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ORIGINAL ARTICLE

Ultrasound detection and identification of cosmetic fillers in the skin

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Abstract

Background While the incidence of cosmetic filler injections is rising world-wide, neither exact details of the procedure nor the agent used are always reported or remembered by the patients. Thus, although complications are reportedly rare, availability of a precise diagnostic tool to detect cutaneous filler deposits could help clarify the association between the procedure and the underlying pathology.

Objectives The aim of this study was to evaluate cutaneous sonography in the detection and identification of cosmetic fillers deposits and, describe dermatological abnormalities found associated with the presence of those agents.

Methods We used ultrasound in a porcine skin model to determine the sonographic characteristics of commonly available filler agents, and subsequently applied the analysis to detect and identify cosmetic fillers among patients referred for skin disorders.

Results Fillers are recognizable on ultrasound and generate different patterns of echogenicity and posterior acoustic artefacts. Cosmetic fillers were identified in 118 dermatological patients; most commonly hyaluronic acid among degradable agents and silicone oil among non-degradable. Fillers deposits were loosely scattered throughout the subcutaneous tissue, with occasional infiltration of local muscles and loco-regional lymph nodes. Accompanying dermatopathies were represented by highly localized inflammatory processes unresponsive to conventional treatment, morphea-like reactions, necrosis of fatty tissue and epidermal cysts; in the case of non-degradable agents, the associated dermatopathies were transient, resolving upon disappearance of the filler.

Conclusions Cosmetic filler agents may be detected and identified during routine ultrasound of dermatological lesions; the latter appear to be pathologically related to the cosmetic procedure.

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Conflict of interest

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Introduction

Fillers are commonly used to counteract the effects of ageing, characterized as reshaping of soft tissues and body features. Ideally, fillers should have long tissue half-life; be biologically inert, i.e., non-reactive with the tissue matrix; and self-aggregate into cohesive structures, i.e., maintain shape and consistency.[1,2] Fillers have low intrinsic toxicity[3] and are now used worldwide for treatment of wrinkles and sagging skin, particularly in the face.

Cosmetic fillers are generally classified into biological and synthetic agents, with the former represented by hyaluronic acid, a degradable and reabsorbable substance of limited tissue life,[4] and the preferred choice of dermatologists. By contrast, synthetic fillers are not easily degraded, have long local life and include silicone and its related derivative dymethylsilosane (also called 'silicone oil'), polymethylmethacrylate (PMMA) and calcium hydroxyapatite.[5] When injected for cosmetic purposes, all fillers are expected to be confined to the dermis,[6,7] to generate the skin elasticity, firmness and strength associated with a younger appearance.[8]

Complications do, however, occur[9] and the identification of the filler and type of filler used may be of great relevance to predict the outcome. Patients may fail to report filler injections because they are not thought of as medical procedures; due to personal

embarrassment or forgetfulness, although fear of reporting the involvement of unauthorized personnel may also influence the decision.

Complications associated with the use of fillers may therefore be predominantly reported in patients who are aesthetically attentive and aware of the cosmetic aspects of any investigative or therapeutic procedure. However, there may also be a population in which the procedure may remain largely unreported; unmasking of these cases may be possible with ultrasound. This non-invasive imaging method allows clear visualization of skin layers and underlying tissues, and may detect common filler agents.[10–13] Furthermore the method may provide additional information, on blood flow or presence of inflammation. We therefore evaluated the sonographic characteristics of filler deposits and of coexisting dermatologic lesions to determine the usefulness of the technique for the diagnosis of complications of filler injections.

Materials and methods

Two studies were performed: an experimental study characterizing the sonographic properties of commonly used fillers and, a review of skin lesions associated with cutaneous filler deposits.

Filler identification procedure

The sonographic properties of cosmetic filler tests were studied *ex vivo* in porcine skin using pharmaceutical preparations of injectable filler agents purchased from a commercial supplier. Freshly cut porcine skin pieces (4 cm^2 each) were injected with fillers at less than 6 h from the time of death; sonograms were performed immediately thereafter. The fillers tested were: hyaluronic acid (Restylene®; Medicis Pharmaceuticals, Scottsdale, AZ, USA, Excellentha®; Ghandour for Medical and Chemicals, Hama, Syria, Elevess®; Anika Therapeutics, Bedford, MA, USA), pure generic silicone, silicone oil (dimethylsilosane, Biogel®; Bio, Santiago, Chile), generic polymethylmethacrylate (PMMA) and generic hydroxyapatite. The procedure was performed under sonographic guidance by a radiologist who performed the injections according to the manufacturer's instructions, using the standard prefilled syringe kits (needle sizes: 25–30G; 10–16 mm long). Post-injection ultrasound showed that the fillers remained highly localized and coalescent at the site of injection (Fig. 2).

In addition, we evaluated the effect of fillers in human skin without pre-existing lesions by performing ultrasound examinations in two patients who received an injection of hyaluronic acid for cosmetic purposes. In these two cases, sonograms were performed before and immediately after the procedure, and at 1, 3 and 6 months after injection; moreover, a skin biopsy was obtained at 2 months after the injection for performing a histological-sonographic correlation.

