EcoVue®
Ultrasound Gel

## Change Your Vue.

Introducing the next generation of ultrasound gel...EcoVue®. Ergonomically designed for ease-of-use, the eco-friendly FlexPac® creates higher product-to-package ratio reducing waste and improving sustainability. Designed with patient safety in mind, our non-refillable & single use products will forever *Change Your Vue* of ultrasound gel.

- Sustainable Packaging
- Natural Ingredients
- Reduces $CO^2$ Footprint


EcoVue.com

# Ultrasound Morphology of Polycaprolactone Filler

*Ximena Wortsman, MD, Natacha Quezada, MD*

Videos online at jultrasoundmed.org

Nowadays, cosmetic fillers are widely used and the reports of complications are rising. Therefore, the possibility to detect and identify noninvasively new fillers can provide a potent tool for managing complications. The objective of this study was to assess the ultrasound morphology of polycaprolactone. First, polycaprolactone was injected into porcine skin and this sonographic morphology was prospectively compared with the one observed in patients injected with this filler. On sonography, polycaprolactone shows as hypoechoic deposits that present multiple bright hyperechoic spots with mini-comet-tail artifact. This morphology differs from the ultrasound appearance of other common fillers.

***Key Words***—cosmetic ultrasound; dermatologic ultrasound; dermatology; fillers; fillers sonography; fillers ultrasound; polycaprolactone; polycaprolactone ultrasound; skin ultrasound

Polycaprolactone is a cosmetic filler consisting of 25 to 50 microspheres and a carboxymethylcellulose hydrogel.[1] It has been used widely for treating wrinkles and for soft tissue augmentation of the face and hands.[1,2] Even though some types of cosmetic fillers are not available in all countries, the fact that there are millions of people traveling across the world can increase the exposure of imaging specialists to the different types of fillers.

Sonography can detect and identify common cosmetic fillers as well as show the skin layers and the anatomical changes in frequent dermatologic conditions with good definition.[3–5]

Regarding cosmetic fillers, it has been described that ultrasound can confirm their presence, discriminate the most common types, and locate, measure, and monitor over time the filler deposits.[3] Therefore, sonography has been reported as the first-line imaging modality for assessing complications arising from the use of cosmetic fillers.[5]

To date, the ultrasound appearance of polycaprolactone has not been reported, and knowledge of its sonographic morphology may support the management of potential complications. Moreover, this may become particularly relevant in cases that have been injected with more than one type of filler in the same region and present adverse reactions.

The objective of this study was to assess the ultrasound morphology of polycaprolactone.

## Materials and Methods

For assessing the ultrasound appearance, polycaprolactone (Ellansé kit with 1-mL prefilled syringe, AQTIS Medical, Utrecht, Netherlands) was injected into freshly cut porcine skin pieces (Video 1). This sonographic morphology was prospectively compared with the

*Received April 6, 2017, from the Institute for Diagnostic Imaging of the Skin and Soft Tissues, Santiago, Chile (X.W.); Department of Imaging, Clinica Servet, Santiago, Chile (X.W.); Department of Dermatology, Faculty of Medicine, University of Chile, Santiago, Chile (X.W.); and Department of Dermatology, Faculty of Medicine, Pontifical Catholic University of Chile, Santiago, Chile (X.W., N.Q.). Manuscript accepted for publication April 10, 2017.*

*Address correspondence to Ximena Wortsman, MD, Institute for Diagnostic Imaging of the Skin and Soft Tissues, Lo Fontecilla 201, of 734, Las Condes, Santiago, Chile.*

*E-mail: xworts@yahoo.com*

**Abbreviations**

*CT, computed tomography; MRI, magnetic resonance imaging; PET, positron emission tomography*

doi:10.1002/jum.14327

one observed in the deposits of patients injected with polycaprolactone.

