Injection Augmentation Mammoplasty Changes as Mimics of Suspicious Breast Calcifications

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Radiology Case. 2024 July; 18(7):14-22 :: DOI: 10.3941/jrcr.5411

ABSTRACT

This case report details two cases of breast augmentation with an unidentified substance which mimic suspicious breast calcifications. We emphasize the difficulties in diagnosis and the resemblance to suspicious breast calcifications, as well as the additional steps taken to distinguish between the two in our management. Diagnostic methods currently include mammogram, contrast-enhanced mammography, ultrasound, and MRI. Contrast-enhanced mammography and ultrasound can be used as complementary imaging methods to improve the detection and analysis of breast lesions. Recognizing calcifications due to augmentation mammoplasty as a potential mimic of suspicious breast calcifications is essential to prevent misdiagnosis and unnecessary surgical procedures.

CASE REPORT

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Two Chinese women attended our clinic as part of the breast screening program. Both patients had a previous history of injection augmentation mammoplasty. The injected substance is unidentified; however, its appearance does not align with typical silicone injection, which typically manifests as multiple highly dense masses with varying rim calcification. There was no prior breast imaging results available at the time of the initial presentation for both patients for comparison. Our hypothesis is that the patients may have received injections containing both hyaluronic acid and calcium hydroxyapatite pellets, although this was never verified by the operators.

Case 1

A 36 year-old Chinese female with history of breast augmentation injection in Malaysia around 10 years ago presented during our routine breast screening programme. Screening mammogram showed bilateral nodular and confluent densities in the breast subcutaneous tissues (Figure 1A–D), likely related to the known injection augmentation. Additionally, there were closely grouped hyperdense areas exhibiting a uniform linear configuration in the posterior right breast, indicative of the injected material. Contrast-enhanced mammogram was performed in the same setting, which showed no discrete suspicious mass or enhancing asymmetry (Figure 2A and B). Ultrasound was performed as the patient felt focal lumpiness in the breast tissue which revealed multiple hypoechoic lesions in the right upper outer quadrant (Figure 3A and B). In the same session, contrast-enhanced spectral mammography was performed, and it did not reveal any asymmetric density or suspicious mass. The patient was discharged as no sinister abnormality was identified.

Case 2

50-year-old Chinese female with history of breast augmentation with injection in Singapore 20 years ago presented during our routine breast screening programme. Mammogram of both breasts demonstrated asymmetric amorphous conglomerations of calcium-density material surrounding by less dense breast parenchyma (Figure 2A and B). In addition, round and oval densities are present bilaterally surrounded with dystrophic calcifications (Figure 4A–D). No discrete breast implant was seen. The patient was recalled for contrast-enhanced mammogram but defaulted follow-up. The reason for the loss to follow-up was unknown, and the patient could not be contacted.

DISCUSSION

Etiology & demographics

Both of our patients were Chinese and of age 36 and 50 respectively. Both had injection augmentation mammoplasty of more than 5 years ago, the former in Malaysia and the latter in Singapore.

Clinical & imaging findings

Ultrasound is efficient in accurately pinpointing the injected material. Nevertheless, when there are no complications and a

thorough medical history is lacking, sonographic findings may be ambiguous and difficult to decipher. In our first case, the patient presented with focal lumpiness on the breast, prompting the performance of ultrasound to investigate the presence of any potentially concerning breast masses. Based on the sonographic patterns identified in our case and their alignment with clinical symptoms, we suggest that the hypoechoic solid-cystic nodules could have resulted from a fibrotic reaction and local inflammation, which can frequently present as palpable masses.

The decision to use contrast-enhanced spectral mammography (CESM) was driven by its easy availability and quicker acquisition time compared to MRI. CESM enables real-time evaluation during the same session, whereas obtaining an outpatient MRI appointment in our local setting typically requires weeks to months. Other advantages of CESM over MRI include lower cost and fewer contraindications. Moreover, CESM is often more comfortable for patients and may offer better specificity in identifying certain breast lesions, especially in cases of extremely dense breast tissue. CESM has also shown superior performance to standard mammography, with a high sensitivity approaching that of MRI [1-4].