Clinical cases

To provide an *in vivo* perspective, we review the records of patients with sonographic tests performed for dermatological disorders, and detectable deposits of cosmetic fillers. The criteria for inclusion in the case review were:

1 Sonographic detection of foreign material within the skin.
2 Confirmation from at least two external (non-sonographic) sources (patient, referring physician and/or procedure operator) of a previous filler injection.
3 Finding of a match between the images acquired in patients and the sonographic patterns obtained in porcine skin injected with the commercially available pharmaceutical form of cosmetic fillers.

This review was performed at the Department of Radiology, Clinica Servet (Santiago, Chile; a national referral centre for skin ultrasound examinations). The database contained a total of 10123 consecutive patients who were referred by dermatologists between March 2001 and October 2009 for sonographic evaluation of localized skin lesions. Thus, a cosmetic filler that matched the inclusion criteria was detected in the lesions of 118 patients.

The skin diseases that had prompted the imaging examination were characterized in the referral form which included age, gender, coexisting pathology, lesion characteristics (duration,

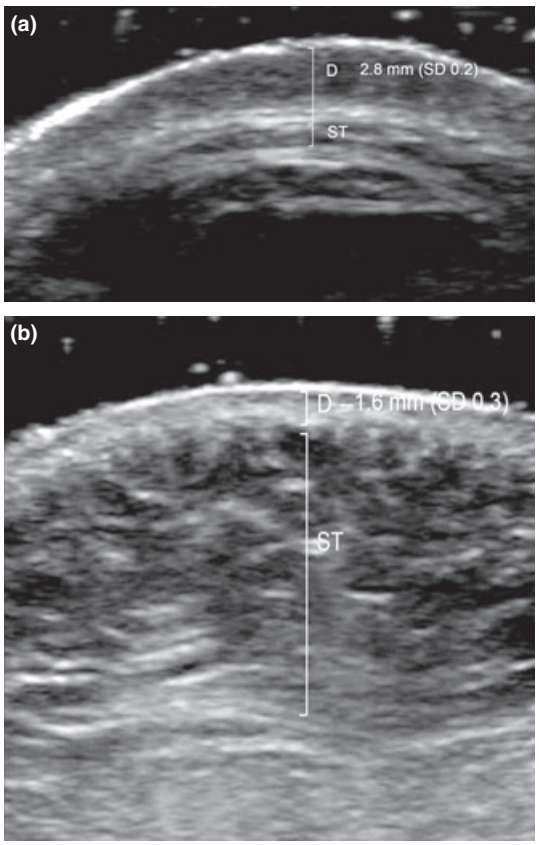

Figure 1 Ultrasound comparison of normal skin (transverse view): (a) porcine and, (b) human (facial). D, dermis; ST, subcutaneous tissue; SD, standard deviation.

