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Research Article

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High Resolution Ultrasound of Fillers and Their Implications in Aesthetic Medicine: A Study in Human Cadavers

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Abstract

The use of fillers for cosmetic or therapeutic purposes is very common and it's increasing daily. Although it's true that in most cases the results are as expected, the use of these substances is not free from the development of complications, even when it's performed by highly trained medical physicians. On the other hand, these substances can be used indiscriminately by untrained personnel leading to a serious public health complication known as iatrogenic allogenosis, which leads to problems related to malpractice. Most of the time, professionals are consulted for a second opinion regarding the use of these substances, because use of these substances might be unknown due to the patients denying or forgetting the use of these. The presence of a previous unknown filler in aesthetic areas that require treatment may trigger severe or irreversible reactions, especially if non-absorbable fillers were injected. High resolution ultrasound is an extremely useful diagnostic tool for the identification of fillers. In this paper we will describe the ultrasound appearance of hyaluronic acid, calcium hydroxyapatite, liquid silicone, silicone oil, biopolymers, and Polymethylmethacrylate (PPMA) and then we compare it with it's reported appearance in previous studies. The injection of the substances was carried out in human cadavers with the intention of gathering ultrasound images as similar to the imaging behavior of these substances in vivo. The obtained images can be used as precise references in the ultrasound evaluation, diagnosis, follow-up and behavior of the filler materials in the benefit of a comprehensive approach in the management of patients.

Key Words: Fillers, High Resolution Ultrasound, Hyaluronic Acid, Silicone Oil, Iatrogenic Allogenosis.

Introduction

In this moment, the use of fillers is very common, and it's not exclusive to cosmetic but also therapeutic purposes, and are found in multiple pathologies since they allow to obtain favorable aesthetic results that were previously only obtained with surgical procedures [1]. Unfortunately, some of these substances might lead to different complications caused by their use, regardless if implemented by qualified medical personnel, untrained doctors, or non-medical personnel [2]. Due to the increase in its use, there is a need for a diagnostic tool that allows to properly identify the types of fillers, their volume-amount, level of absorption, rule out and clarify possible complications.

High-resolution ultrasound has proven to be an excellent diagnos-

tic method for the study of fillers, since each of the exogenous substances have a defined ultrasound appearance and the so substance used can be precisely identified [3-6]. Some authors have made excellent imaging reports that serve as a reference for the proper identification of injectable fillers; [7, 8]. However, new substances emerge almost daily or there is variation between the different commercial brands of the same substance, so the objective of this study was to describe the ultrasound characteristics of some of the substances commonly known as fillers used in Colombia, whether approved for use or not, and their ultrasound appearance in human cadavers, which allow them to be used as a parameter for the adequate identification of these substances in vivo, positively impacting the identification, monitoring and management of patients.

Materials and Methods

A descriptive cross-sectional cohort study was conducted. Exogenous material was injected into the faces of human cadavers by two Dermatologists, two Plastic Surgeons and a doctor specialized in Aesthetic Medicine, with training in the use of these substances. The injection was carried out in human cadavers at the Latin American Center for Research and Training in Minimally Invasive Surgery (CLEMI). The injection sites were the intercalary region, nasolabial folds, and the zygomatic malar region. A standardized maximum volume of 2 cc was used per substance, per corpse. The injected substances were: high and low density hyaluronic acid, calcium hydroxyapatite, liquid silicone, silicone in oil, biopolymers, Polymethylmethacrylate. Two non-conventional substances and not considered as filler material were also injected, which were Vitamin C and vegetable oil. The use of Vitamin C has increased, frequently being used as a stimulater for the formation of collagen, depigmenting and antioxidant [9]. Vegetable oil commonly injected by non-ideo personnel, is an object of malpractice and injected in a vicious way, generally under the name of substances for medical use, and generally promoted as “cutting-edge, fashionable or last generation technology.”