MRI is the preferred imaging method for assessing the integrity of breast implants, complications related to breast augmentation, situations with inconclusive results from conventional imaging, and as an additional tool to mammography in individuals with freely injectable materials. However, the expensive nature of MRI necessitates its prudent utilization [5]. We did not opt for MRI in our cases, as contrast-enhanced spectral mammography confirmed the absence of a suspicious mass in our initial patient Therefore, an MRI would provide limited additional value. Additionally, in the situation of our second patient, the patient did not attend the follow-up appointments.

Upon reviewing the literature, we identified a couple of case reports of patients who experienced breast calcifications resembling malignancy following injection breast augmentation [6-7]. In a 2017 case report by Lance et al. [6] a patient who underwent injection augmentation mammoplasty with polyacrylamide hydrogel (PAAG) developed extremely dense breast tissue with regionally distributed round and amorphous heterogeneous calcifications on mammography, resembling suspicious calcifications. Biopsy results yielded benign findings of abundant acellular foreign material with no identifiable breast parenchyma. Another study by Wang et al. [7] found that patients who underwent injection augmentation with autologous fat presented with clustered microcalcifications on mammography, which appeared highly suspicious for breast malignancy. However, histological examination revealed these calcifications were due to fat necrosis. Although the injection material in both of our cases is unknown, we hypothesize that it is likely to be foreign material.

Treatment & prognosis

Patients who opt for injection augmentation procedures may encounter various long-term implications, necessitating tailored follow-up protocols and screening adjustments to mitigate these risks effectively. Complications may include granuloma formation, infections, migration of injected material, tissue necrosis, asymmetry, and challenges in imaging interpretation, complicating the detection of other potentially serious breast abnormalities. Asymptomatic patients are recommended to undergo annual clinical examinations to evaluate the ongoing condition of the injected material and surrounding tissue. Patients should also be educated to identify symptoms such as breast lumps, pain, redness, or asymmetry. Imaging studies, such as mammography, ultrasound, or MRI, tailored to the type of injected material, may be conducted to monitor for complications and differentiate between the augmentation material and any potential pathological changes. Additional breast screening adjustments may be necessary. For instance, ultrasound, CESM, or MRI may complement mammography to offer more comprehensive imaging. Radiologists must also consider the patient's augmentation history to ensure accurate interpretation of imaging results. If imaging results are inconclusive, a biopsy may be required to ascertain the nature of any suspicious findings.

Biopsy was not performed for our patients due to several reasons. Following consultation with the pathologist, it was deemed impractical to try to identify the injectable material through histological analysis. The challenges included the mobility of the dense particles and the difficulty in accurately targeting them with stereotactic-guided biopsy. Additionally, the widespread distribution of these dense particles made it challenging to pinpoint a specific one for biopsy. The first patient was discharged as no sinister abnormality was identified on contrast-enhanced mammography. The second patient was scheduled for a contrast-enhanced mammogram follow-up but missed the appointment and was not contactable.

Differential diagnosis

Breast malignancy is consistently a top concern and must be ruled out. We excluded breast malignancy for one of the patients as the contrast-enhanced mammogram did not indicate any suspicious breast masses. Regarding our second patient, she missed her follow-up appointment, and as a result, a contrast-enhanced mammogram was not conducted. Fat necrosis was also considered, but due to the appearance of the calcifications, it was considered less probable. Other potential diagnoses to consider include breast hematoma, especially chronic ones. However, neither patient reported any previous or recent trauma.

Breast Malignancy – High density mass on mammogram with irregular shape and spiculated margins on mammogram. On ultrasound appears as hypoechoic solid mass lesion with angular or spiculated or microlobulated margins, taller than wide, showing posterior acoustic shadowing and significant internal vascularity. The lesion may or may not show calcifications within. On MRI breast the malignant mass usually shows rapid contrast uptake and washout pattern (Type III curve) [8].

Hematoma – Breast hematomas typically occur after trauma to the breast, iatrogenic injury, or in patients with

bleeding disorders or those taking anticoagulant medications. The imaging features of hematomas varies base on age of the hematoma/blood. Acute / subacute (< 1 month) hematomas on mammogram appears as an ill-defined area of increased density or well circumscribed high density mass lesion. On ultrasound the smaller lesions appear as focal hyper-echogenicity with small cystic lesions while the larger lesions demonstrate well defined cystic lesion with septations and echogenic debris. No internal vascularity is seen. The appearance of a chronic hematoma is similar to that of fat necrosis [9].