The ultrasound appearance of polycaprolactone detected in porcine skin was then compared with the one observed in human skin. For this purpose, a group of patients was prospectively studied according to the following inclusion and exclusion criteria. The inclusion criteria included patients with history of injection with polycaprolactone that were evaluated and derived by dermatologists to a color Doppler ultrasound examination due to cutaneous abnormalities, and the corresponding ultrasound examinations performed between January 2015 to October 2016. Exclusion criteria included a clinical history of injection of other types of cosmetic fillers, and the sonographic identification of other types of cosmetic fillers in concomitance with polycaprolactone.

### *Sonographic Evaluation*

All of the ultrasound examinations were performed and interpreted by the same radiologist with training in dermatologic ultrasound. These sonographic studies followed the guidelines for performing dermatologic ultrasound examinations,[6] which included gray scale and color Doppler in at least two perpendicular axes of the affected areas. In all cases, the same equipment (Logic E9 XD Clear, General Electric Health Systems, Waukesha, WI) working with a high-frequency compact linear probe (7–18 MHz) was used, and the study was performed following the Helsinki principles of medical ethics. The institutional review board approved the study and waived the need for an informed consent from the patients.

## Results

### *Comparison of Sonographic Morphology of Polycaprolactone Between Porcine and Human Skin*

The ultrasound morphology of polycaprolactone in porcine and human skin was similar and showed a matrix with hypoechoic deposits that contains bright hyperechoic spots with a mini-comet-tail artifact (Figure 1).

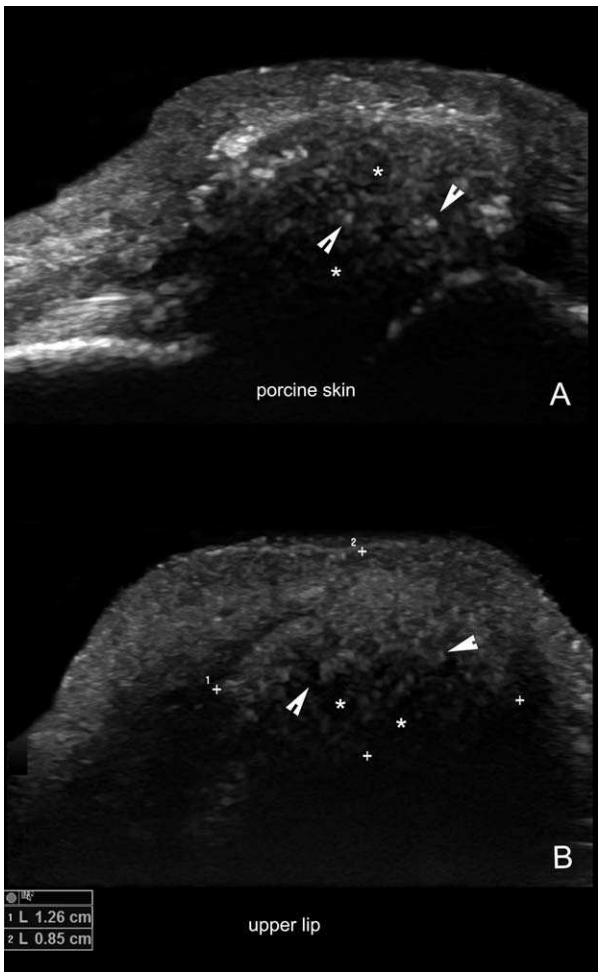
### *Sonographic Characteristics of Patients Injected With Polycaprolactone*

The patient group consisted of 7 females (mean age: 33 years; standard deviation 11; range 27 to 57 years). In all patients, polycaprolactone was detected in the hypodermis. In 86% (n = 6) of cases, polycaprolactone was found in the tip of the nose and also involved the upper lip in one case. In 14% (n = 1) of patients, polycaprolactone was detected in the nasofold lines (Figure 2; Videos 2 and 3). The time between the injection of polycaprolactone and the ultrasound examination varied between 4 months and 3 years.