After the injection of each of these substances, an ultrasound of the face was performed by a Radiologist with 10 years of training in Dermatological Ultrasound. The studies were carried out on a Xario 200 equipment with a high-resolution 18 to 22 MHz linear translator, to maximize performance of the ultrasound examination strict parameters were stablished for the use of ultrasound in dermatology, this parameter indicated by groups of experts were followed during the studies [10-12]. With the obtained image records, a precise description of the aspects of each substance was made, highlighting their typical characteristics that clearly differentiate them from the others, and the images obtained were compared with that is described in the literature.

Results

Of the nine substances injected, it was possible to obtain characteristic and defined ultrasound images of each one of them. Before injecting each of the substances, an ultrasound scan was carried out on the face of each of the corpses, to rule out the presence of previous fillers or tissue abnormalities. Because the preservation of the corpses was carried out by freezing, to perform the ultrasound study it was necessary to wait 4 hours so that the tissues had the most similar ultrasound appearance possible to the tissues in vivo, abolishing freezing devices that would alter the ultrasound appearance after injection of fillers.

High-density hyaluronic acid was observed as rounded, pseudo cystic nodules, generally larger than 6 mm, figure 1a. In contrast, low-density hyaluronic acid did not exceed 2 mm in diameter, figure 1b. Calcium hydroxyapatite produced confluent, dense, hyper echoic images, figure 2. The substance illegally marketed in Colombia under the name of Biopolymers, when was injected and explored by ultrasound, had the appearance of snowstorm, typical of silicone in oil, figure 3. In contrast, liquid silicone produced the characteristic echogenic cystic images similar to breast prostheses, figure 4. Polymethylmethacrylate or PPMA was observed as multiple linear foci of average length 2 to 3 mm, highly hyper echoic, figure 5. After the immediate application of vitamin C, a diffuse increase in the echogenicity of the dermis and subcutaneous cellular tissue was observed, figure 6. Vegetable oil was observed as multiple highly confluent hyper echoic lines that diffusely infiltrated the tissues, figure 7.

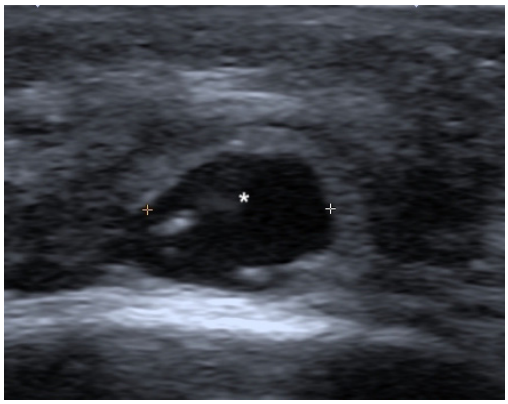

Figure 1a: Grey scale ultrasound image, transverse view, intercilliary region, shows a round, pseudo cystic nodules (*), typical for Hight density Hyaluronic acid, the pseudo cystic is larger than 6 mm and is in deep location close to the bone

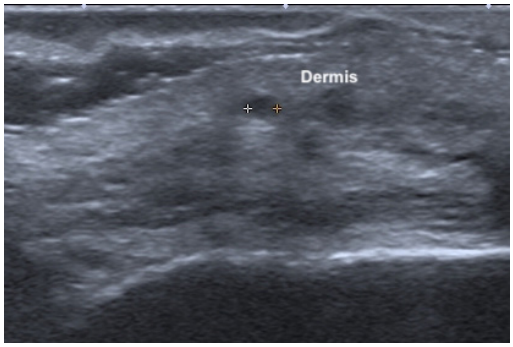

Figure 1b: Low Density Hyaluronic Acid (+). Grey scale ultrasound image, transverse view, malar region, shows a round, pseudo cystic nodule not bigger than 2 mm in diameter in superficial location just below dermis

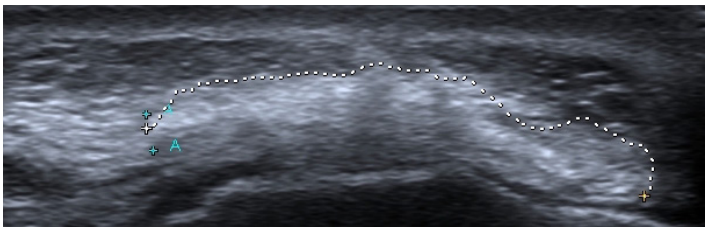

Figure 2: Grey scale ultrasound image, longitudinal view, malar region, shows hyperechoic deposits of hydroxyapatite forming a continuous and confluent layer.