Fat necrosis – On mammography, appear as well-circumscribed with fine curvilinear calcifications around the walls with a centre of fat-density. On ultrasound, they appear as round or oval well circumscribed cystic masses with homogenous mobile internal echoes and sometimes, fat fluid level within. It is non-compressible and shows no internal vascularity

CONCLUSION

The radiographic appearance of cosmetic materials can differ greatly in terms of shape and radiodensity depending on the specific substance used. This challenge becomes even greater when the substance is unidentified. Radiologists must possess a comprehensive understanding of the diverse range of imaging outcomes observed in patients who have had breast augmentation with foreign substances. This understanding is essential for accurate diagnoses and recommending suitable treatment plans. Clinicians can improve diagnostic precision by familiarizing themselves with this uncommon form of breast augmentation and obtaining pertinent patient histories.

TEACHING POINT

It is important to remember that breast augmentation using foreign materials can lead to calcified abnormalities that might resemble suspicious calcifications on a mammogram. Recognizing this similarity is crucial for effective management.

QUESTIONS

Question 1

Which of the following answer choices is true?

1. There are 4 types of enhancement kinetic curves for MRI Breast
2. Type III curve shows a washout pattern
3. Type II curve is considered benign
4. Type I curve is suspicious for malignancy
5. Type IV curve is indeterminate

Answer: choice 2. Type III curve shows a washout pattern

Explanation:

1. There are only three types of enhancement kinetic curves for MRI Breast.

[On MRI breast the malignant mass usually shows rapid contrast uptake and washout pattern (Type III curve).]

2. Type III curve shows a washout pattern. [On MRI breast the malignant mass usually shows rapid contrast uptake and washout pattern (Type III curve).]

3. Type II curve shows initial uptake followed by the plateau phase towards the latter part of the study and is considered concerning for malignancy.

4. Type I curve shows progressive or persistent enhancement pattern and is usually considered benign.

5. There are only three types of curves.

Question 2

Which of the following answer choices is false?

1. Contrast-enhanced spectral mammography (CESM) can be used as an alternative to detect enhancing masses
2. It is faster and cheaper than MRI.
3. CESM cannot be used in patients with dense breast tissue
4. CESM can be done in the same visit session.
5. CESM involves the use of iodinated contrast agents

Answer: choice 3. CESM cannot be used in patients with dense breast tissue

Explanation

1. Contrast-enhanced spectral mammography (CESM) can be used to detect enhancing masses [This technique can effectively detect enhancing masses.]

2. The procedure requires a shorter duration than MRI and is cheaper. [The decision for contrast-enhanced spectral mammography (CESM) was made because of its easy availability and faster acquisition time compared to MRI. CESM enables immediate assessment within the same session.]

3. CESM can be used in patients with dense breast tissue [Contrast-enhanced spectral mammography (CESM) is also beneficial for problem-solving, particularly in instances of extremely dense breast tissue.]

4. It is a fast process and can be done within the same session. [CESM enables immediate assessment within the same session.]

5. Iodinated contrast is utilised followed by dual-energy images

Question 3

Which of the following answer choices is false?

1. Breast malignancy must be ruled out for all patients presenting with breast lumps
2. Mammogram features include high density mass with irregular shape and spiculated margins.
3. All breast malignancy present with suspicious calcifications.
4. Ultrasound features include hypoechoic solid mass with internal vascularity
5. On MRI enhancement pattern of breast malignancy includes rapid contrast uptake and washout pattern

Answer: choice 3. All breast calcifications present with suspicious calcifications.

Explanation

1. Breast cancer is consistently a primary concern and must be eliminated as a possibility. [Breast malignancy is consistently a top concern and must be ruled out.]

2. Suspicious features on mammogram include high density mass with irregular shape and spiculated margins [High density mass on mammogram with irregular shape and spiculated margins on mammogram.]

3. All breast calcifications present with suspicious calcifications. [The lesion may or may not show calcifications within.]

4. Ultrasound features include hypoechoic solid mass with internal vascularity. [On ultrasound appears as hypoechoic solid mass lesion with angular or spiculated or microlobulated margins, taller than wide, showing posterior acoustic shadowing and significant internal vascularity.]

5. MRI kinetic curve of breast malignancy usually shows type III washout pattern. [On MRI breast the malignant mass usually shows rapid contrast uptake and washout pattern (Type III curve).]

Question 4

Which of the following answer choices is false?