## Discussion

The ultrasound morphology of polycaprolactone was different from the sonographic appearance of other common cosmetic fillers, such as hyaluronic acid, which is

**Figure 1.** Polycaprolactone in porcine and human skin. **A**, Porcine skin ultrasound (gray scale) showing deposits of polycaprolactone. **B**, Human skin. Twenty-eight-year-old woman with polycaprolactone in the upper lip (transverse view; upper lip, level close to the nasal region). A similar morphology of the porcine and human deposits shows hypoechoic matrix (* and between markers) and multiple bright hyperechoic spots with mini-comet-tail artifact (arrowheads) in (**A**) and (**B**).



anechoic or hypoechoic and does not contain bright hyperechoic spots (Figure 3).[3,5]

The hyperechoic spots with mini-comet-tail artifact that we described in polycaprolactone have been also reported in polymethylmethacrylate[3,5]; however, the echogenicity of the matrix of polycaprolactone is hypoechoic, and in polymethylmethacrylate, the matrix of the deposits is hyperechoic (Figure 4). Probably, the presence of these bright hyperechoic spots with mini-comet-tail artifact can be related to the microspheres present in both types of cosmetic fillers.

The hypoechogenicity of the matrix of the deposits of polycaprolactone may be due to its hydrogel nature, and we confirmed its presence in patients with history of injection of this filler up to 3 years.

It may be important to know this sonographic morphology for assessing the location and duration of polycaprolactone under real-world conditions. So far, this filler has been suggested to be reabsorbed in up to 4 years[1,2]; however, to date it is unclear whether this potential reabsorption takes place in all components of the filler (microspheres and hydrogel) or only in its hydrogel part. Thus, this process can be monitored by a noninvasive imaging technique with a wide field of view such as ultrasound.

In contrast to clinical reports that mention that the deposits of polycaprolactone are located in the dermis,[1,2] we found this filler primarily in the hypodermis in all patients. This coincides with previous reports that demonstrate the sonographic presence of common types of cosmetic fillers in the hypodermis.[3,5] Hence, the latter finding is not surprising, and in addition to the skills and training of the operator, it may be the result of normal anatomical conditions such as the thin dermis of the face and the length of the needle that comes with the kits of the fillers, because usually the needle is longer than the thickness of the facial dermis.[3] Whatever the reason, these factors can facilitate the hypodermal presence of polycaprolactone.

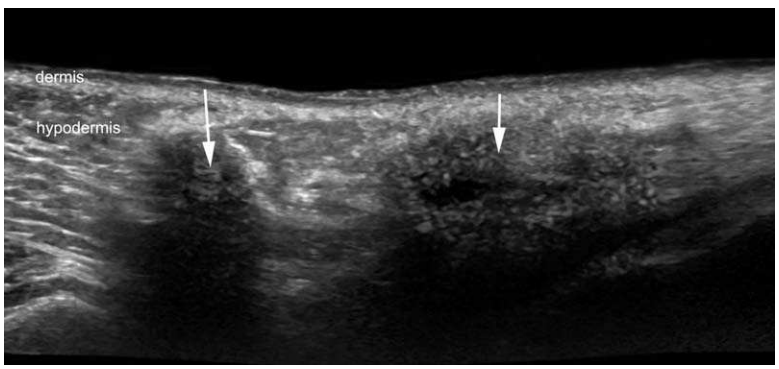
Patients who provide an unclear history of cosmetic procedures or present a background with several cosmetic procedures are not uncommon these days. Therefore, sonography can support the identification of the potential causes of complications or adverse reactions to fillers. Besides, these sonographic findings can be critical in patients with more than one type of cosmetic filler in the same corporal region such as the face.

Regarding the injection of fillers, there are circumstances that may increase the difficulty of obtaining a clear and precise clinical history of cosmetic procedures. These conditions include the wide range of operators, such as physicians from different specialties or nonmedical personnel who belong to different institutions, cities or countries, which can prevent the proper exchange of this medical information. Moreover, a large number of these procedures are performed in medical offices and without ultrasound guidance.