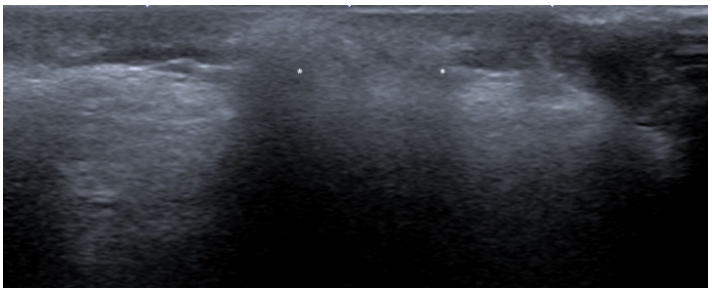

Figure 3: Ultrasound image of the substance rotule under the name of Byopolimers shows extensive hyperechoic deposits in the subcutaneous tissue (*) with snowstorm artifact that is classic for silicon oil

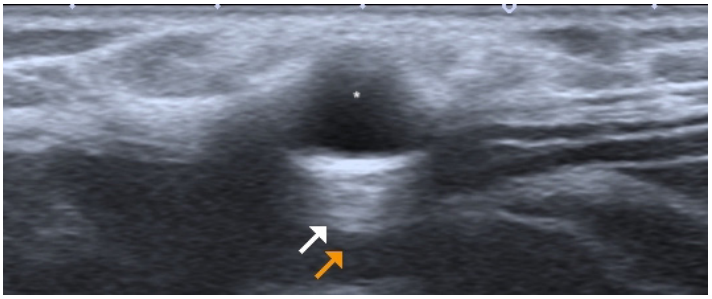

Figure 4: Grey scale ultrasound image, transverse view, malar region, shows a round, pseudo cystic nodule (*) that is taller than wider and with similar echogenicity to the breast implants, arrows show some acoustic enhancement.

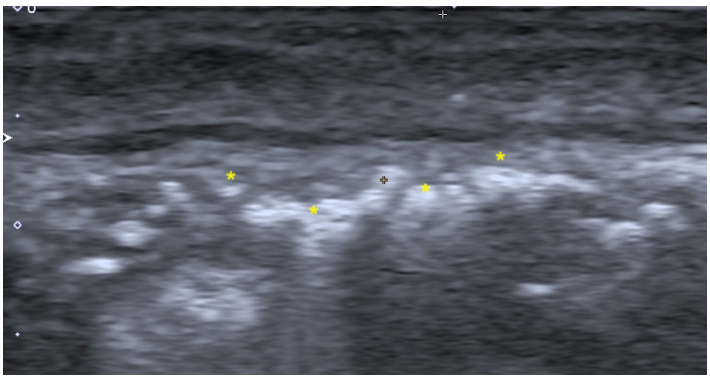

Figure 5: Polymethylmethacrylate or PPMA (*)immediately after injection was observed as multiple linear dots of average length 2 to 3 mm, highly hyperechoic some of them with mini comet tail artifact, the dots are located in subcutaneous celular tissue

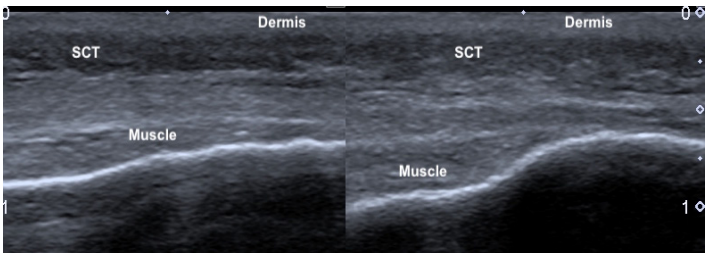

Figure 6: Grey scale ultrasound image, transverse view, zygomatic region, shows increased in echogenicity of all layers of the skin after application of vitamin C with increase in wide.