1. MRI is the favoured imaging technique for evaluating the integrity of breast implants and its related complications. [MRI is the preferred imaging method for assessing the integrity of breast implants, complications related to breast augmentation, situations with inconclusive results from conventional imaging, and as an additional tool to mammography in individuals with freely injectable materials.]

2. It is expensive compared to the other investigation modalities. [However, the expensive nature of MRI necessitates its prudent utilization]

3. The kinetic curve is derived from Contrast-Enhanced Spectral Mammogram.

4. MRI typically requires a longer duration compared to contrast-enhanced spectral mammography.

5. MRI is utilises gadolinium- based contrast.

Answer: choice 3. The kinetic curve is derived from Contrast-Enhanced Spectral Mammogram.

Explanation:

1. MRI provides high-resolution images that allow for detailed visualization of the breast tissue and implants, making it highly effective at detecting ruptures or leaks, particularly in silicone gel implants. [MRI is the preferred imaging method for assessing the integrity of breast implants, complications related to breast augmentation, situations with inconclusive results from conventional imaging, and as an additional tool to mammography in individuals with freely injectable materials.]

2. MRI is generally more expensive compared to other imaging modalities such as ultrasound and mammography. The higher cost is due to several factors:

Advanced Technology: MRI machines are complex and expensive to manufacture and maintain.

Operating Costs: Operating an MRI machine requires highly trained personnel, including radiologists and MRI technologists. The maintenance and cooling systems required for the machine also add to the operational costs.

Time-Consuming: MRI scans typically take longer to perform than other imaging techniques. The duration of the scan and the need for precise positioning contribute to higher costs.

Detailed Imaging: The high level of detail and accuracy provided by MRI makes it a valuable diagnostic tool, justifying its higher cost in many clinical situations. [However, the expensive nature of MRI necessitates its prudent utilization]

3. Kinetic curves are derived from MRI. During a breast MRI, after the injection of the contrast agent, images are taken at specific time intervals. The changes in signal intensity are measured and plotted over time to create the kinetic curves. These curves help in assessing the vascularity and perfusion characteristics of tissues, which can be crucial for differentiating between benign and malignant lesions.

4. MRI requires a longer and more detailed preparation time as well as longer scanning time requiring multiple sequences.

5. Gadolinium enhances the contrast of images by altering the magnetic properties of nearby water molecules, making tissues with higher blood supply or altered vascular permeability more visible on MRI. Gadolinium contrast is especially useful in breast MRI for detecting and characterizing lesions, assessing the integrity of breast implants, and evaluating breast cancer.

Question 5

What of the following answer choices is false?

1. Breast tumours often undergo angiogenesis, which can result in increased enhancement on contrast-enhanced spectral mammography (CESM).

2. Iodinated-contrast agent is used to highlight neovascularity within the breast tissue

3. CESM can improve sensitivity of detecting breast cancer in dense breast.

4. CESM utilises dual-energy imaging.

5. CESM is superior to MRI in evaluating breast implants.

Answer: choice 5. CESM is superior to MRI in evaluating breast implants.

Explanation

1. CESM uses iodine-based contrast agents to enhance the visibility of vascularized tumors on mammograms. [Contrast-enhanced mammography (CESM) uses iodinated-contrast to highlight neovascularity.]

2. CESM involves the injection of an iodinated contrast agent into the bloodstream. Iodine-contrast agent accumulates in areas of increased blood flow and vascular permeability, such as those associated with tumor neovascularity. CESM utilizes dual-energy X-ray imaging to capture two sets of images at different energy levels. One set highlights the iodine contrast, while the other provides standard mammographic images. [Contrast-enhanced mammography (CESM) uses iodinated-contrast to highlight neovascularity.]

3. The iodinated contrast highlights areas of neovascularity, making it easier to detect and characterize tumors that have increased blood supply. Tumours with significant angiogenesis will show up more prominently due to the enhanced contrast uptake, aiding in distinguishing malignant from benign lesions. As such, CESM can improve the sensitivity of mammography for detecting breast cancer, especially in dense breast tissue where traditional mammography might be less effective. [Contrast-enhanced spectral mammography (CESM) is also beneficial for

problem-solving, particularly in instances of extremely dense breast tissue.]

4. In CESM, two sets of images are captured — one at low energy (similar to standard mammography) and one at high energy.

5. MRI provides more detailed information about soft tissues compared to CESM and is preferred for assessing the integrity of breast implants. [MRI is the preferred imaging method for assessing the integrity of breast implants, complications related to breast augmentation, situations with inconclusive results from conventional imaging, and as an additional tool to mammography in individuals with freely injectable materials.]

