



# Imaging Spectrum of Augmented Breast and Post-Mastectomy Reconstructed Breast with Common Complications: A Pictorial Essay

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Breast augmentation is becoming more common, be it for cosmetic reasons or post-mastectomy. Multiple articles in the literature describe the imaging findings of various types of cosmetic breast augmentation. Some articles describe imaging findings for different types of post-mastectomy reconstructions. This essay aims to serve as a comprehensive reference for the multimodality imaging of various types of breast augmentations in native breast and post-mastectomy reconstructions. Familiarity with these findings will facilitate the detection of complications and new or recurrent breast malignancies in patients. With the extensive illustrations provided in this essay on normal and abnormal imaging findings of augmented breasts, readers will receive exposure that will facilitate effective practice.

**Keywords:** Breast augmentation; Reconstruction; Implants; Free filler injection; Silicone

## INTRODUCTION

Breast augmentation is becoming more common, be it for cosmetic reasons or post-mastectomy. Radiologists need to be aware of the common and unusual techniques of breast augmentation and their imaging findings. In our centre, we encounter various cases. Some patients are not very forthcoming about their history of breast augmentation, which makes interpretation and diagnosis even more challenging. Knowledge and familiarity with the imaging characteristics of breast augmentation will help the reporting radiologists recognize abnormalities and provide timely input to clinicians.

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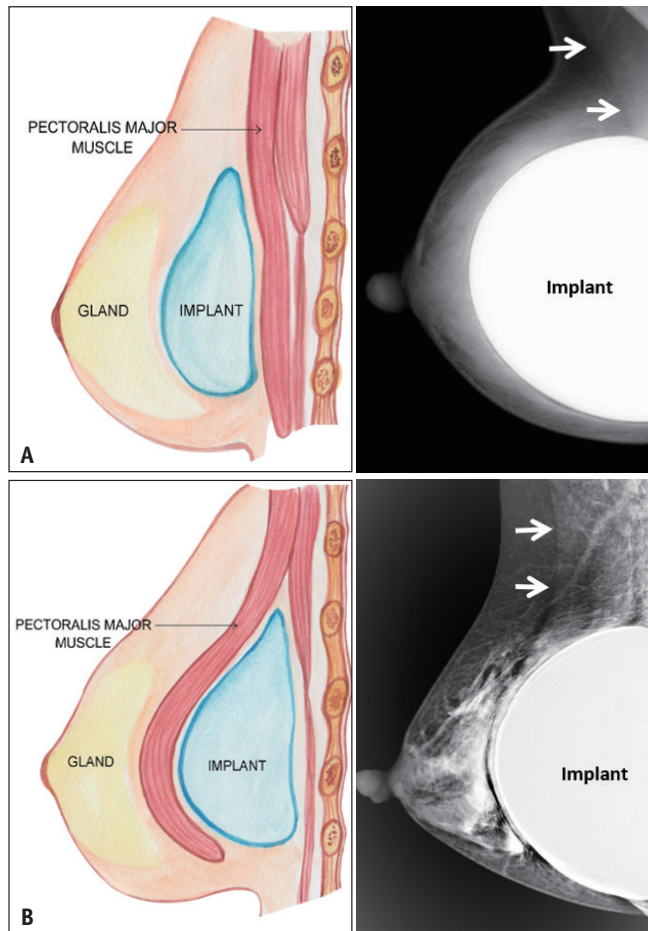
## Breast Augmentation in Native Breasts

### Implants/Prosthesis

Breast implants can be categorized based on the number of lumens and the filling material (silicone or saline). A single-lumen implant is a multilayered envelope filled with silicone or saline. A standard double-lumen implant has silicone gel in the inner compartment and saline solution in the smaller outer compartment. A reverse double-lumen implant has an inner saline compartment and an outer silicone compartment. The implant can be placed anterior to the pectoralis muscle (retroglandular location) (Fig. 1A) or posterior (retropectoral location) (Fig. 1B) [1].

Mammography (Fig. 2) shows a silicone implant as a homogeneously dense oval mass, whereas a saline implant has a dense outer layer with lucent contents. The presence of a valve distinguishes a saline implant from a silicone implant. A double-lumen implant is generally identified on a mammogram with double density.

On ultrasound (Fig. 3), both saline and silicone implants appear anechoic, triangular, and surrounded by a linear echogenic envelope. The envelope can have single or parallel echogenic lines. In double-lumen implants, the two compartments are generally depicted.



**Fig. 1. Location of implant.**

**A.** Retroglandular implant. The line diagram and right MLO mammogram show the implant in front of the pectoralis major muscle (arrows) within the retroglandular space. **B.** Retropectoral implant. The line diagram and right MLO mammogram show the implant placed behind the pectoralis major muscle (arrows) within the retropectoral space. MLO = mediolateral oblique

A non-contrast MRI with T1-weighted (T1W) and T2-weighted (T2W) sequences and silicone-specific and silicone-suppressed sequences are generally sufficient to assess implant integrity. On MRI (Fig. 4), the envelope and fibrous capsule of the implant show low signal intensity on all sequences. The normal radial folds are observed as perpendicular low signal infolding of the envelope, extending inward from the periphery [2]. The valve in saline implants is observed as a low signal mural nodule on all sequences. On T2W images, silicone demonstrates intermediate to high signal intensity while saline demonstrates high signal intensity. On T1W images, both saline and silicone implants show low signal intensity. The silicone shows high signal on the silicone-specific sequence, while it shows loss of signal in the silicone-suppressed sequence. A double-lumen implant shows silicone and saline

signals depending on their contents.

Complication rates of approximately 20–40% have been reported for augmentation in the literature; the rate is higher for mastectomy related reconstruction than for cosmetic augmentation surgeries. Early postoperative complications include hematoma (Fig. 5), infection, breast pain, nipple/breast sensation changes, and asymmetry [1]. When severe, these complications may impel the patient to undergo explantation surgery in some cases. Late complications related to implant surgery commonly include capsular contracture and implant rupture.

### **Capsular Contracture** (Fig. 6)

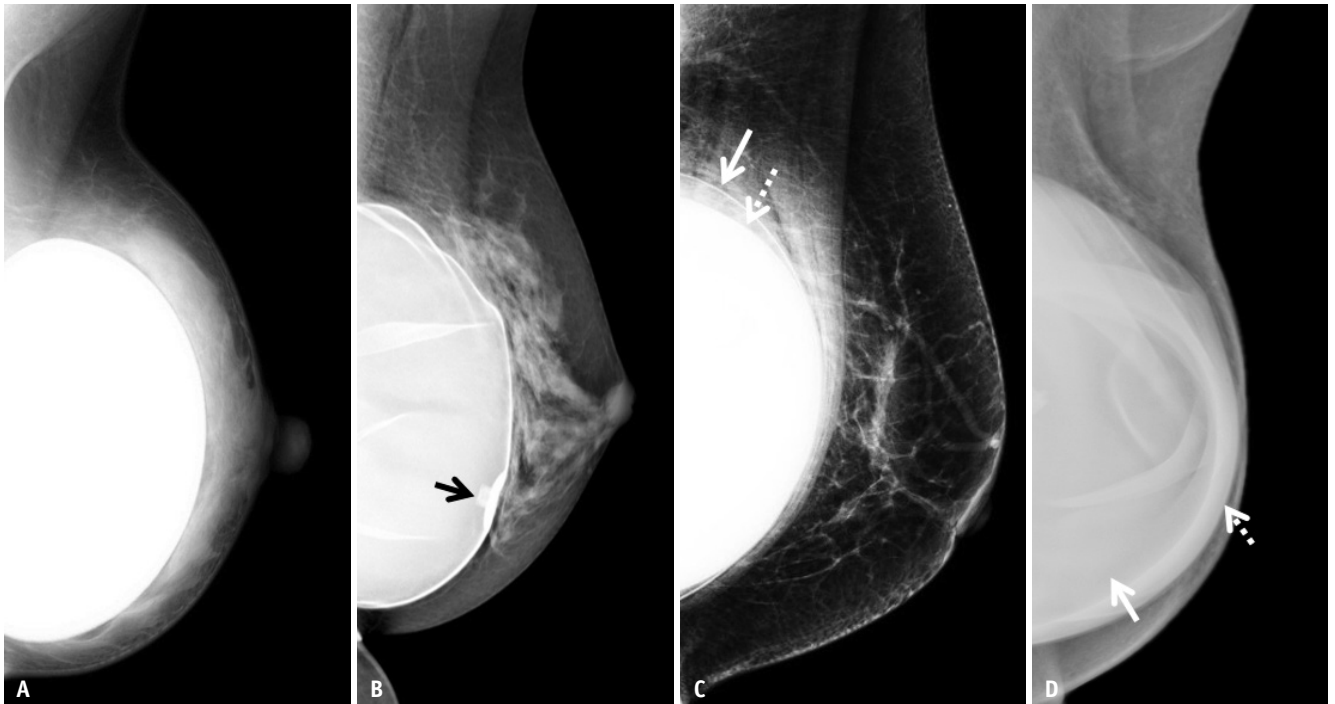
Being a common complication, it results from excessive scarring around the implant capsule [2]. Clinically, the patient may present with a disfigured breast, pain, or hardness. Imaging findings include a deformed implant contour, which becomes irregular and more spherical and may show coarse peri-implant calcifications.

### **Implant Rupture**

The rate of rupture is directly proportional to the age and the site of implants; being higher for retropectoral implants [3]. The imaging appearance varies with the type of implant as well as the type of rupture. Early diagnosis is important, as extracapsular silicone may be difficult to extract from breast parenchyma, whereas the misdiagnosis of implant rupture may lead to unnecessary surgery to remove an otherwise intact implant.