In spite of the circumstances, ultrasound can support the identification and quantify the extent of the deposits of polycaprolactone and other common cosmetic fillers. Furthermore, color Doppler ultrasound can unveil the presence of inflammation through the detection of increased blood flow in the periphery of the deposits.[5]

Currently, the identification of polycaprolactone by computed tomography (CT) and magnetic resonance imaging (MRI) has not been reported. Valuable attempts have been made to identify cosmetic fillers on MRI, mostly in small case series with few types of fillers and supposedly

**Figure 2.** Polycaprolactone in human skin. Fifty-nine-year-old woman with two deposits of polycaprolactone (arrows) located in the hypodermis of the right nasofold line (gray scale ultrasound; transverse view). Notice the hypoechoic matrix of deposits with prominent hyperechoic bright spots that show mini-comet-tail artifact.



well-known injection episodes.[7] In these cases, very good inter-rater agreement has been reported for identifying hydrophilic fillers; however, the rest of substances have showed a great disparity of inter-rater agreement.[7] A recent report[7] included the MRI identification of polyacrylamide in 50% of cases (7 of 14) and hyaluronic acid in 15% (3 of 14), besides silicone and collagen, after an average time of 51 days after injection. Nevertheless, this situation may be distant from real-world conditions, in which the multiple variants of hyaluronic acid lead the numbers of cosmetic procedures. Besides, there are patients with both

**Figure 3.** Comparison of sonographic morphology between polycaprolactone versus hyaluronic acid. **A**, Polycaprolactone. Fifty-seven-year-old woman with polycaprolactone at the tip of the nose (gray scale ultrasound; longitudinal view). The filler consists of a matrix with hypodermal hypoechoic deposits (*) that contain bright hyperechoic spots with mini-comet-tail artifact (arrows). **B**, Hyaluronic acid. Sixty-year-old woman with hyaluronic acid in the left cheek (gray scale ultrasound; transverse view) demonstrates multiple hypodermal deposits conformed by oval-shaped, anechoic pseudocystic structures. Notice that there are no bright hyperechoic spots within the deposits (o).

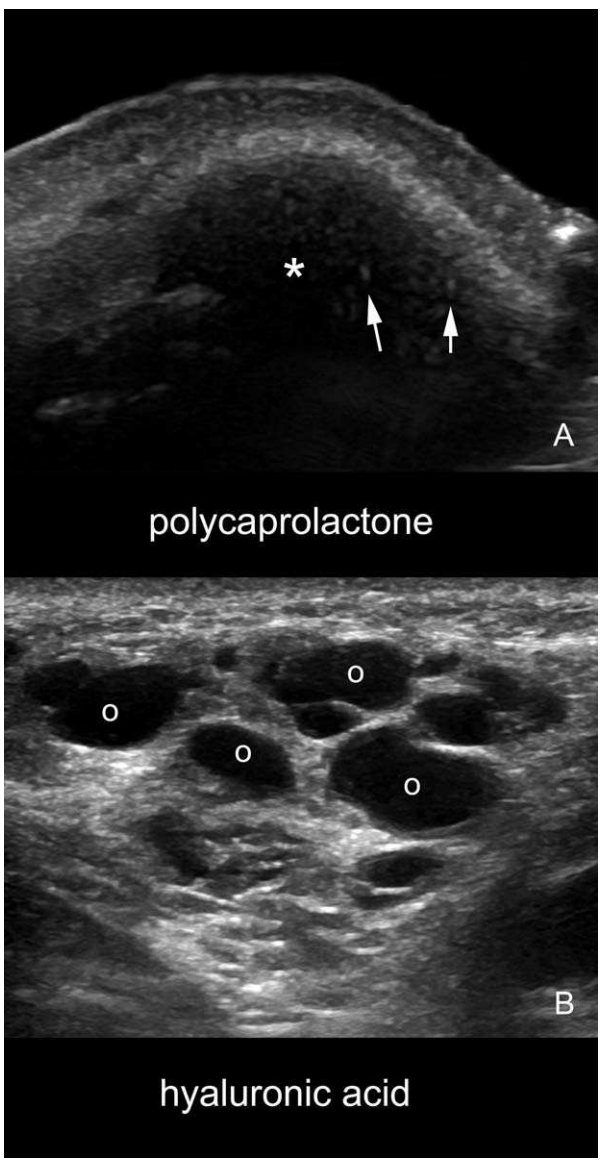
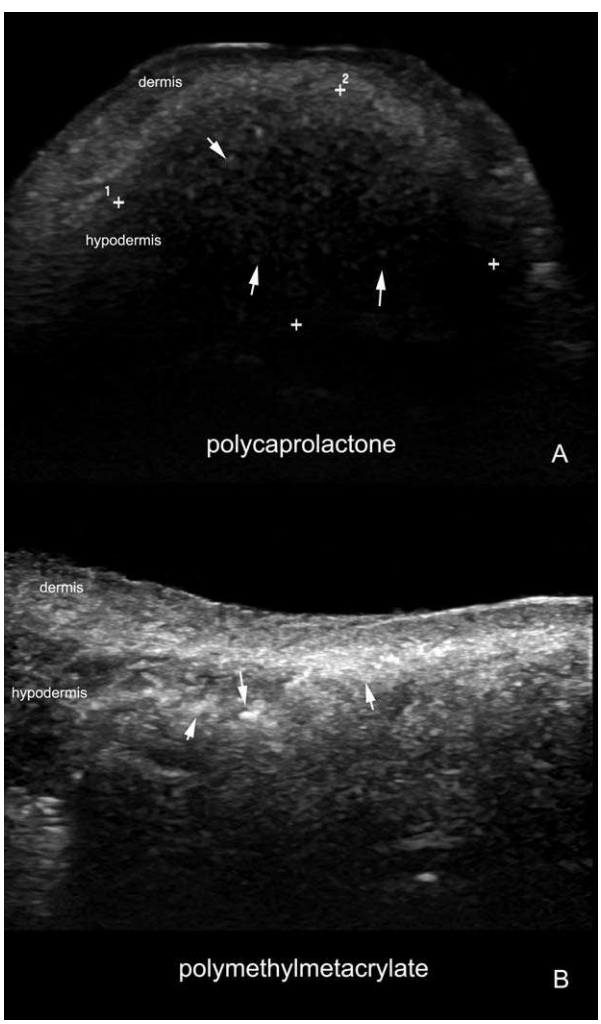