Authors' contributions

Dr. Esther Tan was in charge of the primary writing of the paper, conception of the research and collection of images.

Dr. Shi Haiyuan contributed through conception of the research, reviewing the images and approval of the final version of publication.

Disclosures

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Consent

Informed consent from the patients were obtained.

Human and animal rights

There were no experiments on human or animal subjects involved in this case report. Ethical standards followed the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000.

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FIGURES

Figures 1-3: 37-year-old female with complications related to augmentation mammoplasty from an unknown substance.

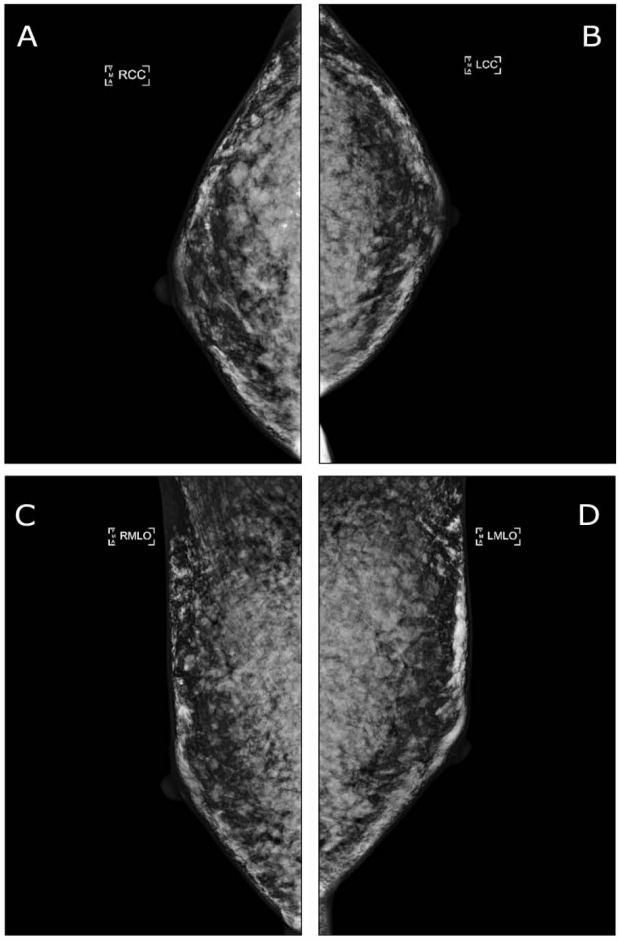

Figure 1A-1D: Technique – Conventional mammogram (100kVp, 30mAs), Mediolateral oblique (A–B) and Craniocaudal (C–D) views both breasts Findings – Multiple round and oval-shaped equal density masses with calcifications in both breasts.

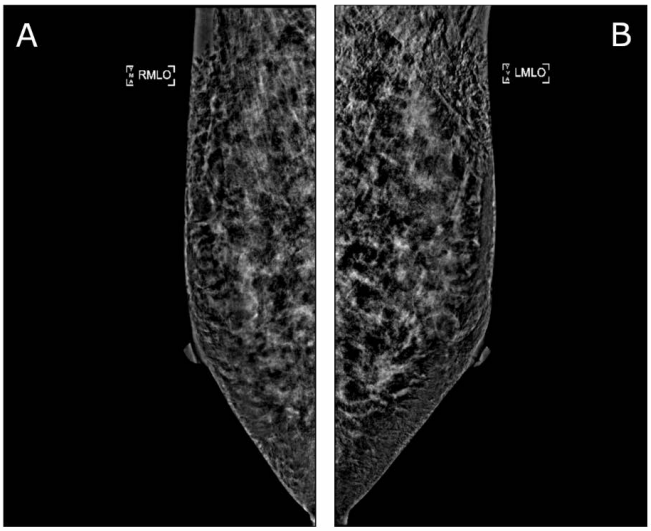

Figure 2A,2B: Technique – Dual energy Contrast-Enhanced Spectral Mammography (28 kVP and 45 kVP) utilising 100 ml of IV Iodopamidol - 300. Findings – No suspicious enhancing mass or asymmetric density.