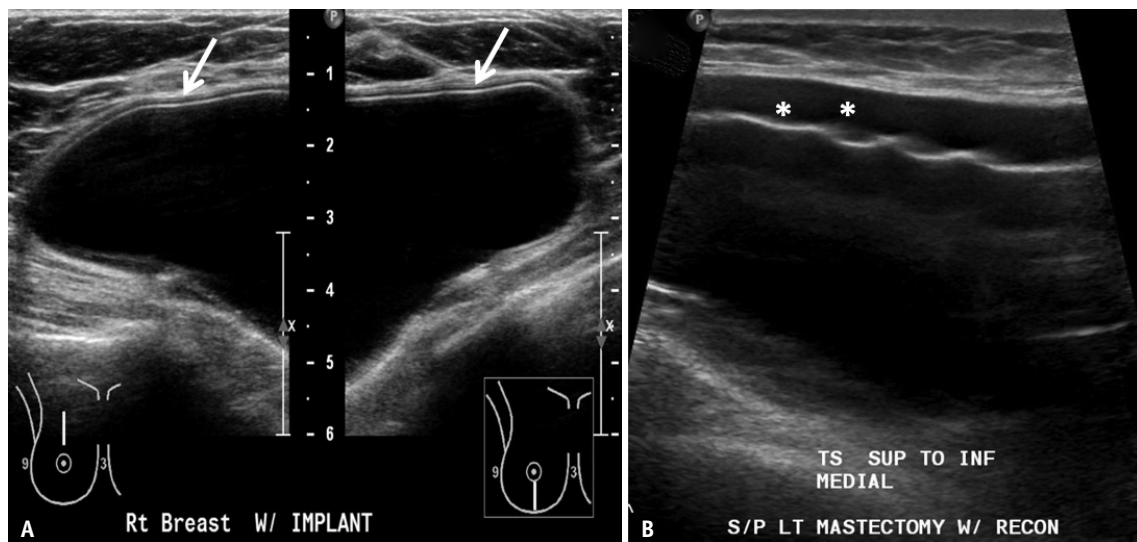
Saline implant rupture (Fig. 7) is a frequent clinical diagnosis due to rapid decompression. On imaging, the collapsed silicone envelope appears wrinkled and folded with loss of normal contour and volume of the implant.

Silicone implant ruptures are of two types: intracapsular and extracapsular. In an intracapsular rupture (Fig. 8), a breach occurs in the implant shell although the peri-implant capsule remains intact, and this results in the leakage of the silicone gel between the envelope and capsule. It may be occult on mammography or show subtle signs such as a focal bulge. Ultrasound may show separation of the envelope from the capsule. MRI is the most sensitive and specific modality for detecting intracapsular ruptures. The ruptured envelope appears as low signal curvilinear lines within the T2W-bright silicone sequences, which is referred to as the “linguine sign.” Other subtle signs of intracapsular rupture are the focal separation of the envelope from the fibrous capsule forming teardrop-shaped involutions of the



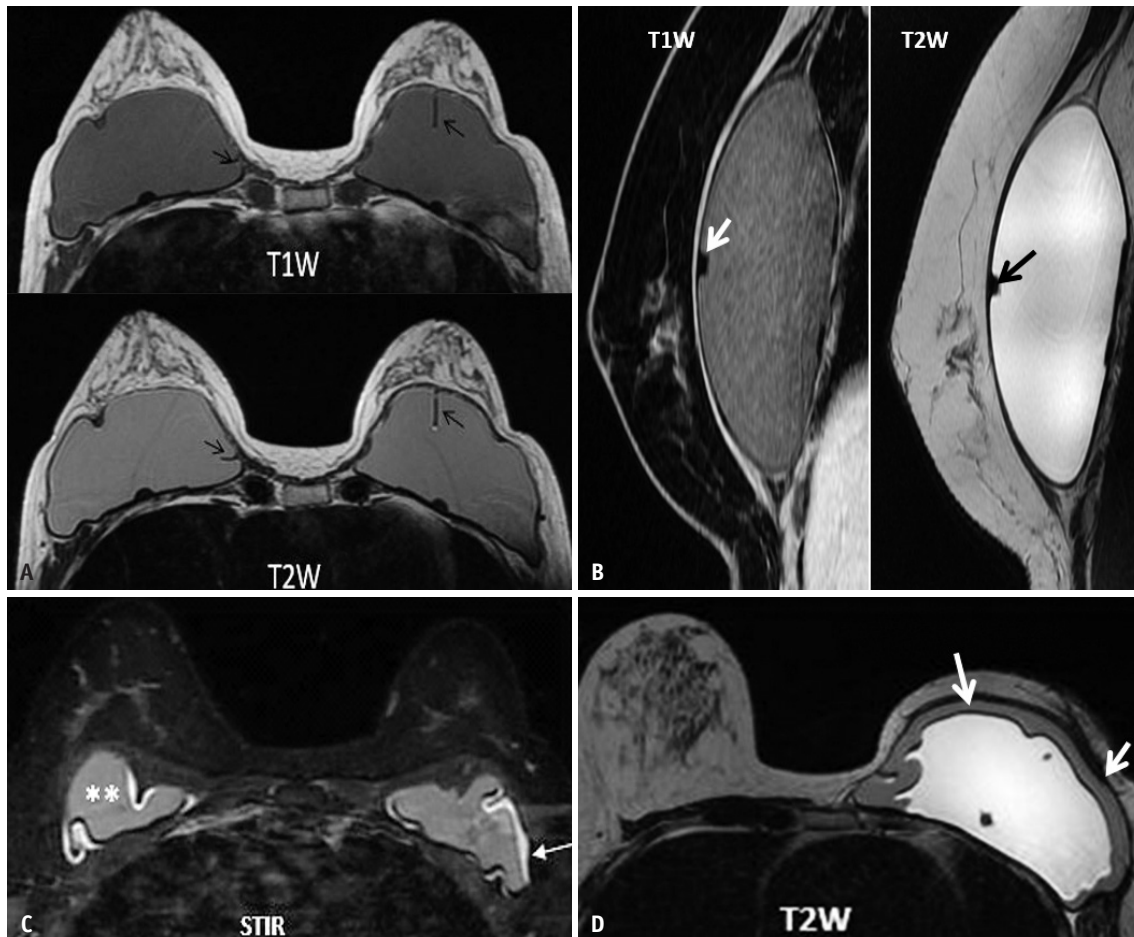
**Fig. 2. Types of implants on mammogram.**

**A.** The left mammogram in MLO projection shows retroglandular silicone implant observed as a homogeneously dense oval mass in front of the pectoralis muscle. **B.** The left mammogram in MLO projection shows a retropectoral saline implant observed as a relatively lucent implant. The implant envelope, as well as the radial folds, are observed as dense lines. The anterior dense nodularity represents the valve (arrow). **C.** The left mammogram in the MLO projection shows a retropectoral standard double-lumen implant with a homogeneously dense inner silicone compartment (dashed arrow) and relatively lucent outer saline compartment (solid arrow). **D.** The left mammogram in the MLO projection shows a reverse double-lumen implant with an outer silicone compartment (dashed arrow) and an inner relatively lucent saline compartment (solid arrow). MLO = mediolateral oblique



**Fig. 3. Types of implants on ultrasound.**

**A.** Right breast ultrasound shows a triangular unilocular anechoic silicone implant with parallel echogenic lines (arrows) representing implant envelope. **B.** Ultrasound of left neo-breast, after mastectomy with reconstruction, shows a double-lumen implant with an outer smaller anechoic compartment (asterisks) and a larger inner anechoic compartment. There is no significant difference between the saline and silicone compartments on ultrasound, and it is not always possible to differentiate between the “standard” and “reverse” double-lumen implants on ultrasound.



**Fig. 4. Types of implant on MRI.** The implant envelope appears hypointense on T1W as well as T2W images for all types of implants. **A.** The silicone implant (top left axial) appears hypointense on the T1W image and intermediate intensity on a T2W image. Thin, linear hypointense signals from the periphery extending inwards (arrows) represent normal radial folds. **B.** The saline implant (top right sagittal) appears hypointense on the T1W image and hyperintense on the T2W image. A hypointense nodular signal along the anterior surface of implants (arrows) represent a normal valve observed in the saline implant. **C.** The double-lumen implant (bottom left) with inner silicone compartment shows intermediate signal (asterisks) and outer saline compartment with hyperintense signal (arrow) on inversion recovery (STIR) image. **D.** Reverse double-lumen implant in a patient with left mastectomy and reconstruction. The inner saline compartment shows hyperintense signal (with tube observed as small hypointense foci), and the outer silicone compartment shows an intermediate signal on the T2W image (arrows). STIR = short tau inversion recovery, T1W = T1-weighted, T2W = T2-weighted

envelope (keyhole/noose sign), subcapsular lines, and the “salad oil sign.”

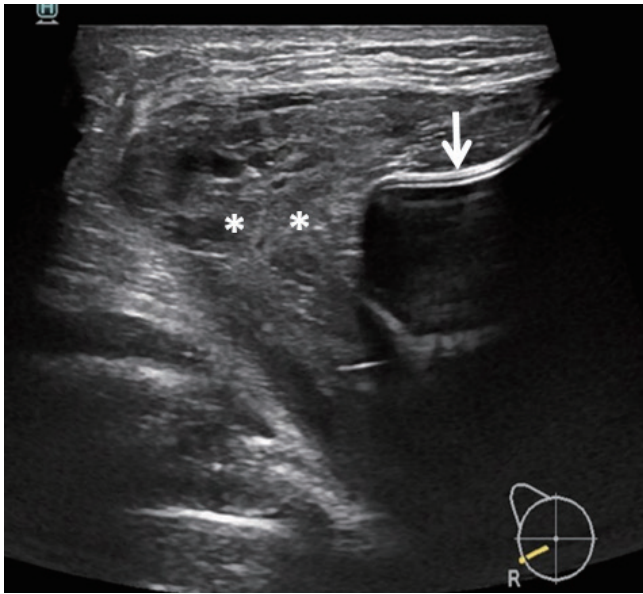
An extracapsular rupture (Fig. 9) refers to the rupture of the implant envelope and capsule, which leads to leakage of the silicone gel beyond the implant capsule. Free silicone is noted outside the implant envelope in the breast parenchyma. On mammography, free silicone can be seen as circumscribed radiopaque masses outside the implant capsule. On ultrasound, free silicone typically appears as an echogenic nodule with a dirty posterior shadowing that gives rise to the “snowstorm sign.” On MRI, free silicone is observed as a discrete extracapsular mass that follows the signal intensity of silicone. They may enhance on post-contrast images.

Most patients with extracapsular implant rupture undergo explantation (Fig. 10) with or without replacement with a new implant.

