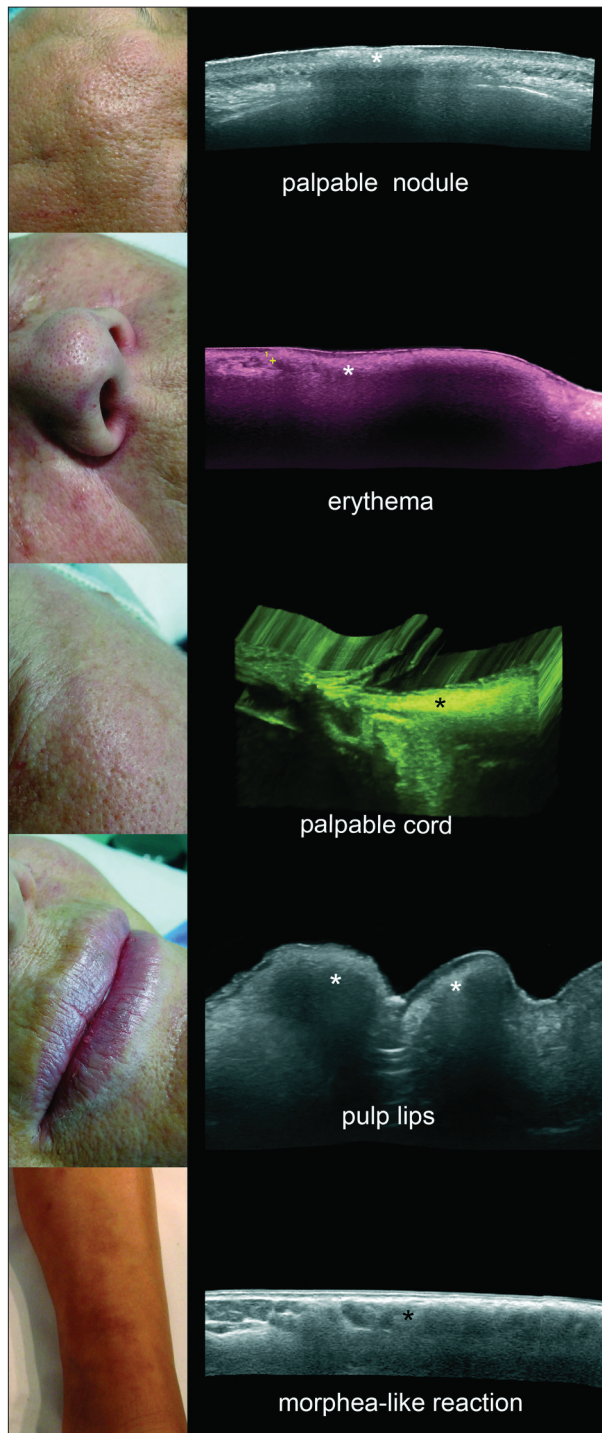


Figure 8. Types of silicone oil involvement in the lips (3-dimensional grayscale longitudinal reconstructions of the upper and lower lips, color filter); asterisk indicates silicone oil deposits; and m, orbicularis oris muscle.

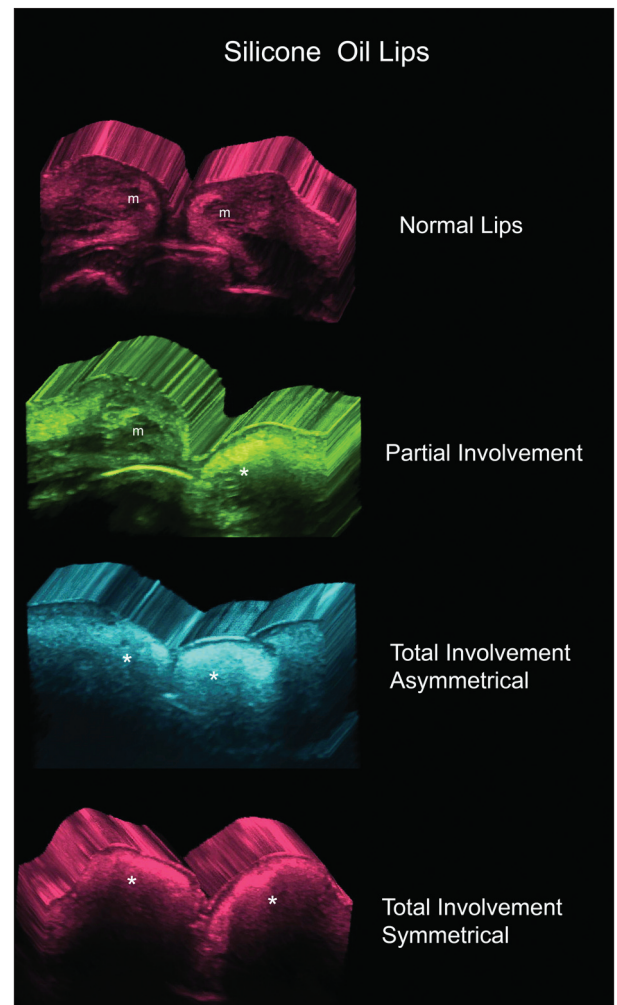


Figure 9. Polymethylmethacrylate. **A.** Grayscale sonogram (transverse view, color filter, upper lip) showing dermal and hypodermal PMMA deposits that also partially involve the upper orbicularis oris muscle (m). **B.** Three-dimensional grayscale reconstruction (transverse view, right nasofold line) showing dermal and hypodermal PMMA deposits. Note the hyperechogenicity and posterior mini-comet tail artifact (arrows) of PMMA.