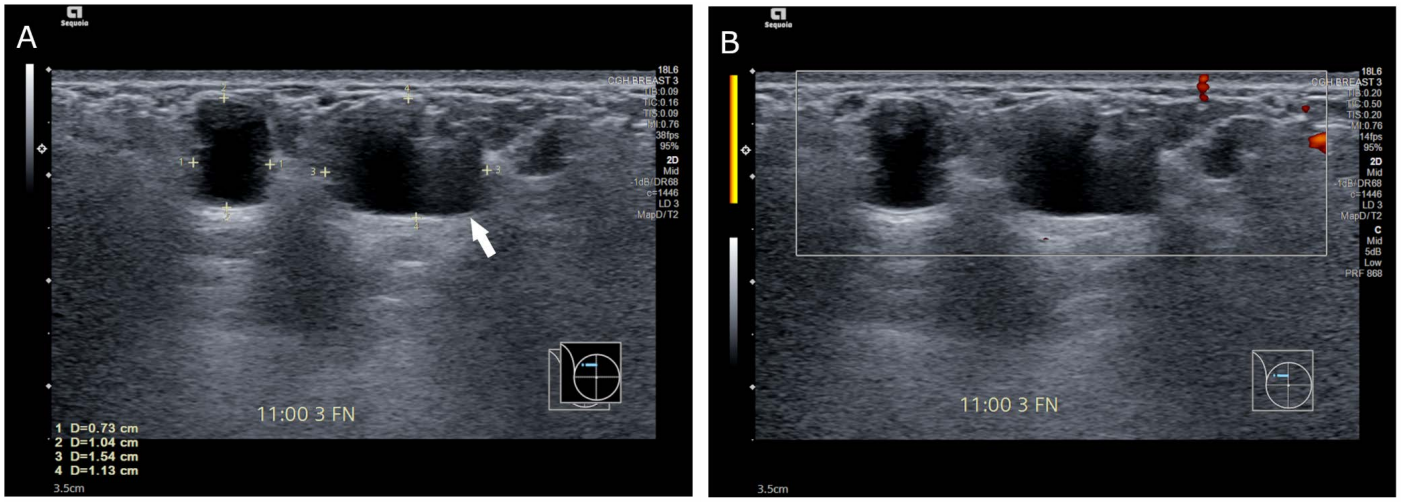

Figure 3A,3B: Technique – Transverse grey scale ultrasound image (G) and transverse ultrasound doppler image of right breast (H) using Linear Array transducer (5–12MHz)
Findings – Multiple hypoechoic lesions in the right upper outer quadrant, the larger ones appear complex solid-cystic largest measuring up to 1.5 x 1.1 cm (TS x CC) without vascularity on colour Doppler ultrasound.

Figure 4: 50-year-old female with complications related to augmentation mammoplasty from an unknown substance.