### Free Filler Injections

#### *Polyacrylamide Gel (PAAG) Injection* (Fig. 11)

PAAG has been used as a filler injection for breast augmentation since 1997 in China and the former Soviet Union. PAAG contains 95–97.5% water and demonstrates the imaging characteristics of water. PAAG is injected into the retroglandular space or at the upper region of the breast [4]. On mammography, PAAG is observed as homogeneously isodense and generally symmetrical

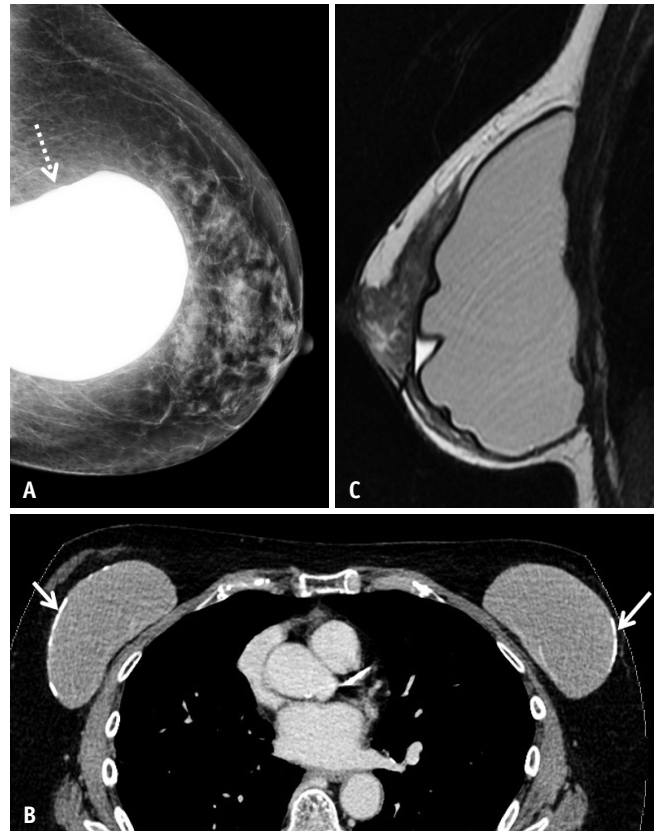


**Fig. 5. Post implant hematoma-ultrasound right breast.** On day 6 after implant surgery, the patient presented to the clinic with painful swelling of the right breast. Ultrasound image shows large mixed echogenic collection with septae and echoes (asterisks) around the implant (arrow). It was proven to be a large peri-implant hematoma that required surgical removal of the implant for symptomatic relief.

masses within the retroglandular space. The lack of dense envelopes differentiate them from implants. On ultrasound, PAAG appears as an unencapsulated fluid collection within the retroglandular space with internal echoes [5]. On MRI, PAAG demonstrates water signal, and it is observed as large, retroglandular, generally homogeneous, T1W hypointense, and T2W hyperintense collections.

**Liquid Silicone Injection** (Fig. 12)

Free silicone gel injection into the breasts was introduced in the 1940s, but it has been banned due to safety issues. We still encounter cases of free silicone injection in our practice. Free silicone is injected into the breast parenchyma, pectoralis muscles, or both [2]. On mammography, free silicone appears as multiple, diffusely scattered, extremely dense, round to oval masses with or without peripheral calcifications. On ultrasound, free silicone can present as clear cysts or echogenic nodules with dirty posterior shadowing, which gives rise to the “snowstorm” appearance. Dense shadowing from silicone granulomas can mask the underlying tumor. Frequently, the skin is also thickened, and it shows extensive shadowing. Therefore, mammography and ultrasound may be deemed inconclusive (Breast Imaging Reporting and Data System 0). This mandates the use of MRI as the screening modality



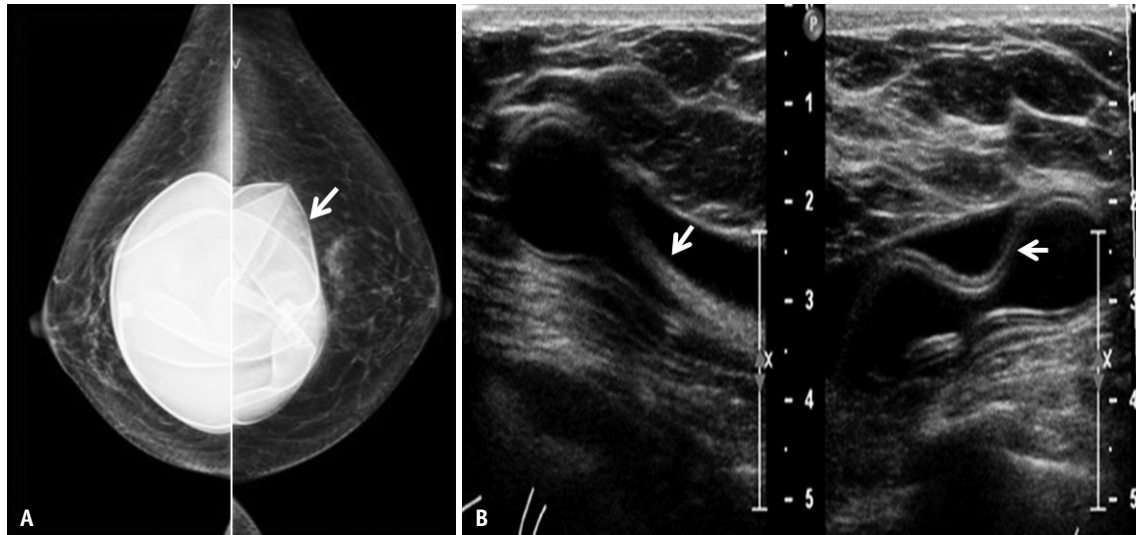
**Fig. 6. Capsular contracture.**

**A.** Left mammogram of a female with breast pain shows a retroglandular silicone implant with calcification (dotted arrow) of the capsule. The implant appears spherical with an irregular contour. **B.** Axial CT scan of the same patient shows bilateral implant capsular calcifications (arrows). **C.** Sagittal T2-weighted MRI of the patient shows the implant with a wavy outline secondary to contracture.

in silicone-injected breasts. Free silicone shows typical signal characteristics with hypo- to intermediate intensity on T1W images and hyperintensity on T2W images. Silicone-specific sequences may be used to differentiate them from benign breast cysts. Occasionally, a silicone granuloma may enhance and mimic malignancy, and biopsy may be needed for differentiation.

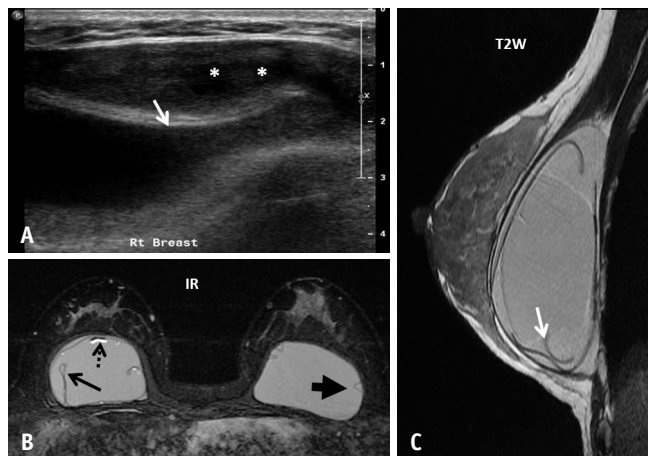
**Autologous Fat Injection** (Fig. 13)

For small to moderate breast augmentation, autologous fat transfer is sometimes performed. The fat is harvested using liposuction from a part of the body and injected into the breasts, usually into the retroglandular space. Fat necrosis is a frequent complication of autologous fat augmentation. The appearance of fat necrosis can vary depending on the stage of necrosis. On mammography, free fat injection appears as single or multiple radiolucent (fat density) masses with or without peripheral calcifications.



**Fig. 7. Rupture of saline implant.**

**A.** Mammography shows intact right breast saline implant with a regular outline and normal folds. The ruptured left saline implant is smaller and partially collapsed with a wrinkled envelope (arrow). The diagnosis is generally made clinically as a sudden loss of implant volume with the “deflated tyre” effect occurs. The extravasated saline gets absorbed by the body. **B.** Ultrasound of the left breast shows a collapsed left breast implant with curved echogenic lines (arrows) representing the collapsed elastomer envelope.



**Fig. 8. Intracapsular implant rupture.**

**A.** Ultrasound of a patient demonstrates the “stepladder” sign with horizontally stacked echogenic lines (arrow) due to the separation of the implant envelope from the capsule with silicone between them (asterisks). **B, C.** Axial short tau inversion recovery sequence (**B**) and sagittal T2-weighted sequence (**C**) MRI show bilateral intracapsular silicone implant rupture. The separation of the implant envelope from the capsule with silicone separating them in intracapsular rupture is observed as a “teardrop” sign (thin black arrow), “noose sign” (thick arrow), or linguine sign (thin white arrow). Minimal T2 hyperintense signals within the silicone may suggest the mixing of peri-implant fluid with the silicone gel to produce the “salad oil” sign (dashed arrow).

On ultrasound, the injected fat can appear as clear or complicated cysts or, sometimes, echogenic masses, which are commonly avascular [6]. On MRI, injected fat shows a typical fat intensity signal on T1W and T2W images that are suppressed on fat-saturated sequences. This typical appearance is generally diagnostic. Fat necrosis may

enhance on MRI, and if associated with fibrosis, it may produce a bizarre-spiculated appearance with architectural distortion. In such cases, biopsy may be warranted to rule out malignancy.