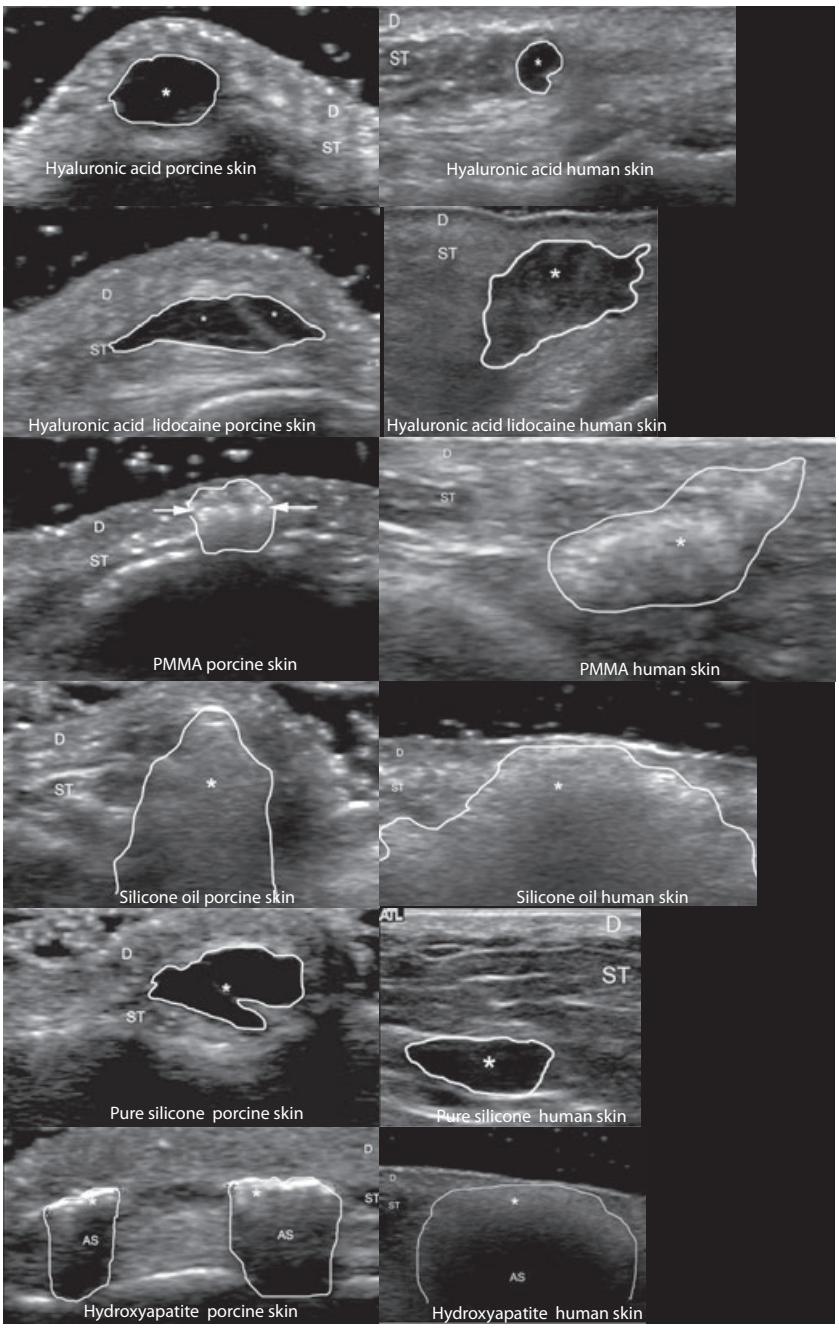

Figure 2 Comparative ultrasound of fillers in porcine skin (*) and in a patient (transverse views): note that echogenicity patterns are similar (filler deposits enclosed within the white line); location is predominantly the subcutaneous tissue. D, dermis; ST, subcutaneous tissue; AS, acoustic shadowing artefact.

location, size and clinical course) and treatment(s). When a cosmetic filler was detected both patient and referring physician or, when available, the performing operator were asked to confirm a previous cosmetic filler injection in the affected area. We excluded from this review patients in whom sonographic alterations suggestive of foreign components injections had been detected in the ultrasound examination, but the deposits did not corresponded to commercially available cosmetic fillers or, the confirmation by at least two external sources (non-sonographic) was not obtained. These cases corresponded to patients who had received mesotherapy, e.g., injections of lipolytic agents (homoeopathic components, plants extracts or vitamins) or autologous

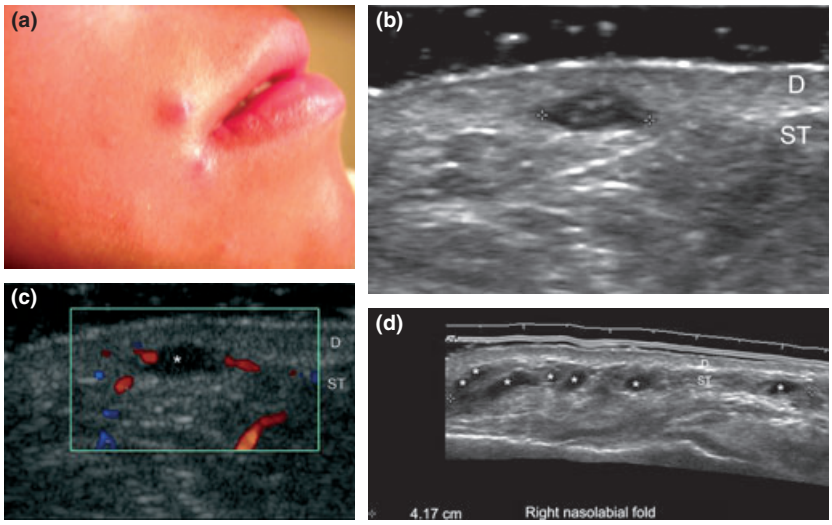

Figure 3 Hyaluronic acid dermatopathy. (a) Swelling and erythema in the right nasolabial fold. (b) Ultrasound (transverse view) showing anechoic epidermal cyst at the dermis/subcutaneous border (between markers). (c) Colour Doppler ultrasound (transverse view): increased blood flow surrounds the cystic structure. (d) Ultrasound (panoramic longitudinal view) of the right nasolabial fold shows multiple anechoic pseudocysts in the subcutaneous tissue corresponding to hyaluronic acid deposits (*). D, dermis; ST, subcutaneous tissue.

fat. Also excluded were three patients claiming to have received collagen injections (not confirmed by a referring physician or procedure operator) and one patient who claimed to have self-injected in the face with petrolatum (vaseline; not an accepted filler agent).

Where available the histology of the lesions were reviewed and correlated to the sonographic image. Neither of the patients had a non-sonographic imaging study (MRI, CT or PET/CT) performed before the ultrasound examination, nor an imaging a study was subsequently requested in any of the cases.

The same radiologist (XW) performed all sonographic examinations that routinely included scanning of the lesional area and loco-regional lymph nodes, and colour Doppler evaluation of local blood flow. The ultrasound system (HDI 5000; Philips Medical Systems, Bothell, WA, USA) was equipped with a compact linear probe of variable frequency (7–15 MHZ). Axial and lateral resolutions were 100 μm/pixel and 90 μm/pixel, respectively. System software included extended field of view, compound image and resolution enhancer (XRES). Neither standoff pads (to adjust focus) nor intravenous contrast media were used.

Control population

Reference data on cutaneous layers echogenicity and thickness were generated in a group of 170 healthy subjects (155 female/15 male; 19–89 years old) who, after giving informed consent, underwent sonography of the frontal midline area and right upper cheek. On ultrasound, the normal dermis, appeared as a hyperechoic structure easily separated from the hypoechoic subcutaneous tissue (Fig. 1). The dermis was 1.4 mm thick (SD: 0.3) at the frontal area and 1.6 mm (SD: 0.3) at the cheek.