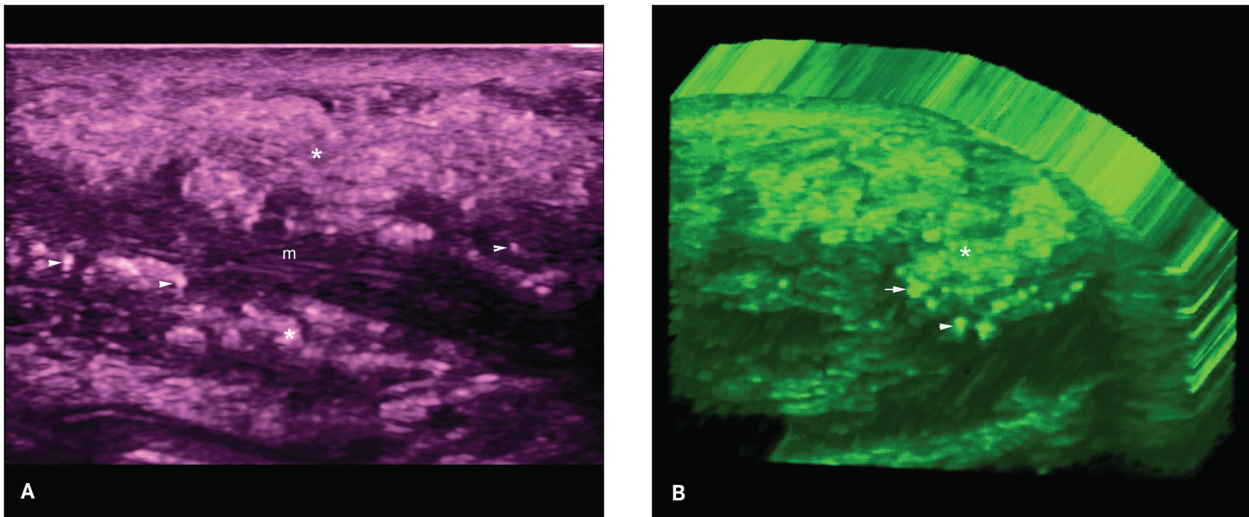
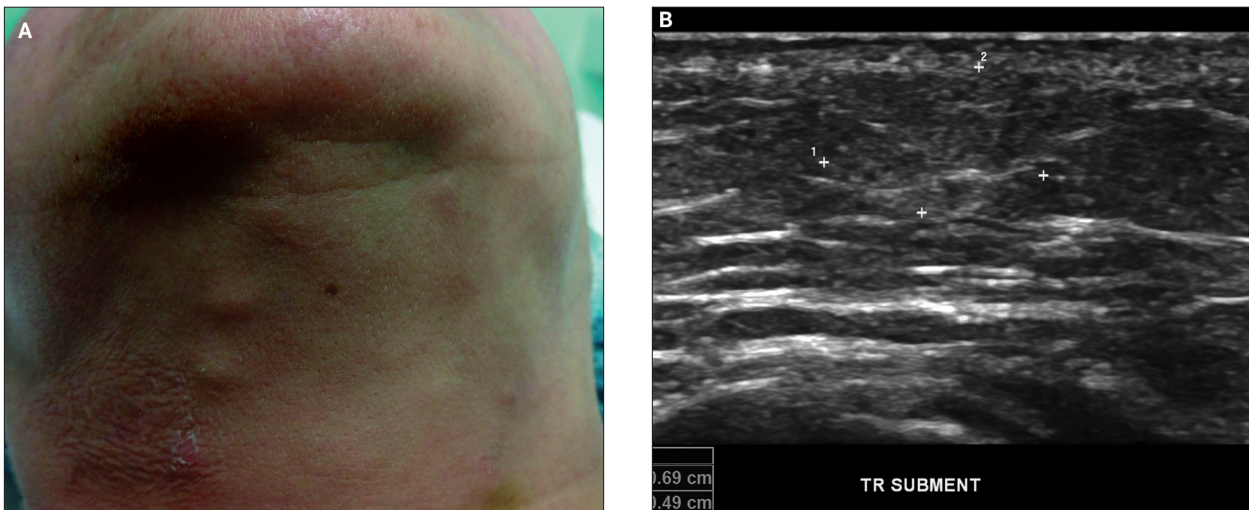


Figure 10. Poly-L-lactic acid complication in a 51-year-old patient. **A.** Clinical appearance showing erythema, edema, and nodules in the anterior neck. **B.** Grayscale sonogram (transverse view) showing a 6.9 × 4.9-mm hyperechoic islet in the hypodermis, suggesting edema in correlation with one of the palpable nodules.



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