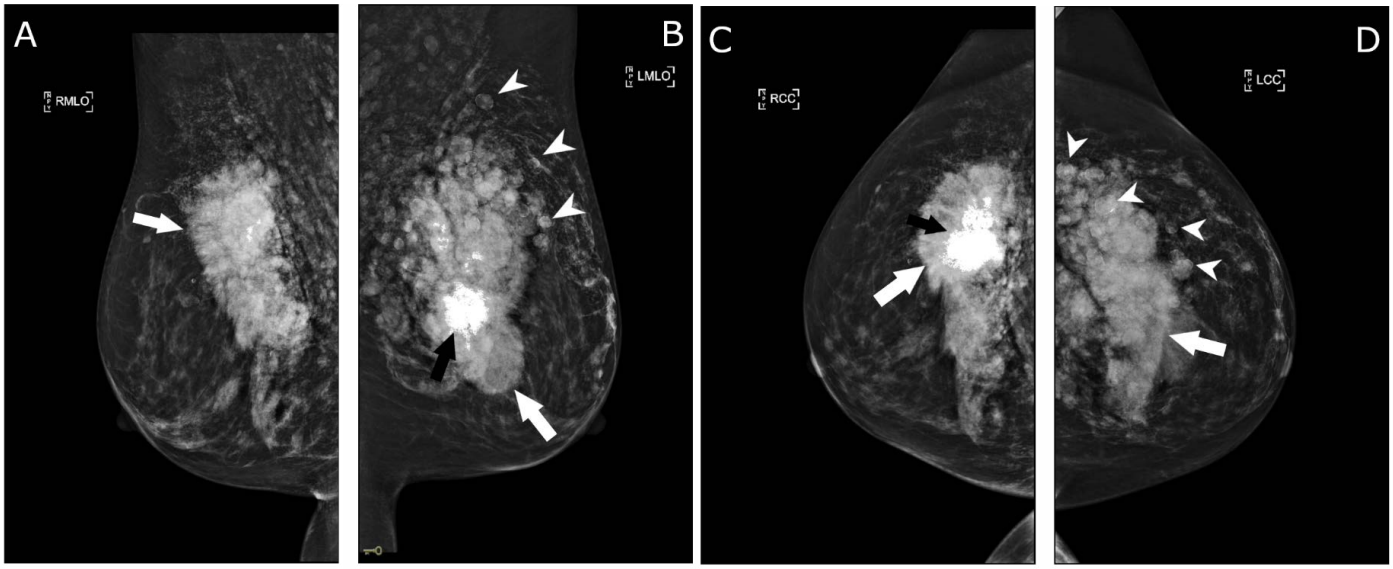

Figure 4A-4D: Technique – Conventional mammogram (100kVp, 30mAs), Mediolateral oblique (A–B) and Cranio-caudal (C–D) views of the bilateral breasts
Findings – Multiple high-density masses are seen in the bilateral breasts (white arrows). Large conglomerations of benign-appearing calcium density in both breasts (black arrows). Smaller benign-appearing calcium densities are seen in the bilateral breasts. Multiple round and oval-shaped equal density masses with calcifications are also seen in the left upper outer quadrant (arrow heads).

SUMMARY TABLE

Etiology	Foreign body substances such as free silicon, paraffin/oil, Polyacrylamide gel, autologous fat, hyaluronic acid
Incidence	Approximately 8 per 1000 women
Gender Ratio	Almost all women
Age Predilection	May occur in any age group
Risk Factors	Nil
Treatment	Regular screening for breast malignancy if asymptomatic
Prognosis	Usually favourable
Imaging findings	On mammogram, asymmetric, rounded amorphous densities are present bilaterally, surrounded by less dense breast parenchyma. On ultrasound, multiple hypoechoic lesions may appear mixed solid-cystic

DIFFERENTIAL TABLE

Differential Diagnosis	**Mammogram**	**Ultrasound**	**Magnetic Resonance Imaging**	**Contrast-Enhanced Spectral Mammography**
Injection Augmentation Mammoplasty	Asymmetric, rounded amorphous densities surrounded by less dense breast parenchyma. Scattered dystrophic calcifications present. No discrete breast implant.	Hypoechoic collections with mixed internal echoes and no internal vascularity. Silicon material will show "snowstorm appearance" of echogenic foci with posterior shadowing.	Variable, depending on type of augmentation material. MRI signal of polyacrylamide gel and silicon: T1w hypointense and T2w hyperintense.	No enhancement
Breast Malignancy	High density spiculated/ irregular mass with or without suspicious calcifications	Hypoechoic non-compressible mass with angular or spiculated or microlobulated margins, taller than wide with posterior acoustic shadowing and internal vascularity	Mass with speculated margins and irregular shape. Usually showing heterogenous or rim-enhancement. T1 iso-hypointnese and hypointense on T2FS. Type 3 washout curve seen on enhancement curves.	Enhancing spiculated/ irregular mass or asymmetrical enhancement
Hematoma	Acute / subacute – well circumscribed high density mass Chronic – similar to fat necrosis	Acute / subacute – Well-defined lesion with internal echoes. May have septations and echogenic debris. No internal vascularity. Chronic hematoma – similar to fat necrosis	Depending on the age of blood/hematoma – Acute (1 to 3 days) – T1 iso, T2 hypointense Early subacute (2 to 7 days) – T1 hyper, T2 hypointense Late subacute (7 to 14-28 days) – T1 hyper, T2 hyperintense, Chronic (>14 to 28 days) – T1 hypo, T2 hypointense	No enhancement
Fat Necrosis	Well-circumscribed with fine curvilinear calcifications around the walls with a centre of fat-density.	Round or oval well circumscribed cystic masses with homogenous mobile internal echoes with echogenic rim (due to calcifications) and posterior acoustic shadowing. No internal vascularity	NA	No enhancement

KEYWORDS

Contrast-enhanced spectral mammogram; augmentation mammoplasty; injected foreign body; breast augmentation; stereotactic-guided biopsy