**Liquid Paraffin Injection** (Fig. 14)

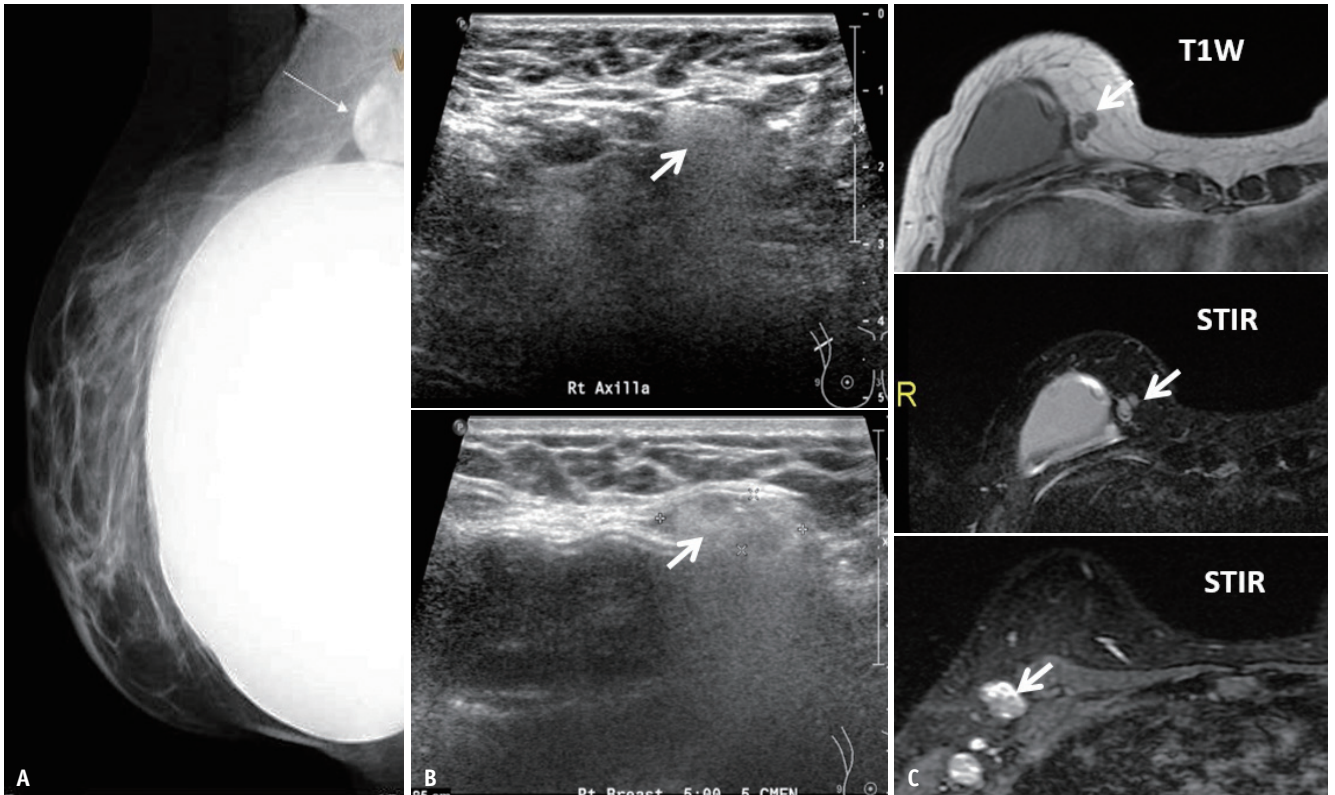
Though widely used for breast augmentation in early 20th century, it is banned due to its serious adverse effects and potential bad cosmesis. Mammography shows multiple, variable size, circumscribed isodense masses in the breast; predominantly in retroglandular space. Associated architectural distortion and dystrophic calcifications may be seen with paraffinomas [7]. Ultrasound has a limited role in these patients due to severe fibrotic reaction causing extensive posterior shadowing.

**Combination of Implant and Free Filler** (Fig. 15)

Occasionally, patients may undergo combination of breast implant and free filler injection to achieve desired size of augmented breast. This further compromises the assessment of breast parenchyma on conventional imaging.

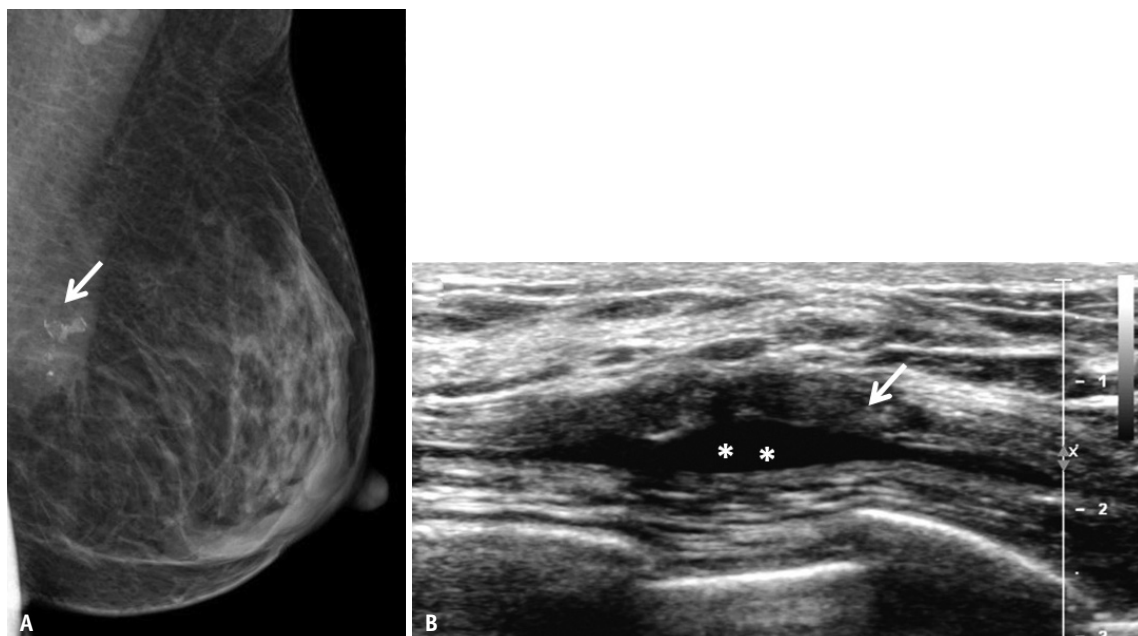
**Post-Mastectomy Breast Reconstruction**

Post-mastectomy breast reconstruction can be performed using implants, autologous flaps, or a combination of both. Implant reconstruction is a fast and less complex surgery, but it has a relatively poorer cosmetic outcome than flap



**Fig. 9. Extracapsular implant rupture.**

**A.** Mammogram shows a round dense mass (arrow) outside the implant, which represents free silicone. **B.** Ultrasound shows echogenic foci (arrows) with dirty shadowing, which gives rise to the “snowstorm appearance,” outside the implant as well as in the axillary node. **C.** On MRI, free silicone is observed as a circumscribed T1W hypointense and a T2W hyperintense mass outside the implant (arrows). A similar high signal intensity is observed within the right axillary nodes on an inversion recovery image (arrows). STIR = short tau inversion recovery, T1W = T1-weighted, T2W = T2-weighted



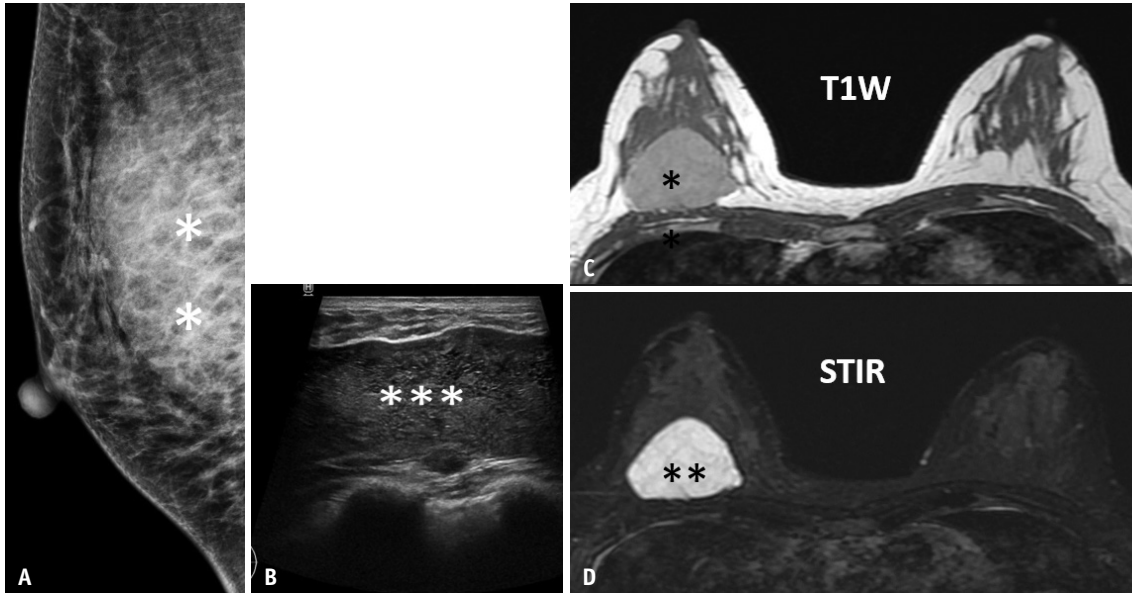
**Fig. 10. Post explantation.**

**A.** Mammogram shows a vague retroglanular isodense mass with coarse internal calcifications representing a residual capsule (arrow). **B.** Ultrasound shows a thick-walled elongated hypoechoic structure (arrow) representing the residual fibrous capsule with a small amount of residual fluid (asterisks).

reconstruction. Autologous flap reconstruction is becoming a relatively common procedure and it can be pedicled or free. Some of the common reconstructions observed in practice are described below.