Measurements and statistical analysis

Because of large differences in the amounts injected, sonographic measurements of deposit size were expressed in centimetres (cm) for hyaluronic acid, in millimetres (mm) for hydroxyapatite and, in millilitres (mL) for PMMA. Statistical significance was calculated by Student's *t*-tests (SPSS version 16.0; IBM Corporation, Somers, NY, USA). The level of significance was set at $P < 0.05$.

Ethics

The study was approved by the local Institutional Review Board (Clinica Servet) which waived the requirement for consent on the use of sonograms for patients referred for ultrasound of the skin; informed consent was, however, required and obtained for the sonographic study of the two subjects without skin lesions, and for the study in the reference group of healthy controls.

Results

Sonographic characterization of fillers

Biological fillers

Hyaluronic acid. This agent was injected in porcine skin using two available formulations, one corresponded to the pure form and the other one was mixed with lidocaine.[14] Sonographically,

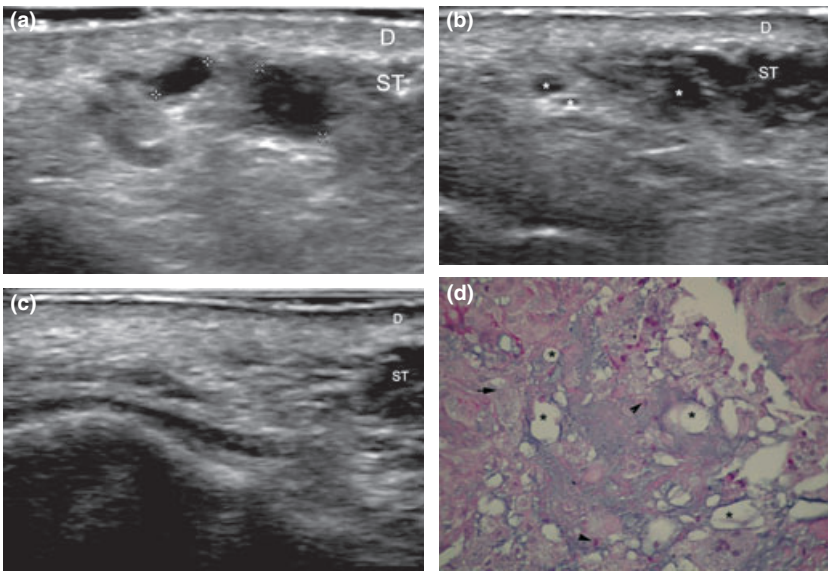

Figure 4 Hyaluronic acid injection: ultrasound of the left nasolabial fold (transverse view). (a) Immediately after injection, anechoic pseudocystic structures (between markers) within the subcutaneous tissue. (b) At 3 months, filler deposits are smaller (*). (c) At 6 months, hyaluronic acid is not detected. (d) Histology (nasofold line, 2 months post-injection; Alcian blue, 40×): sparse histiocytes (arrows) with notable cytoplasmic inclusions (*, micro and macrovacuoles). D, dermis; ST, subcutaneous tissue.

Table 1 Dermatopathies in cosmetic fillers recipients

Dermatological abnormalities* in cosmetic fillers users				
	Hyaluronic acid (*n* = 35)	**Silicone (*n* = 69)**	**PMMA (*n* = 12)**	**Hydroxyapatite (*n* = 2)**
Inflammation (erythema/oedema)	13	69	1	2
Palpable nodules/swelling	25	43	11	0
Cheilitis	0	28	1	0
Morphea-like reaction†	0	4	0	0
Hyperpigmentation	0	2	0	0
Palpable cord	0	2	0	0

PMMA, polymethylmethacrylate.
*Some patients had multiple abnormalities.
†Skin atrophy and tightness.

pure hyaluronic acid appeared as scattered anechoic round structures (pseudocysts) (Figs 2–4). The mixed formulation (hyaluronic acid and lidocaine) presented pseudocysts with inner echoes (debris) and septa (Figs 2 and 5).

The two subjects who had ultrasounds performed serially before and after pure hyaluronic acid injection did not develop any dermatological abnormalities. In these subjects, the filler deposits remained notably coalescent at the injection site, becoming progressively smaller with time: major axis diameter of 4.8 mm immediately after the injection, 2.5 mm at 3 months and undetectable at 6 months (Fig. 4).

Histology of hyaluronic acid-injected skin (pure formulation), performed at 2 months after treatment, was available in the last two cases; it showed resolving inflammatory changes represented by varying degrees of vacuolization in histiocytes, without overt foreign body type reaction.

Synthetic fillers

Silicone. Two forms of silicone fillers were detected: silicone oil and pure silicone. Silicone oil appeared as hyperechoic deposits (snow storm) with high degree of sound scattering (Figs 2 and 6), similar to the pattern reported in patients with ruptured breast implants where the initially anechoic silicone is suddenly expelled and can freely mix and/or spread through the fat lobules of the subcutaneous tissue.[15,16] Thus, pure silicone appears anechoic when injected without pressure in the porcine skin.