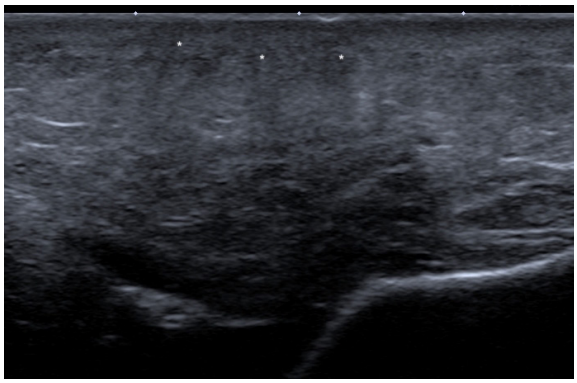

Figure 7: Grey scale ultrasound image, transverse view, malar region, shows total distortion of the normal echo-structure of the skin with highly hyperechoic echogenicity of the layes or the skin that diffusely infiltrated the tissues and some ill define linear hypo echo artifacts (*) This are the ultrasound findings after injection of vegetable oil.

Discussion

Every day the use of exogenous substances known as fillers for aesthetic purposes is becoming more common [13]. Recent data from the American Society for Plastic Surgery (ASPS) confirmed that after the use of botulinum toxin it is the second most common non-invasive medical procedure [14]. Additionally, its cosmetic use is indicated in multiple pathologies such as HIV-associated Lipo-dystrophy, Romberg's disease, Morphea and post-traumatic facial disfigurement [15-22]. Facial asymmetries and post-surgical defects.

It has been described that the ideal filler must meet certain characteristics, such as being cosmetically effective, not being allergenic or inducing immunological reactions, not being carcinogenic, not being teratogenic, not migrating, being biocompatible, biodegradable, and injectable [23]. When used routinely the technique and the results must be reproducible, finally, in addition to what is described, it must be cost effective. Unfortunately, a substance that fulfills all of these characteristics does not yet exist and therefore, with the use of these substances, multiple complications might appear. Their precise diagnosis represents a clinical and imaging challenge. Since in many cases the complications do not appear immediately but later on, the complication may even appear many years after the application of the filler. Hence patient's may not remember or even deny the use of them. [24, 25]. Conditions such as Cutaneous lymphoma, sarcodosis, and dermatomyositis can

present clinically with nonspecific characteristics, and ultrasound can differentiate these entities from complications related to fillers, avoiding misdiagnosis and the use of unnecessary biopsies. Although it is true that diagnostic modalities such as Magnetic Resonance have been used for the characterization of fillers, mainly due to their excellent spatial anatomical resolution, their use may be limited to the identification of the silicone that can be established by means of specific suppression sequences. However, unfortunately, the other fillers may have a nonspecific appearance, indistinguishable from each other or with multiple inflammatory skin pathologies and behave "silicone-like" on MRI without being able to define exactly what type of substance was injected [26-29]. Computerized axial tomography has no indication for the study of fillers, due to its low spatial resolution and only had been used it in some studies to characterize calcium hydroxyapatite [30]. Positron emission tomography PET-CT isn't recommended for evaluation of fillers because the increase in metabolic activity is not specific and can be seen in patients with or without complications caused by the injection of the filler material [31, 32]. Due to the devastating and aggressive presentation of these complications, it is not only important to establish the diagnosis of iatrogenic allogenosis [33]. But also to know precisely the type of substance injected since the treatment of complications may be different depending on the filler that has been used. Knowing exactly which substance was injected helps predict the aggressiveness of the lesions over time and the risk of more severe reactions, for example substances such as silicone can generate major deformities due to the extensive granulomatous reaction that it produces [34]. Therefore, it is essential to have accurate diagnostic tools in the characterization of these products.