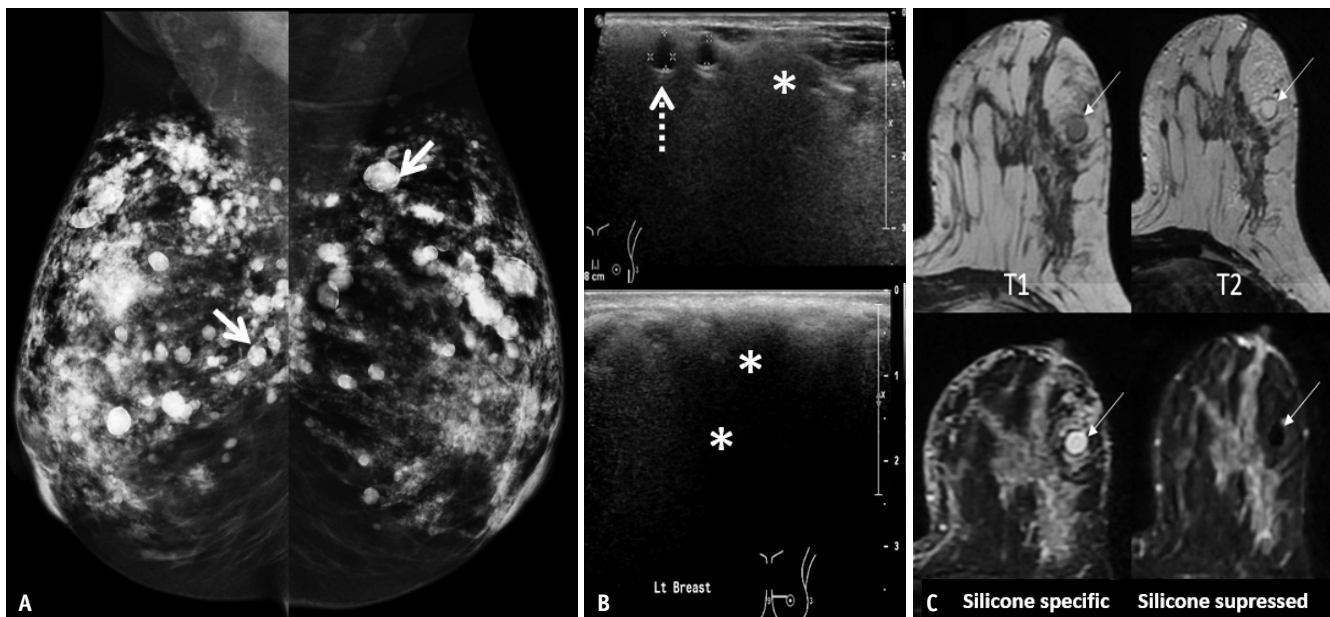
**Post-Mastectomy Reconstruction Using an Implant (Fig. 16)**

A single- or double-lumen implant is inserted within the retropectoral space either at the time of mastectomy



**Fig. 11. Free PAAG injection.**

**A.** Mammogram shows a large isodense mass (asterisks) within the retroglanular space. There is no elastomer envelope or capsule; differentiating it from an implant. **B.** Ultrasound shows a large unilocular retroglanular collection with thick internal echoes (asterisks). **C, D.** PAAG appears as a large retroglanular fluid collection that appears isointense on T1W MRI (**C**) and hyperintense on STIR MRI (**D**) (asterisks). PAAG = polyacrylamide gel, STIR = short tau inversion recovery, T1W = T1-weighted

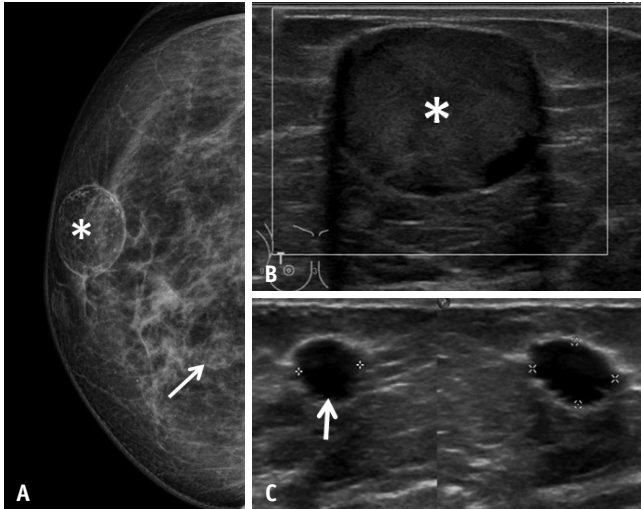


**Fig. 12. Free silicone injection.**

**A.** Mammogram shows numerous high-density nodules (arrows) diffusely scattered in both breasts, representing free silicone. Some of them show peripheral calcifications. **B.** Ultrasound typically shows free silicone as echogenic lesions with dirty shadow and thickened skin, which gives rise to the “snowstorm” appearance (asterisks) and masks the underlying tissue. It can occasionally appear as anechoic cysts (arrow). **C.** On MRI, free silicone appears as circumscribed masses (arrows) with a hypointense signal on a T1-weighted image and hyperintense signal on T2-weighted and silicone-specific images; it appears dark on silicone-suppressed images.

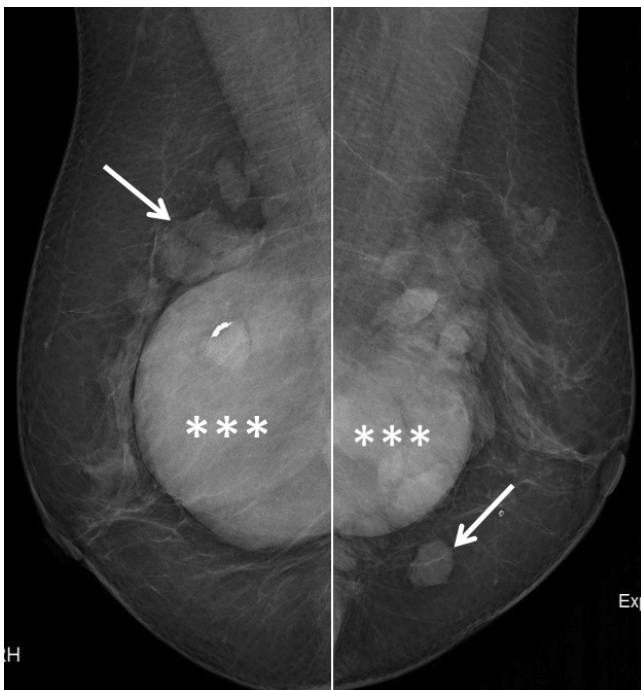


or delayed reconstruction as the second stage. A tissue expander may be placed, in some cases, to stretch the remaining skin and prepare the site for implant insertion at



**Fig. 13. Free fat injection.**

**A.** Mammogram shows few fat-containing lesions (arrow, asterisk) with a dominant lesion in the periareolar right breast that shows eggshell calcifications. **B.** Ultrasound shows a larger oval circumscribed avascular mixed echogenic lesion (asterisk) correlating with the mammographic fatty lesion. It represents injected free fat. **C.** Another ultrasound appearance of injected fat is a clear cystic lesion, as shown in this image (arrow).

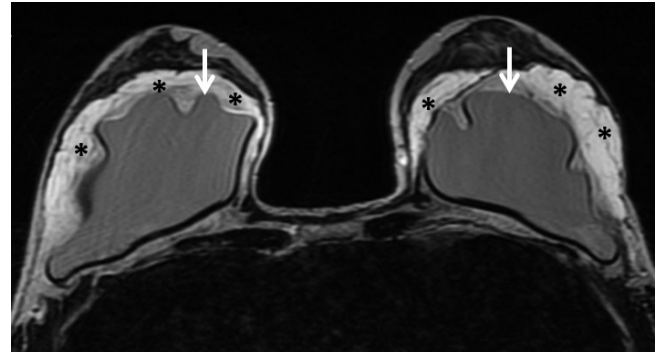


**Fig. 14. Free paraffin injection.** Mammogram shows bilateral variably sized isodense masses, predominantly within the retroglandular space (asterisks, arrows), representing free filler material-paraffinomas as per the provided history of the patient. Some of them are calcified.

a later date.

**Post-Mastectomy Reconstruction with an Autologous Flap**

After mastectomy, the autogenous tissue is transferred to the mastectomy site for reconstruction. The main advantages are the natural soft consistency of the reconstructed breast and the ability of autogenous tissue to



**Fig. 15. Bilateral breast augmentation with free PAAG and implants.** Axial T2W image shows bilateral retropectoral silicone implants (arrows) with surrounding T2W hyperintense free PAAG (asterisks) to further augment the breasts. A small amount of the fibroglandular parenchyma is pushed anteriorly. PAAG = polyacrylamide gel, T2W = T2-weighted

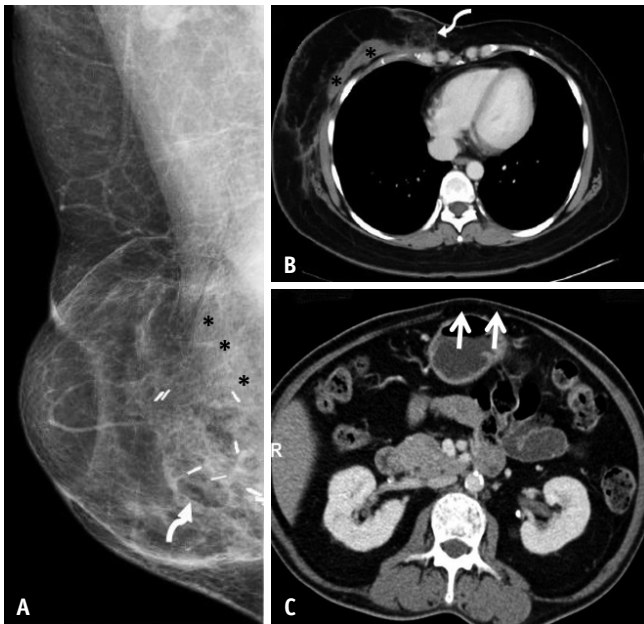


**Fig. 16. Post-mastectomy implant reconstruction.** **A.** Axial T1-weighted MRI image shows a right mastectomy with a single-lumen silicone (asterisks) implant reconstruction. **B.** Axial T2-weighted MRI image of another patient shows right mastectomy with double-lumen implant reconstruction. The inner silicone compartment shows an intermediate signal (asterisks), whereas the outer saline compartment shows a hyperintense signal (arrows).

better drape around the chest, providing improved cosmesis.