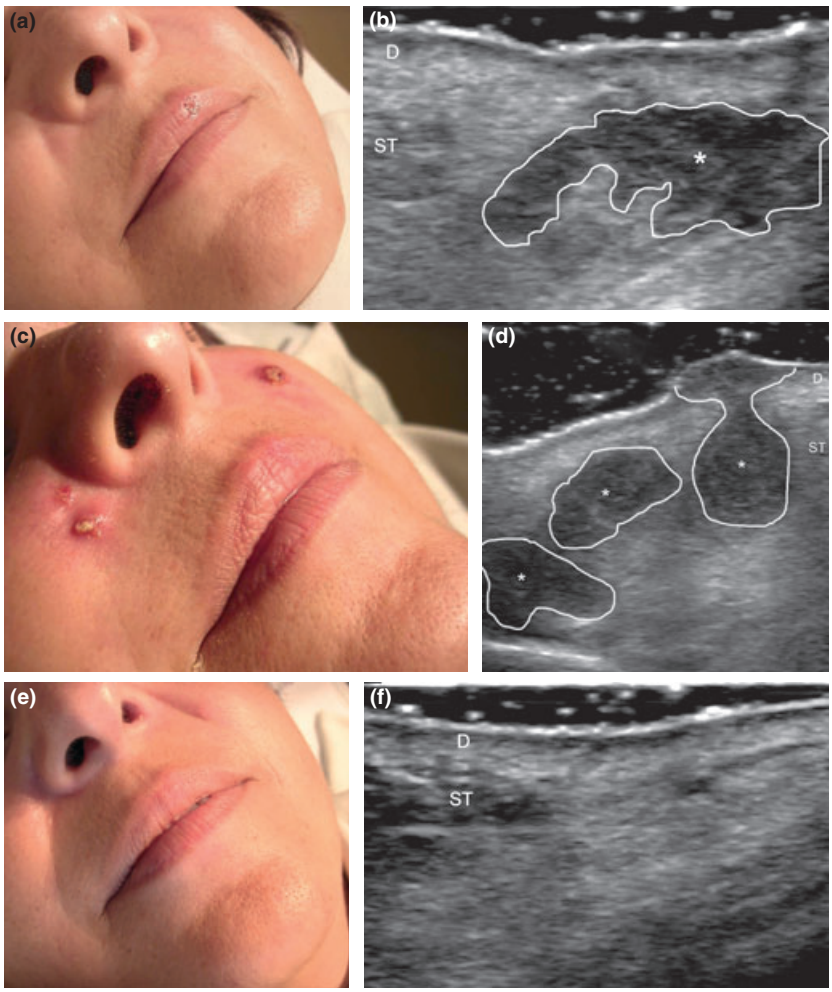

Figure 5 Filler dermatopathy after injection of hyaluronic acid-lidocaine: (a) One month after injection, nasofold nodules, erythema and oedema and inflammatory lesion in the upper lip. (b) Ultrasound (transverse views): hypoechoic pseudocyst (*) with inner echoes (debris) in the subcutaneous tissue. (c) Clinical worsening at 6 weeks after injection. (d) Ultrasound (transverse view): further dispersion of the filler; several of the hypoechoic pseudocysts now contain more debris and one of them is open. (e) Clinical resolution at 6 months. (f) Ultrasound image is normal (transverse view). D, dermis; ST, subcutaneous tissue.

Polymethylmethacrylate. PMMA is supplied in microscopic beads (microspheres of a synthetic polymer of methylmethacrylate) that are suspended in collagen, hyaluronic acid or other colloidal vehicle.[17] At early stages (<3 months after injection), PMMA deposits are generally small (<1 cm), appearing as multiple bright hyperechoic dots producing a mini comet-tail-shaped artefact (posterior reverberance); later on (more than 6 months after injection), some of the larger filler deposits acquire posterior acoustic shadowing artefacts (Figs 2, 8 and 9).

Calcium hydroxyapatite. Calcium hydroxyapatite was injected as microspheres suspended in a polysaccharide carrier.[18] On ultrasound, hydroxyapatite appeared as hyperechoic deposits with variable degrees of posterior acoustic shadowing (Fig. 2).

Clinical cases

A total of 118 patients in whom the presence of a filler was established sonographically were studied (114 female/4 male; mean age: 42 years; range 25–82). None of the controls was found to have foreign deposits in the face. There were no instances of ultrasound failing to detect a confirmed filler injection and all cases included presented also complete concordance between expected ultrasound filler presentation, i.e. corresponding to the image in porcine skin (Fig. 2). Notably, fillers maintained their sonographic identity regardless of how long before imaging the injection was performed (except for the reabsorbable agents, that eventually disappeared) or whether inflammation and/or fibrosis were present (diagnosed by ill-defined hypoechogenicity of the dermis, fluid between subcutaneous fat lobules or ill-defined hypoechoic areas in the subcutaneous tissue). Skin disorders associ-