In our study we were able to establish that each of the injected substances had a typical and specific ultrasound pattern, which allows it to be clearly differentiated from the others. Although it is true that there are previous publications in this regarding this topic [35-37]. The fillers were injected into animal tissues. We consider it important to validate the appearance of fillers experimentally, in human tissue from corpses preserved by freezing. Since the ultrasound appearance of these substances would be as close as possible to the imaging aspect of the same in vivo, allowing adequate reproducibility of the findings. Similarly, because new trademarks of the same product appear every day, the behavior in images may vary slightly due to the particular characteristics of each manufacturer. We included in the study Vitamin C, which even though it is not a filler is frequently injected into the face and body, since it supposedly prevents and improves changes associated with photo aging. The publications in favor of its use argue that its mechanism of action is to protect the skin from oxidative stress by donating an electron sequence to neutralize free radicals [38]. Additionally, it has been described to promote collagen formation by acting as a cofactor in the hydroxylation of proline and lysine, which stabilize the collagen molecule and promote the expression of the gene for collagen formation [39]. Vitamin C is a water-soluble substance, therefore on ultrasound after its application, a slight and diffuse increase in the echogenicity of the tissues was observed with an increase in their thickness but without loss of their differentiation. Very interesting previous studies have used static ultrasound to monitor the in vivo behavior of vitamin C [40]. obtaining images in which the pixel count was mainly analyzed, however the appearance of the tissues in real time, in High resolution ultrasound, which was the method used in this study and which is the ideal modality for the follow-up of dermatological pathology had not been described and therefore the importance of validating its ultra-sonographic characteristics [41].

In Colombia, iatrogenic allogenosis produced by the use of non-medically approved substances, known as biopolymers, is a common problem and there is no clear knowledge of what type of substance is actually used with this name. González and Cols carried out a very interesting study in which it was concluded that under the name of Biopolymers the most common substances used in Colombia corresponded to three products: Silicone, Cellophane and Polymethylmethacrylate [42]. In our study the ultrasound of the substance labeled as Biopolymer, behaved like silicone in oil showing the characteristic image in snowstorms, confirming as observed in previous ultrasound studies that it is one of the most commonly used substances under this name in Colombia [43]. Vegetable oil is another of the substances that are subject to malpractice by non-medical personnel, even when the use of ultrasound is described for the diagnosis of complications, we did not find ultrasound images available as a source of comparison [44]. Vegetable oil produces a diffuse hyper echoic pattern. Previous classifications have shown that fillers with hyper echoic ultrasound behavior are generally not biodegradable and produce more severe complications [45].

Conclusions

High-resolution ultrasound allows to accurately characterize available fillers for approved or not medical use. Ultrasound is an invaluable tool for proper management of complications derived from its use, since with the information obtained it is possible to follow correct behaviors in the management of patients. It's important that physicians know the scope of ultrasound and its usefulness before or after the procedure. Radiologists should be trained in the ultrasound appearance of each of the fillers and the complications of their use. The findings found in this study confirm and support what has been described by other authors and, for the first time, describe the ultrasound appearance in high resolution ultrasound in B mode, in real time, of medically approved substances such as vitamin C and other substances object of malpractice such as vegetable oil. The images obtained can be used as a precise guide in the evaluation, diagnosis, monitoring and behavior of fillers in vivo [46, 47].

References

1. Cavallieri F (2020) Advantages of sonography in fillers and complications. In Image Guided Dermatologic treatments. Switzerland .Springer. 93-102.
2. Wortsman X (2012) Wortsman J.Polyacrylamide fillers on skin ultrasound. J Eur Acad Dermatol Veneorolg. 26: 660.
3. Worstman X (2015) Identification and Complications of Cosmetic Filler: Sonography First. J Ultrasound Med. 2015 Jul; 34: 1163-1172.
4. Grippaudo FR, Mattei M (2011) The utility of high-frequency ultrasound in dermal filler evaluation. Ann Plast Surg 67: 469–47325.
5. Grippaudo FR, Mattei M (2010) High-frequency sonography of temporary and permanent dermal fillers. Skin Res Technol