**Transverse Rectus Abdominis Myocutaneous (TRAM) Flap** (Fig. 17)

This autologous myocutaneous flap is made up of



**Fig. 17. Right post-mastectomy TRAM flap reconstruction.** A, B. Mammogram (A) and axial CECT scan (B) images show that the reconstructed right breast mainly contains fat with atrophied muscle (asterisks). Fat necrosis is observed (curved arrow) in the lower inner quadrant of the right breast. C. Axial CECT of the abdomen in a patient with TRAM demonstrates a left anterior abdominal wall defect (arrows) representing the donor site. CECT = contrast enhanced CT, TRAM = transverse rectus abdominis myocutaneous

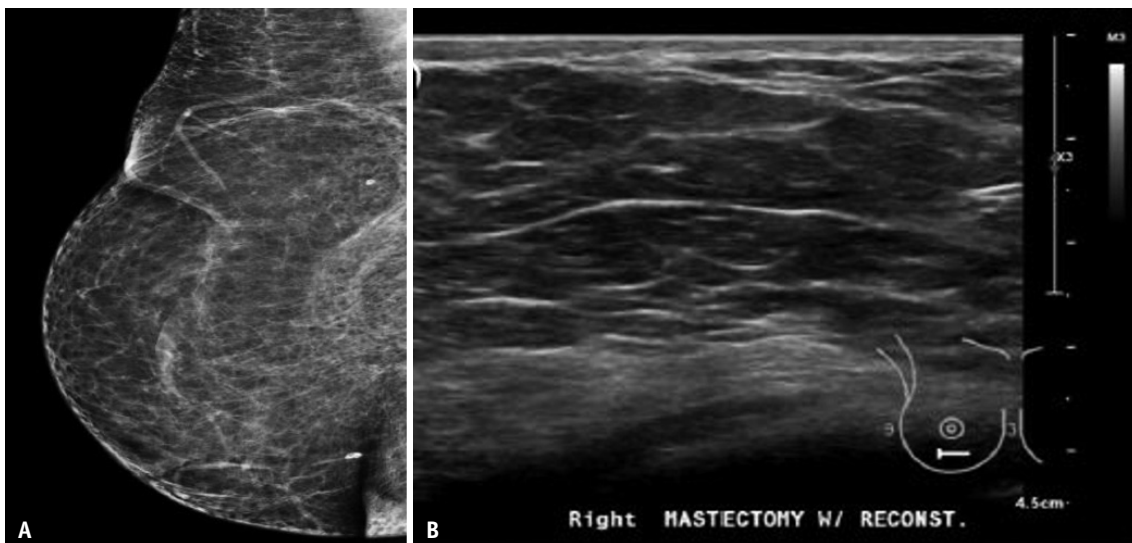
skin, subcutaneous fat, rectus abdominis muscle, and the adjoining vasculature. It restores the volume of the breast and rejuvenates the abdominal shape. The reconstruction can be performed at the time of mastectomy or delayed post-radiotherapy [8]. On imaging, fat and the atrophied rectus muscle are observed to replace the breast parenchyma. Potential complications include postoperative fat necrosis, abdominal wall weakness/hernias, hematoma, delayed healing, and partial or complete flap rejection. Mammography shows predominantly fatty tissue with posteriorly located surgical clips. On ultrasound, predominantly fat tissue is identified, whereas an atrophied muscle may not be observed well.

**Deep Inferior Epigastric Perforator (DIEP) Flap Reconstruction** (Fig. 18)

This is a free tissue flap that requires vascular microanastomosis to establish blood supply to the transferred tissue. An elliptic flap of the abdominal skin and subcutaneous fat is elevated, leaving the rectus muscle *in situ*. This avoids the complication of abdominal wall weakness [9]. Multimodality imaging features of deep inferior epigastric perforator (DIEP) are similar to that of a transverse rectus abdominis myocutaneous (TRAM) flap except for lack of the atrophied rectus muscle.

**Latissimus Dorsi (LD) Myocutaneous Flap Reconstruction**

This surgical technique involves the detachment of the posterior section of the latissimus dorsi (LD) muscle, which



**Fig. 18. Right post-mastectomy DIEP flap reconstruction.** A, B. Mammogram (A) and ultrasound (B) images show right post-mastectomy reconstruction with a predominantly fatty DIEP flap. DIEP = deep inferior epigastric perforator

is transferred to the anterior thorax area to cover the mastectomy site. In a thin patient, it can be used alone (Fig. 19). But more commonly, it is paired with an implant for volume restoration (Fig. 20) [10]. The LD flap is usually used for patients with contraindications for the TRAM or DIEP flap or insufficient lower abdominal tissue.

### Breast Cancer in the Augmented Breast and the Reconstructed Breast

There is no evidence supporting an increased risk of breast cancer after augmentation [11,12]. However, breast augmentation may obscure breast cancer in some cases.

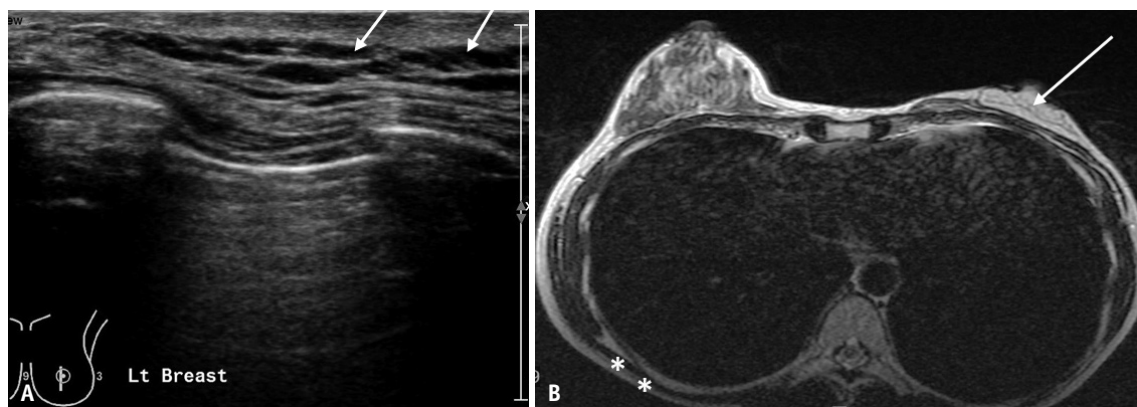
#### Breast Cancer with Implant (Fig. 21)

Implants may obscure a significant part of the breast parenchyma and underlying lesions. Adjuvant implant-

displaced (Eklund) views may be helpful in these cases, and they are part of the routine workup at several centers. Adjuvant screening with breast ultrasound or MRI in female with implants may be considered, especially in high-risk female.

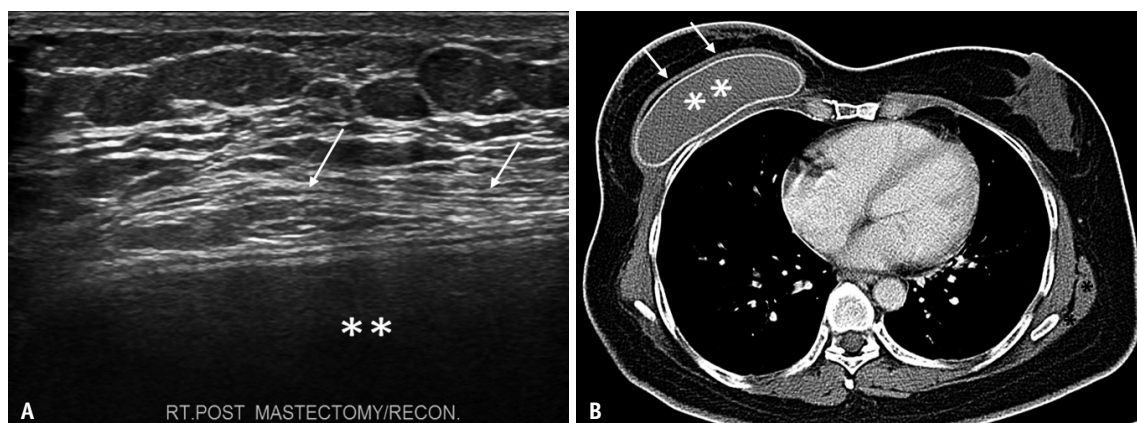
#### Breast Cancer with Free Filler (Fig. 22)

Free filler injections performed for augmentation obscure breast parenchyma to variable degrees depending on their density and location. Free silicone injection significantly obscures the underlying breast parenchyma on mammograms and ultrasound. Therefore, MRI may be recommended for screening in this group of female. The water density of PAAG may not obscure the tumor completely, and a mammogram may still be useful, although MRI provides a better characterization and facilitates a more accurate determination of the extent of the tumor.



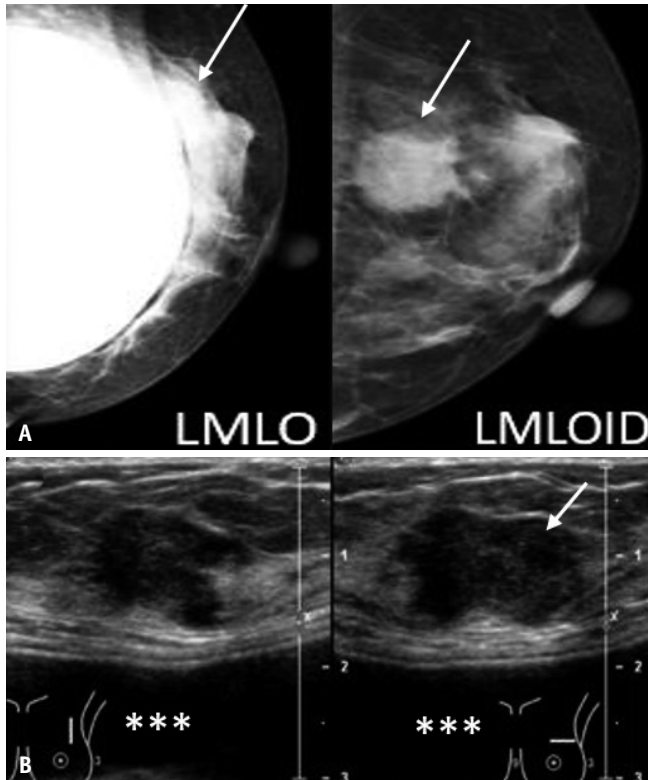
**Fig. 19.** Left post-mastectomy LD flap reconstruction without implant.