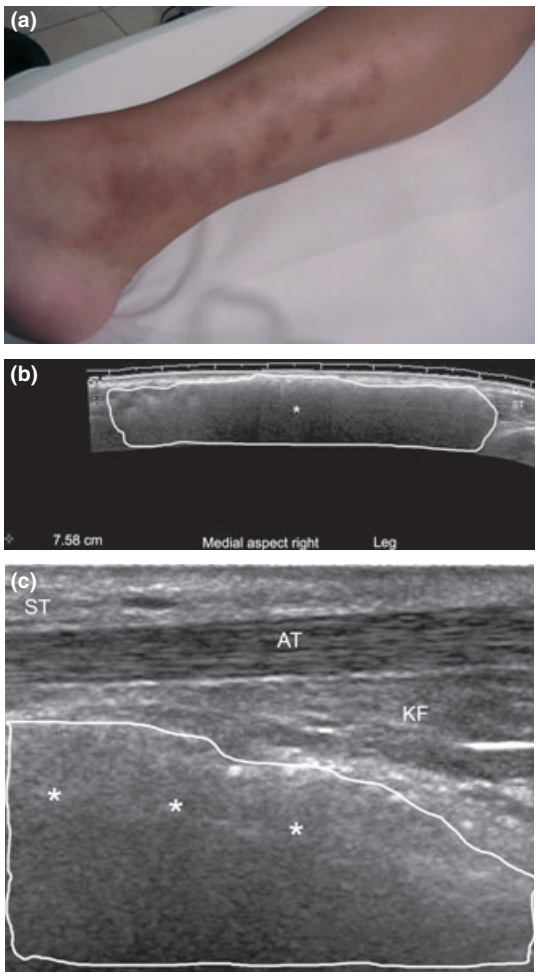

Figure 6 Silicone oil dermatopathy. (a) Morphea-like reaction in the leg. (b) Ultrasound of the medial aspect of the leg (longitudinal view) shows hyperechoic deposits predominating in the subcutaneous tissue (within the white line). (c) Ultrasound (longitudinal view): Silicone oil fills the Kager's fat pad in the posterior ankle (below the Achilles tendon, within the white line). ST, subcutaneous tissue; AT, Achilles tendon; KF, Kager's fat pad; *Silicone oil deposits.

ated with filler deposits are listed in Table 1, and consisted mostly of highly localized inflammatory processes (palpable nodules, cords, erythema and oedema); although there were also cases of diffuse cellulitis, morphea-like reactions and/or fatty tissue necrosis.

Failure to mention a previous injection of cosmetic fillers in the initial referral form ('miss' rate) was noted in most of the cases who had received silicone oil or PMMA; in contrast, the referring physician consistently noted the injection of hyaluronic acid. Statistical testing showed that the first two agents were significantly more often not reported by patients ($P < 0.001$ for silicone oil; $P < 0.01$ for PMMA by Student's *t*-tests).

The patients reported having the fillers injected by the referring dermatologist in 17 cases (all hyaluronic acid), other dermatologists (hyaluronic acid seven cases; PMMA 3), plastic surgeons (hyaluronic acid 11; PMMA 9; hydroxyapatite 1), dentist (hydroxyapatite 1) and cosmetologists (silicone oil 68; generic pure silicone 1). In 107 cases, the injection has taken place in the country where the study was performed (Chile), and in 11 cases in a foreign country (all injected with PMMA). The time from filler injection to ultrasound examination (when already a clinical problem) was 2–10 years for silicone oil; 2 weeks to 3 months for hyaluronic acid; 2 months to 2½ years for PMMA; and 4–6 weeks for hydroxyapatite.

Biological fillers

Hyaluronic acid. Thirty-five patients had been injected with pure hyaluronic acid, while only two received the mixed formulation; unexpectedly, the latter two were found to also have silicone oil deposits (from injections at 6 and 7 years before). Patients injected with the hyaluronic acid – lidocaine mixture had subcutaneous hypoechoic pseudocysts with numerous echoes (debris) and septa (Fig. 5) and, cutaneous blood flow around the filler deposits was increased on Colour Doppler. In one of the patients injected with the mixture of hyaluronic acid–lidocaine, a subcutaneous vessel appeared thrombosed.

Synthetic fillers

Silicone. Although filler was seen in the dermis, its main location was the subcutaneous tissue where the deposits measured 1.8 cm in depth (range: 0.4–5.5 cm); 6.5 cm along the longitudinal axis (1.0–31.4 cm); and 4.6 cm along the transverse axis (0.8–11.7 cm).

In patients who had received injections in the lips, the silicone infiltrated the orbicularis muscle (Fig. 7); and in patients injected in the gluteal and calf regions, it also reached into the local muscles (gluteal and anterior tibial groups). One patient developed submandibular venous thrombosis 5 years after facial injection and while the thrombus itself was silicone oil negative, the vessel was surrounded by abundant filler. Silicone oil was also detected within loco-regional lymph nodes, in the cervical (one case) and inguinal (two cases) areas.

Pure fluid silicone was detected in a single patient; the filler had been injected in the gluteal area, appearing as oval anechoic areas in the subcutaneous tissue resembling encapsulated implants. Interestingly, regardless of silicone form injected none of the recipients had sonographic changes in deposit size or shape or evidence of filler migration over a 6-month follow-up period.

Histology of skin injected with silicone oil (available in 35 cases) showed in all cases 'empty-appearing areas' of varying sizes accompanied by predominantly lymphocytic and histiocytes inflammatory infiltrates, in a foreign body type granulomatous reaction.