16: 265-269.
6. Schelke LW, Van Den Elzen HJ, Erkamp PP, Neumann HA (2010) Use of ultrasound to provide overall information on facial fillers and surrounding tissue. Dermatol Surg 36 (Suppl 3):1843–1851.
7. De Cabo-Francrés FM, Alcolea J.M, Bové-Farré I.Pedret C, Trelles M A (2012) Ecografia de los materiales de relleno inyectables y su interés y seguimiento diagóstico. Cir.plást. iberolatinoam. 38: 179-187.
8. Wortsman X, Jemec G (2013) Sonography of cosmetic Procedures in Dermatologic Ultrasound with clinical and Histologic Correlation. Springer. New York.
9. Padayatty S, Levine M (2016) Vitamin C physiology: the known and the unknown and Goldilocks. Oral Dis. 22: 463-493.
10. Worstman X, Alfagame F, Roustan G, Arias-Santiago S, Martorell A, et al. (2016) Guidelines for performing dermatologic ultrasound examinations by the DERMUS group. J Ultrasound Med. 35: e111-114.
11. Gonzalez C (2018) High resolution ultrasound of benign diseases of the skin Rev Asoc Colomb Dermatol. 26: 230-239.
12. Gonzalez C (2014) Characterization of Dermatological lesions by ultrasound. Rev. Colomb. Radiol. 2014; 25: 4006-4014
13. Chacon AH (2015) Fillers in dermatology: from past to present. Cutis. 96: E17-19.
14. American Society of Plastic Surgeons (2016) Plastic Surgery Statistics Report [internet]. 2014 [citado 2018 dic. 15]. Disponible en: http://www.plasticsurgery.org/news/plastic- surgery- statistics/2014-statistics.html Epub 2014 Mar 11.Moon HJ. Use of Fillers in Rhinoplasty. Plast Surg. 2016 Jan;43: 307-317.
15. Thareja SK, Sadhwani D, Alan Fenske N (2015) En coup de sabre morphea treated with hyaluronic acid filler. Report of a case and review of the literature.Int J Dermatol. 2015 Jul; 54: 823-826.
16. Vedamurthy M, Vedamurthy A, Nischal K (2010) Dermal Fillers: Do's and Dont's. Cutan Aesthet Surg. 2010 Jan;3: 11-15.
17. Ashinoff R (2000) Overview: soft tissue augmentation. Clin Plast Surg 27: 479-487.
18. Klein AW (2001) Collagen and other injectables of the skin. Dermatol Clin 19: 491-508.
19. Kadouch JA, Tutein Nolthenius CJ, Kadouch DJ, van der Woude HJ, Karim RB, et al. (2014) Complications after facial injections with permanent fillers: important limitations and considerations of MRI evaluation. Aesthet Surg J 34: 9213-9236.
20. Becker M, Balague N, Montet X, Calmy A, Salomon D, et al. (2015) Hyaluronic acid filler in HIV-associated facial Lipoatrophy: evaluation of tissue distribution and morphology with MRI. Dermatology. 230: 367-747.
21. Comite SL, Liu JF, Balasubramanian S, Christian MA (2004) Treatment of HIV-associated facial lipoatrophy with radiance FN (Radiesse). Dermatol Online J. 10: 2.
22. Onesti MG, Troccola A, Scuderi N (2009) Volumetric correction using poly-L-lactic acid in facial asymmetry: parry Romberg syndrome and scleroderma. Dermatol Surg 35: 1368-1375.
23. Kinney B, Hughes C (2001) Soft Tissue Fillers: an overview. Aesthetic Surg J 21: 469-471.
24. Vedamurthy M (2008) Standard guidelines for the use of dermal fillers. Indian J Dermatol Venerol Leprol. 74: S23-27.
25. Ginat DT, Schatz CJ (2012) Imaging of facial fillers: additional insights. AJNR Am J Neuroradiol. 33: E140-E141.
26. Mundada P, Kohler R, Bpudabbous S, Toutous L, Platon A, et al. (2017) Injectable facial fillers: imaging features, complications, and diagnostic pitfalls at MRI and PET CT.Insights into Imaging.December. 8: 557-572.