**Figure 4.** Comparison of sonographic morphology between polycaprolactone versus polymethylmethacrylate. **A**, Polycaprolactone. Twenty-seven-year-old woman with polycaprolactone at the tip of the nose (gray scale ultrasound; transverse view). The matrix with hypodermal hypoechoic deposits (between yellow markers) contains bright hyperechoic spots with mini-comet-tail artifact (arrows). **B**, Polymethylmethacrylate. Forty-five-year-old woman with polymethylmetacrylate at the right nasofold line (gray scale ultrasound; transverse view) demonstrates an hypodermal hyperechoic matrix of deposits that presents bright hyperechoic spots with mini-comet-tail artifact (arrows).



degradable and synthetic agents in the same region and difficulties to clinically confirm the history of these procedures. Furthermore, in our experience, most of the referrals for ultrasound studies tend to increase 2 to 4 months after injection, because adverse reactions to the most commonly injected fillers such as the new families of hyaluronic acid are reported to appear during that period.[8] However, this imaging referral can vary widely from immediately after injection to 8 to 10 years after injection in synthetic fillers.[5] Therefore, to date, the endeavor of identification of a filler on MRI appears to strongly need confirmation of an history of injection.[7,9,10] In contrast, in spite of whether the patient remembers, if there is an unclear clinical history of cosmetic procedures or the amount of time that has passed after injection, ultrasound can usually identify the presence and type of the most common cosmetic fillers by assessing the different sonographic patterns and using the same dermatologic examination protocol.

To date, only pure silicone presents a dedicated sequence on MRI, called silicone-only, which has been described in the study of breast implants.[11] Nevertheless, pure silicone has not been FDA-approved for skin injections or cosmetic purposes.