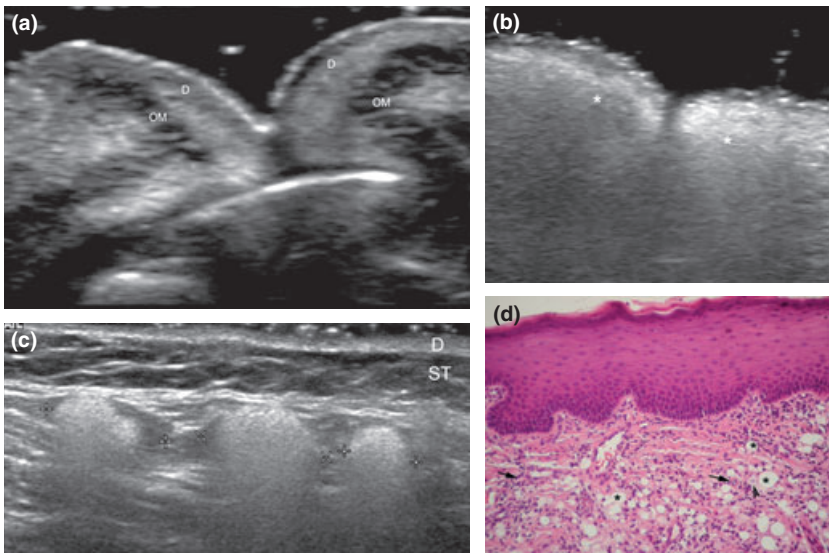

Figure 7 Silicone oil (a–d). (a) Normal sonographic anatomy of the lips (longitudinal view). (b) Sonogram of lips injected with silicone oil (longitudinal view): hyperechoic material (*) is seen throughout the cutaneous layers and orbicularis muscle of both lips. (c) Ultrasound (transverse view): Silicone oil within the submandibular lymph nodes (between markers) appearing as hyperechoic deposits with scattering artefact. (d) Histology (upper lip, 10 years post-injection magnification; H&E, 10×): normal squamous epithelium; at the corium there are numerous vacuoles (*) of varying sizes, accompanied by predominantly lymphocytic inflammatory infiltrates (arrows). D, dermis; ST, subcutaneous tissue; OM, orbicularis muscle of the lips.

Polymethylmethacrylate. Deposits were found in the subcutaneous tissue, and in the glabella and nasolabial folds (two cases), orbicular oris (one case; Fig. 8) and gluteal tissues including the gluteus and ischiotibial muscles (nine cases; Fig. 9). Gluteal dermis contained only trace amounts of PMMA. The PMMA deposits size was 0.6–8 mL in the facial area and 277–740 mL in the gluteal region (previously reported facial injection volumes: 1–8 mL[19]).

Calcium hydroxyapatite. The two patients in whom the filler was detected had been, injected in the nasolabial folds. The filler was, mostly found in the subcutaneous tissue, with only small dermal deposits. Hydroxyapatite deposits measured 2.3–4 mm in depth; 2.8–19.6 mm along the longitudinal axis; and 4.4–19.8 mm along the transversal axis.

Discussion

Adverse effects that occur in the treatment of cosmetic or low morbidity diseases are particularly deplorable. Complications following fillers are fortunately rare, as according to the American Society of Plastic Surgery Statistics, minimally invasive cosmetic procedures increased 69% from 2000 to 2009, to reach more than 10 million cases and many of these are filler injections.[20] Nevertheless, the number of publications on cosmetic filler complications appears to be growing.[21] Therefore, development of appropriate investigative methodology to detect injected cosmetic fillers and elucidate the clinical correlates appears to represent an unmet need.

Using fillers injected in porcine skin as a model, we were able to differentially identify sonographic properties specific for each filler agent making possible to detect and characterize the products *in vivo* and *in situ* and thus, their relation to the presenting lesion(s). In this regard, it is notable that deposits of the biological product hyaluronic acid appear as anechoic structures in the tissue, sonographically similar to cysts but without epidermal lining or significant debris (with the exception of the mix composed by hyaluronic acid and lidocaine that presents inner echoes or debris within the pseudocysts), while synthetic fillers generally generate stronger echoes (hyperechogenicity) and different predominant posterior artefacts; for example, silicone appears to be mostly associated with sound scattering, PMMA to reverberance and calcium hydroxyapatite with shadowing indicating absorption of the ultrasound waves.

Overall, cosmetic fillers were consistently detected with non-invasive ultrasound (matching all inclusion criteria) and found predominantly in the subcutaneous layer rather than the dermis, with broad distribution of the filler particles throughout the tissues (disordered packing). As the cosmetic effect (contour reshaping) is dependent on the agent aggregating into a single body, filler scattering (i.e., wide distribution) may be a factor interfering with cosmetic success. It can be speculated that scattering is attributed to individual tissue factors preventing coalescence or injection technique and was found with both degradable and non-degradable agents; however, scattering is not the only factor for the development of dermatological complications, as illustrated by the

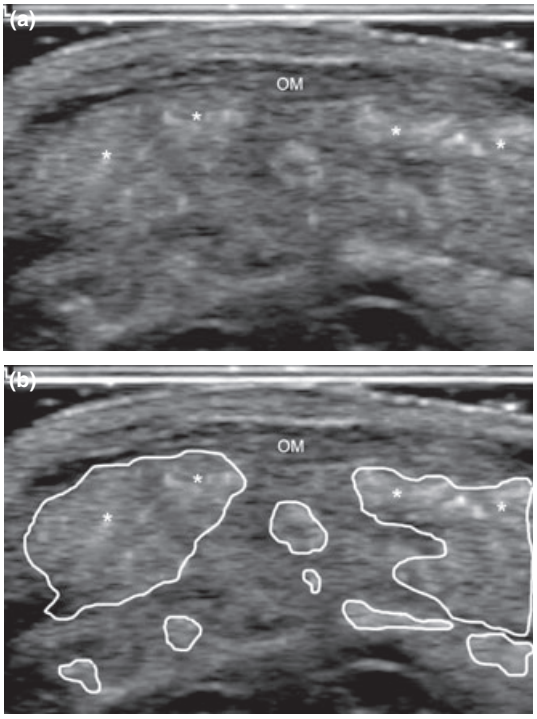

Figure 8 Polymethylmethacrylate (PMMA) dermatopathy. (a) Ultrasound (transverse view) shows PMMA deposits (*) as hyperechoic bright dots presenting posterior reverberance (mini comet-tail artefacts) spread within the orbicularis muscle of the upper lip. (b) Outline of PMMA deposits (within the white line). OM, orbicularis muscle of the lip.