27. Tal S, Maresky HS, Bryan T, Ziv E, Klein D, et al. (2016) MRI in detecting facial cosmetic injectable fillers. Head Face Med. 12: 27.
28. Di Girolamo M, Mattei M, Signore A, Grippaudo FR (2015) MRI in the evaluation of facial dermal fillers in normal and complicated cases. Eur Radiol 25: 1431-1442.
29. Harish S, Chiavaras MM, Kotnis N, Rebello R (2011) MR imaging of skeletal soft tissue infection: utility of diffusion-weighted imaging in detecting abscess formation. Skelet Radiol. 40: 285-294.
30. Feeney JN, Fox JJ, Akhurst T (2009) Radiological impact of the use of calcium hydroxylapatite dermal fillers. Clin Radiol 64: 897-902.
31. Ginat DT, Schatz CJ (2013) Imaging features of midface injectable fillers and associated complications. AJNR Am J Neuroradiol; 34: 1488-1495.
32. Ho L, Seto J, Ngo V, Vuu H, Wassef H, et la. (2012) Cosmetic-related changes on 18F-FDG PET/CT. Clin Nucl Med. 37: e150-e153.
33. Coiffman F (2008) Alogénosis iatrogénica: Una nueva enfermedad. Cir. Plást. Iberolatinoamericana. 34: 01-10.
34. Pearl R, Laud D, Kaplan E (1978) Complications following silicone injections for augmentation contours of the face.Plastic and Reconstructive Surgery: 61: 888-891.
35. Wortsman X, Wortsman J, Catalano O, Cardenas G, Sazunic I, et al. (2012) Ultrasound detection and identification of cosmetic fillers in the skin.J Our Acad Dermatol. 26: 233-239.
36. Menis D, Castellanos González M, LLamas-Martin r, Vanaclocha S (2014) The utility of skin ultrasound for the diagnosis of complications of tissue fillers materials. Dermosifiliogr. 105: 797-798.
37. Alfageme F, Alfagame F, Roustan G, Ed Panamerica (2017) Ecografia en materiales de relleno inyectables. En Ecografia en Dermatología y Dermoestética. Buenos Aires. 2017: 131-136.
38. Telang PS (2013) Vitamin C in dermatology. Indian Dermatol Online J. 4: 143-146.
39. Pullar J, Carr A, Vissers M (2017) The Roles of Vitamin C in Skin Health Nutrients. 2017 Aug; 9: 866.
40. Crisan D, Roman J, Crisan M, Scharffeter-Kochanek K, Badeau R, et al. (2015) The role of vitamin C in pushing back the boundaries of skin aging: an ultrasonographic approach. Clin Cosmet Investig Dermatol. 8: 463-470.
41. Alfagame F (2014) Ecografía cutánea Actas Dermo-Sifiliográficas, 105: 891-899.
42. González LF, Alvar JD, Cano H (2017) Análisis infrarrojo del hialucorp, metacorp y silicona líquida en el marco de la alogénosis iatrogénica. RCCP. 23: 37-45.
43. González CP (2019) High Resolution Ultrasound of Soft Tissues for Characterization of Fillers and its Complications.

Rev. Colomb. Radiol. 30: 5064-5068.
44. Dominguez-Zambrano A, Haddad-Tame J L, Torres-Baltazar I, Jiménez- Muñoz G, Satré- Ortíz N, et al. (2013) Enfermedad por modelantes: problemática actual en México y presentación de casos. Cir plást. iberolatinoam. 39: no.4 Madrid oct./dic. 2013.
45. Wortsman X (2018) Atlas of Dermatologic Ultrasound. Springer.
46. Pérez-Pérez L, García-Gavin J, Wortsman X, Santos-Briz A (2017) Delayed advérese subcutáneos reaction to a new Family of hyaluronic acid dermal fillers with clinical, ultrasound and histologic correlation. Dermatol Surg. 43: 605-608.
47. Wortsman X. Wortsman J (2012) Polyacrylamide fillers on skin ultrasound. J Eur Acad Dermatol Veneorolg. 26:660-661.