In contrast, the MRI identification algorithms for fillers appear to show neither big differences in the appearance of hydrophilic substances nor clear characteristic patterns in nonhydrophilic agents, by using the most commonly reported sequences ($T_1$ with and without contrast, $T_2$, and $T_1$ and $T_2$ with fat saturation).[7,9–11]

Thus, MRI can be useful for studying complications of fillers such as nodules, inflammation or abscesses, after a well-documented episode of filler injection has been confirmed, which may also be controversial under real-world conditions because of its high cost, time-consuming nature, and need of intravenous contrast.[12]

In addition, CT may support the identification of calcium hydroxyapatite because of its calcium component[13]; however, to date, patterns of identification of other types of cosmetic fillers have not been reported, and its use is mostly limited to study complications.

Importantly, knowledge of the sonographic appearance of polycaprolactone and other cosmetic fillers may avoid discriminating false positive results in the staging of malignant tumors by positron emission tomography (PET) CT, because filler deposits have shown hypermetabolism on PET-CT.[13,14]

Limitations to this work may be the small number of patients; however, the appearance of polycaprolactone was consistently similar in all cases.

In conclusion, ultrasound can be a useful imaging tool for detecting and identifying the deposits of polycaprolactone, which can support a more precise diagnosis and follow-up. This could be particularly relevant in cases with adverse reaction to fillers, or may help to clarify the diagnosis in patients undergoing other imaging studies such as CT, PET-CT, or MRI.

## References


1. Galadari H, van Abel D, Al Nuami K, Al Faresi F, Galadari I. A randomized, prospective, blinded, split-face, single-center study comparing polycaprolactone to hyaluronic acid for treatment of nasolabial folds. *J Cosmet Dermatol* 2015; 14:27–32.
2. Figueiredo VM. A five-patient prospective pilot study of a polycaprolactone based dermal filler for hand rejuvenation. *J Cosmet Dermatol* 2013; 12:73–77.
3. Wortsman X, Wortsman J, Orlandi C, Cardenas G, Sazunic I, Jemec GB. Ultrasound detection and identification of cosmetic fillers in the skin. *J Eur Acad Dermatol Venereol* 2012; 26:292–301.
4. Wortsman X, Wortsman J. Polyacrylamide fillers on skin ultrasound. *J Eur Acad Dermatol Venereol* 2012; 26:660–661.
5. Wortsman X. Identification and complications of cosmetic fillers: sonography first. *J Ultrasound Med* 2015; 34:1163–1172.
6. Wortsman X, Alfageme F, Roustan G, et al. Guidelines for performing dermatologic ultrasound examinations by the DERMUS Group. *J Ultrasound Med* 2016; 35:577–580.
7. Tal S, Maresky HS, Bryan T, Ziv E, Klein D, Persitz A, Heller L. MRI in detecting facial cosmetic injectable fillers. *Head Face Med* 2016; 12:27.
8. Pérez-Pérez L, García-Gavín J, Wortsman X, Santos-Briz Á. Delayed adverse subcutaneous reaction to a new family of hyaluronic acid dermal fillers with clinical, ultrasound, and histologic correlation. *Dermatol Surg* 2017; 43:605–608.
9. Ginat DT, Schatz CJ. Imaging features of midface injectable fillers and associated complications. *AJNR Am J Neuroradiol* 2013; 34:1488–1495.
10. Di Girolamo M, Mattei M, Signore A, Grippaudo FR. MRI in the evaluation of facial dermal fillers in normal and complicated cases. *Eur Radiol* 2015; 25:1431–1442.
11. Kim SH, Lipson JA, Moran CJ, et al. Image quality and diagnostic performance of silicone-specific breast MRI. *Magn Reson Imaging* 2013; 31:1472–1478.
12. Lorenc ZP. Commentary on: complications after facial injections with permanent fillers: important limitations and considerations of MRI evaluation. *Aesthet Surg J* 2014; 34:924–925.
13. Feeney JN, Fox JJ, Akhurst T. Radiological impact of the use of calcium hydroxylapatite dermal fillers. *Clin Radiol* 2009; 64:897–902.
14. Adejolu M, Huo L, Rohren E, Santiago L, Yang WT. False-positive lesions mimicking breast cancer on FDG PET and PET/CT. *AJR Am J Roentgenol* 2012; 198:W304–W314.