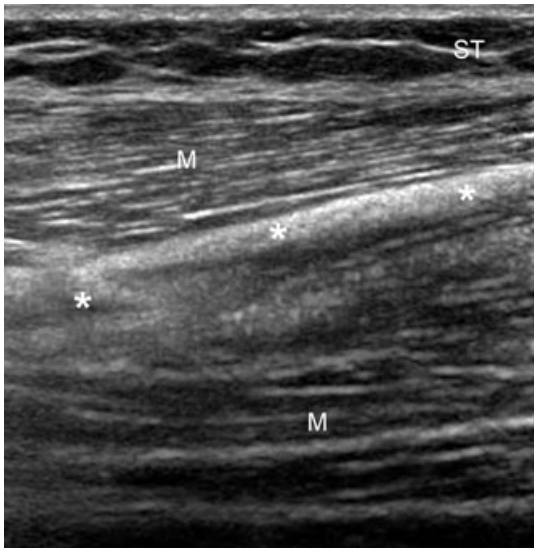

Figure 9 Polymethylmethacrylate (PMMA) within the ischiotibial muscles. Ultrasound (longitudinal view) shows hyperechoic bright dots (*Mini comet-tail shaped artefact) within the ischiotibial muscles. ST, subcutaneous tissue; M, ischiotibial muscles.

presence of scattering and absence of complications in the two subjects injected with hyaluronic acid and followed serially.

As our patients were highly selected through their referral for ultrasound, with large number of cases injected with silicone injections, the clinical population may not be representative of the experience in other centres.[22] Neither silicone oil (dimethylsilosane) nor pure free silicone has been approved by the FDA for skin injection, although silicone oil has been approved for the treatment of retinal detachment. Polydimethylsilosane (PDMS-1000), a purified form of silicone oil, has reportedly been used off-label in the USA, as soft tissue filler[23] and overtly in other countries for cosmetic purposes.[24]

As silicone oil had been injected by different operators, and the procedure had taken place 2–10 years before the ultrasound examination, it was not possible to ascertain the specific type of silicone preparation (generic, mixed or purified) used for the injection. An additional problem with silicone oil treatment was the observed mimicry between the associated dermatopathies and common dermatological conditions such as morphea, angio-oedema or actinic cheilitis that made clinical diagnosis difficult. This is in contrast with the dermatopathies associated with hyaluronic acid injection that usually appeared at 2 weeks to 3 months after treatment facilitating the establishment of pathogenic causality. In the latter case, filler reabsorption also led to complete clinical resolution of associated dermatopathies, while dermatopathies associated with the use of permanent fillers did not resolve within a 6-month observation period. As regards the cosmetic filler PMMA, this is used in dermatology, plastic surgery, orthopaedics and dentistry.[19,25] We did detect the agent in the face and, in large amounts, in the gluteal region.

Traditionally, histology serves as the most important investigation in the form of clinicopathological correlates.[26] However, in our cases of cosmetic fillers, histological examination did not provide direct assistance as it neither detected nor identified the injected agent. Moreover, usually patients who are subjects of cosmetic interventions try to avoid invasive procedures such as biopsies in highly exposed areas (for e.g. in the face). It is nevertheless remarkable that despite the fact that fillers are expected to be biologically inert skin biopsies consistently showed signs of inflammation, either non-specific (hyaluronic acid) or foreign body granulomatous reactions (silicone oil). The presence of inflammation suggests, in turn, that fillers may reach loco-regional lymph nodes through phagocytosis and cellular transport, rather than direct injection into lymphatic vessels.

This study clearly indicates the usefulness and convenience of ultrasound as a diagnostic tool to locate any of the evaluated fillers. This may be of relevance not only in the case of complications, but also when considering therapy with interferon, which is contraindicated in patients who already have non-reabsorbable cosmetic filler implants,[27] or when further cosmetic effect is still desired as a second injection of degradable filler in the original site may elicit adverse reactions. Moreover, ultrasound can help with

the monitoring of deposit extension when further medical or surgical management is considered. Lastly, ultrasound can also assist, perhaps, in the prevention of iatrogenic effects from the interpretation of other imaging modalities such as MRI, CT or PET/CT, that may provide confusing results and potentially, false positive imaging studies when applied to calcium hydroxylapatite deposits.[28]

Conclusion

Ultrasound can accurately identify *in situ* a filler agent, determine the location and size of cutaneous deposits, their presence in ectopic locations and also measure local blood flow. No other technology currently available will provide all those parameters non-invasively and thus ultrasound represents a useful adjunct tool for further investigation into this field.

Acknowledgement

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