**A.** Ultrasound shows reconstructed left breast with LD flap (arrows). **B.** MRI of the same patient shows a small left reconstructed breast (arrow) with an LD flap. An LD flap alone may not provide enough volume, and this may result in the asymmetry of the breasts. Note the absent left LD muscle compared with the intact right LD muscle (asterisks). LD = latissimus dorsi



**Fig. 20.** Right post-mastectomy reconstruction with LD flap and implant.

**A.** Ultrasound shows thin LD muscle layer (arrows) anterior to the implant (asterisks). **B.** Post-contrast CT image of the same patient shows mastectomy with an LD muscle flap (arrows) anterior to the silicone implant (white asterisks). The LD muscle on the right side is flipped anteriorly compared with the normal LD muscle on the left side (black asterisks). LD = latissimus dorsi



**Fig. 21. Breast cancer in an augmented breast.**  
**A.** Left mammogram in standard MLO projection, as well as implant-displaced MLO (LMLOID) projections, shows a tumor (arrows) in the upper half of the left breast that is better appreciated with the implant-displaced view. **B.** Ultrasound shows an irregular heterogeneously hypoechoic mass (arrow) in the left breast at the 1 o'clock position with an underlying implant (asterisks). LMLO = left mediolateral oblique, LMLOID = left mediolateral oblique implant displaced

**Implant-Related Anaplastic Large Cell Lymphoma (ALCL) (Fig. 23)**

This is a rare form of T-cell lymphoma associated with breast implants, particularly the textured type, and it generally presents approximately 8–10 years post-implantation. The etiology remains unclear, but it is thought to be secondary to a combination of chronic inflammation, implant texture, and subclinical infective pathology related to the formation of a biofilm [13]. Clinical presentations of sudden-onset persistent pain and swelling of the breast, which are usually unilateral, may provide clues for diagnosis. On imaging, anaplastic large cell lymphoma can present as peri-implant effusion or enhancing mass related to the implant capsule with associated axillary lymphadenopathy in up to 15% of cases. MRI is the most sensitive modality for the detection of these findings.

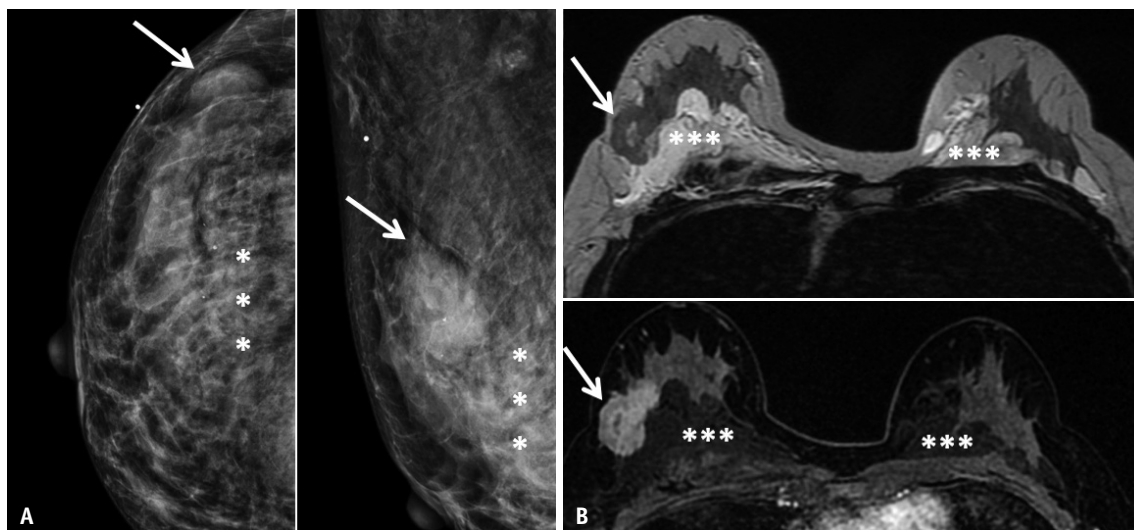
**Recurrent Tumor in the Reconstructed Breast (Fig. 24)**

Though uncommon, a recurrent tumor in an autologous flap may be observed in clinical practice, especially if the primary tumor was aggressive and the patient does not receive adjuvant treatment. Most recurrent tumors in flaps are clinically detected, although some deep-seated lesions may be detected on surveillance imaging.

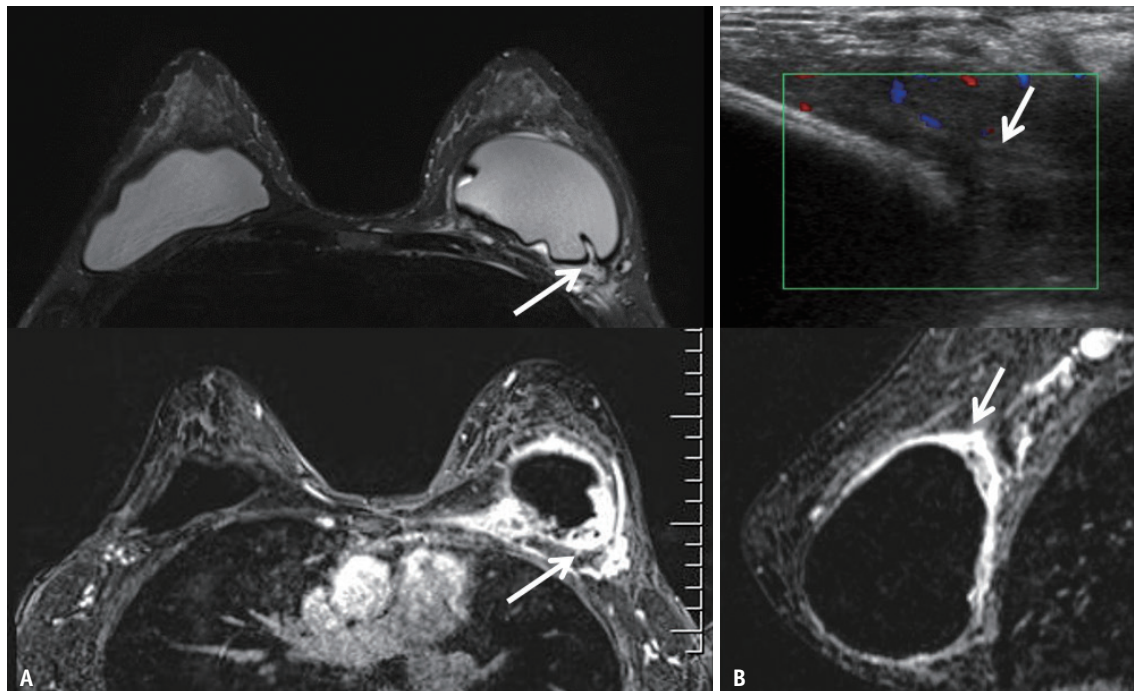
**Other Complications of Breast Augmentation**

**Stromal Fibrosis (Fig. 25)**

Stromal fibrosis is a benign pathologic process

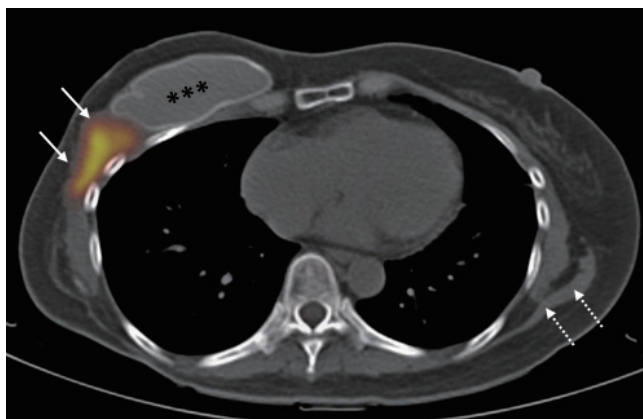


**Fig. 22. Breast cancer in an augmented breast.**  
**A.** Right mammogram in craniocaudal and mediolateral oblique view for a patient with free PAAG injection and right breast palpable mass. An isodense mass (arrows) nearly merges with PAAG (asterisks) on the mammogram. **B.** T2-weighted (top right) and post-contrast T1-weighted fat-saturated (bottom right) axial MRI images of the same patient show a large irregular enhancing mass (arrows) in the upper outer quadrant of the right breast with underlying large PAAG gel (asterisks). This mass was histologically proven to be an invasive ductal carcinoma. PAAG = polyacrylamide gel



**Fig. 23. Implant-related ALCL.**

**A.** T2-weighted fat-saturated axial (top left) MRI image shows minimal left peri-implant fluid. Post-contrast T1-weighted fat-saturated axial (bottom left) and sagittal MRI (bottom right) images show thick nodular rim-like enhancement (arrows) along the left breast implant capsule. **B.** Ultrasound shows a vascular hypoechoic lesion around the implant (arrows). It was proven to be ALCL on histology. The patient was treated with implant removal and capsulectomy followed by chemotherapy. (Figure courtesy: Dr. Supriya Kulkarni, Associate Professor, University of Toronto, Canada). ALCL = anaplastic large cell lymphoma



**Fig. 24. Recurrence in a reconstructed breast.** The patient had right mastectomy and reconstruction with an implant and LD flap 3 years ago. She presented with a vague palpable lump in her right breast. PET scan showed an fluorodeoxyglucose avid mass (arrows) in the lateral half of the reconstructed breast. The implant (asterisks) was pushed medially by the mass. Note the absent right LD muscle from its expected location compared with the normal left LD muscle (dashed arrows). The mass was histologically proven to be a sarcoma. LD = latissimus dorsi

characterized by the proliferation of fibrous tissue. Free filler material may cause a foreign body reaction resulting in bizarre stromal fibrosis that may mimic cancer in some patients.

**Pectoralis Muscle Rupture (Fig. 26)**

This is one of the rare complications resulting from chronic overstretching of the muscle secondary to large filler injections.

**Silicone/PAAG Migration (Fig. 27)**

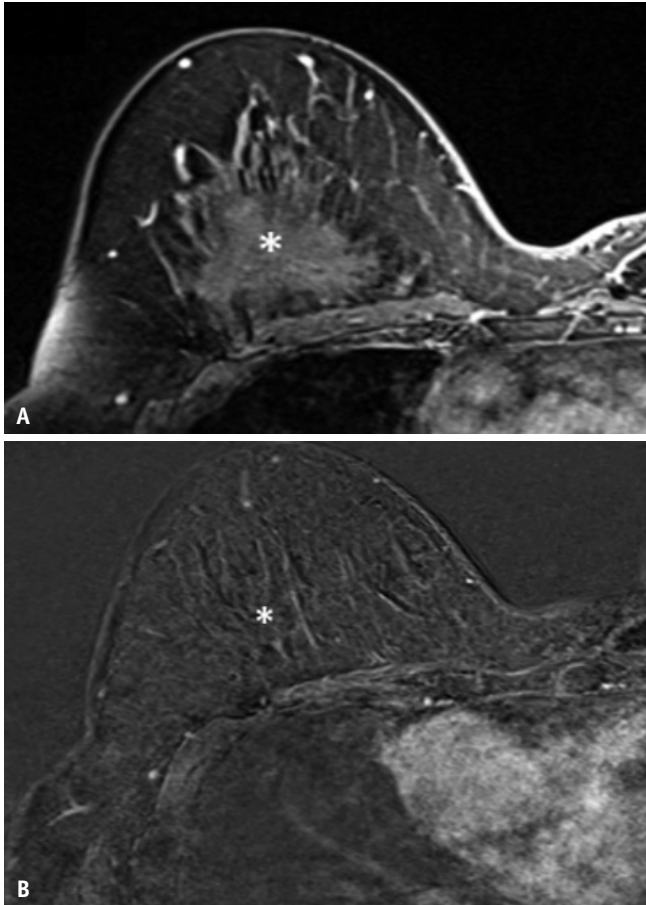
Most free filler injections are performed without imaging guidance, and they are frequently observed in the pectoralis muscle. Rarely, they may migrate to different body parts, including the arms, torso, lungs, and liver.

**Asymmetrical Enlargement (Fig. 28)**

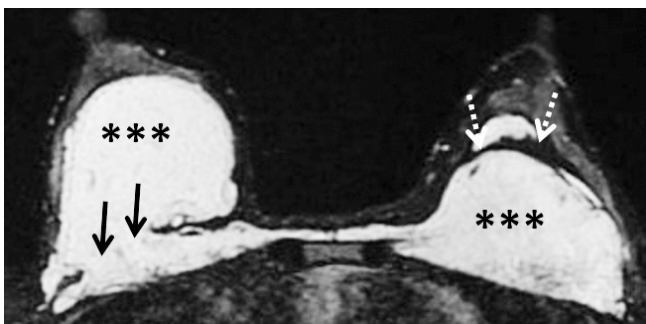
The augmented breast may become asymmetrical and cosmetically unacceptable during injection or as a late complication.

**Large Peri-Implant Seroma (Fig. 29)**

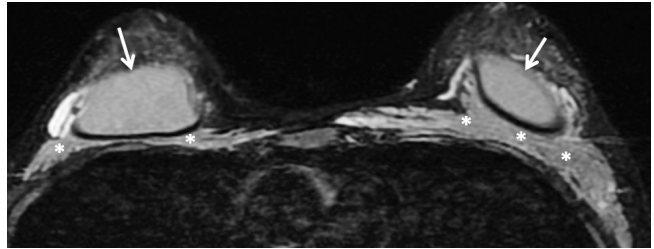
This is a late complication that is observed approximately 2 to 10 years after implant insertion. It may be secondary to non-infective inflammatory reactions or infective processes, but rarely due to implant-related anaplastic lymphoma. Cytological analysis of seroma fluid is mandatory to identify the etiology.



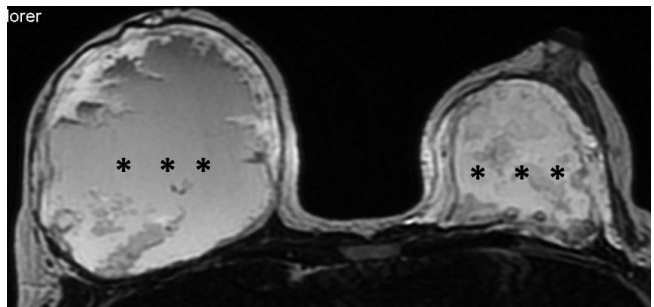
**Fig. 25. Stromal fibrosis.** A female with a previous free silicone injection presented with a palpable lump in her right breast. Mammogram (not shown) showed a spiculated high-density mass in the upper half of the right breast.  
**A, B.** A post-contrast T1-weighted fat saturated MRI image (**A**) and a subtracted image (**B**) of the patient showed a non-enhancing spiculated mass (asterisks). The mass was histologically proven to be stromal fibrosis, and it was stable on follow-up.



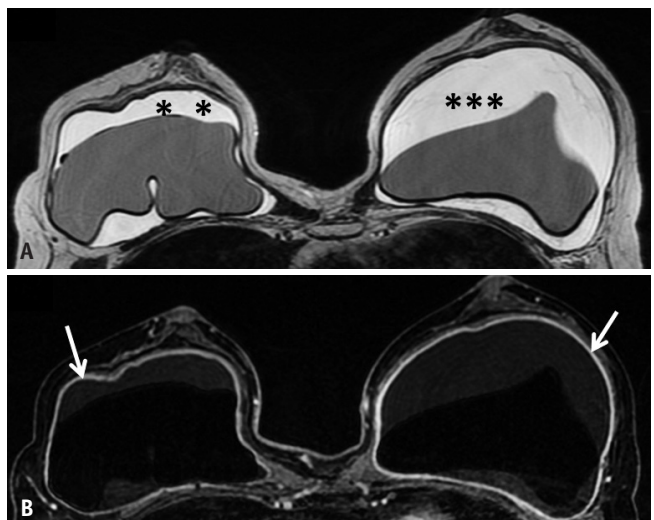
**Fig. 26. Pectoralis muscle rupture in free PAAG injection.** Patient presented with a sagging right breast. PAAG injection was performed 17 years ago. T2-weighted axial MRI image shows large fluid intensity material (asterisks) within the retroglandular and retropectoral spaces. The rupture of the inferior part of the right pectoralis major muscle (arrows) explains the sagging of the breast. In the left breast, PAAG is predominantly observed within the retropectoral space with stretching and thinning of the pectoralis major muscle (dotted arrows). PAAG = polyacrylamide gel



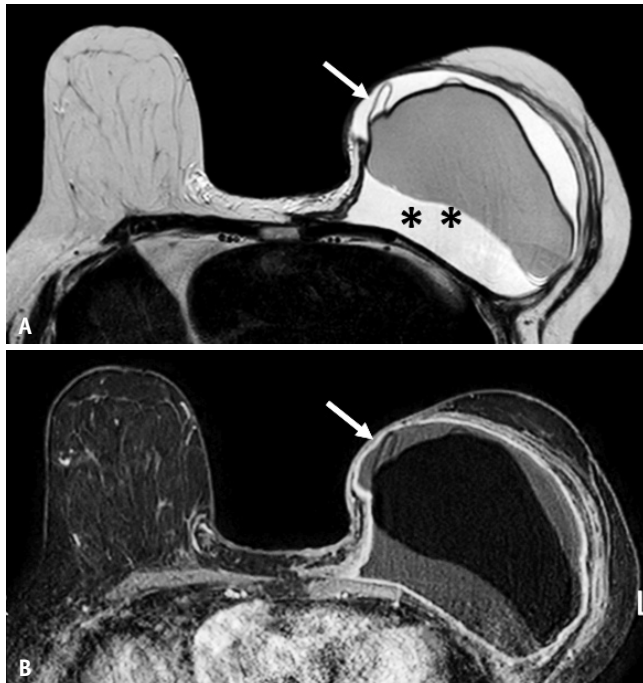
**Fig. 27. Free PAAG injection in pectoralis muscle.** Inversion recovery axial images show bilateral implants (arrows) with surrounding T2-weighted intermediate intensity collections representing free PAAG injection (asterisks). Significant amount of PAAG is observed within the bilateral pectoralis muscles. On the left side, it extends toward the lateral chest wall. PAAG = polyacrylamide gel



**Fig. 28. Asymmetrical enlargement of breasts after PAAG injection (asterisks).** T2-weighted axial image of a patient who received a free PAAG injection 11 years ago and presented with sudden-onset swelling of both breasts; the swelling was more pronounced in the right breast. MRI shows large asymmetric fluid collections within the retroglandular space bilaterally. The right breast is significantly stretched and swollen. Surgical removal of PAAG was performed for symptomatic relief in this patient. PAAG = polyacrylamide gel



**Fig. 29. Large peri-implant effusion.** MRI of a female with bilateral breast silicone implants inserted 15 years ago presented with sudden painful enlargement of both breasts.  
**A, B.** T2-weighted (**A**) and post-contrast T1-weighted fat saturated (**B**) axial MRI images show bilateral large peri-implant effusion (asterisks); it was larger on the left side. The implants were intact. Minimal enhancement of the implant capsule was also noted bilaterally (arrows). The aspirated fluid was negative for lymphoma.



**Fig. 30. Post-mastectomy flap failure.**

**A, B.** T2-weighted (**A**) and post-contrast T1-weighted fat saturated (**B**) MRI images show the left breast after mastectomy reconstruction with the latissimus dorsi flap and silicone “cohesive” gel implantation. Flap failure with tissue necrosis along the medial aspect of the flap can be observed. This exposed the underlying implant and resulted in the rupture of the implant with peri-implant seroma (asterisks). The implant envelope is observed floating within the seroma fluid medially (arrows). Other signs of intracapsular rupture are lacking in this patient due to the cohesive nature of silicone gel which avoids leaking. The implant capsule shows diffuse enhancement due to reactive inflammation. Surgical exploration confirmed a ruptured implant, and it was removed.

#### Flap Failure with Secondary Implant Rupture (Fig. 30)

Autologous flaps may occasionally become necrosed and be rejected by the body. The risk of this complication is higher with prolonged surgery, bilateral reconstruction, delayed reconstruction, smoking, and in older female.

## CONCLUSION

With the myriad of breast augmentation and reconstruction techniques available today, we, as radiologists, should familiarize ourselves with the spectrum of imaging findings across different modalities to facilitate the detection of common complications. We also need to bear in mind the potential challenges during screening, including the mimickers and maskers of malignancy. The prudent use of adjuvant ultrasound and MRI is needed in these patients to avoid delay in the diagnosis of breast cancer.

## Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

## Author Contributions

Conceptualization: Niketa Chotai. Data curation: all authors. Formal analysis: all authors. Project administration: Renuka Nair Kunju Krisnan. Supervision: Niketa Chotai. Visualization: Niketa Chotai. Writing—original draft: Renuka Nair Kunju Krisnan. Writing—review & editing: Niketa Chotai.

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