

# **Breast Implants: normal and abnormal findings. Basic aspects that the resident must know.**

Keywords: Protheses, Complications, Ultrasound, MR, Breast

Type: Educational Exhibit

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## **LEARNING OBJECTIVES**

The purpose if this exhibit is:

1. To describe the different types of breast implants, their location and features.
2. To review the main complications of implants and their radiologic features.
3. To explain concurrent breast abnormalities that can be found in radiologic exams.

## **BACKGROUND**

In our daily practice we often have to asses breast implants, so it is necessary to know the main types, their location and characteristics.

We have to be able to detect complications of protheses and their image features in US and MR.

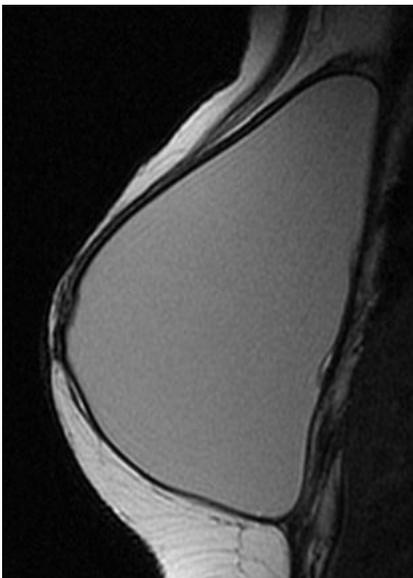
It is also important to asses concurrent breast abnormalities, in order to interpret correctly this studies.

## 1. TYPES OF BREAST IMPLANTS.

Nowadays, the most frequent breast implants are:

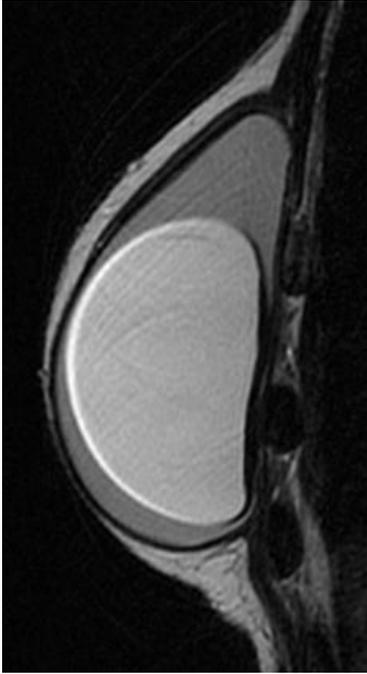
- Single lumen: filled with silicone (homogeneous high-signal-intensity viscous silicone on T2-weighted images) or saline solution (with different signal intensities depending on the pulse sequence). Fig. 1.
- Standard double lumen: filled with silicone gel in the inner lumen and with saline solution in the outer one (inner lumen of high signal-intensity silicone surrounded by a smaller outer lumen that contains saline and has different signal intensities).
- Reverse double lumen: saline solution in the inner lumen and silicone in the outer lumen. Fig. 2.
- Expanders.

There are also another less common types: reverse-adjustable double-lumen, gel-gel double-lumen, triple-lumen, Cavon "cast gel", custom, solid pectus, sponge (simple or compound), sponge (adjustable).



**Fig. 1:** Sagittal FSE T2-weighted sequence. Single lumen silicone filled in retropectoral location.

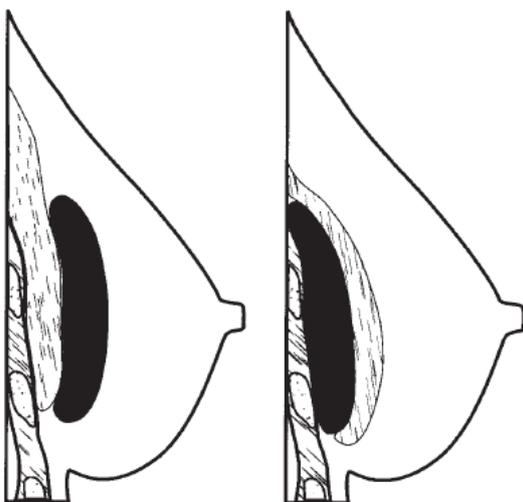
**References:** - Salamanca/ES



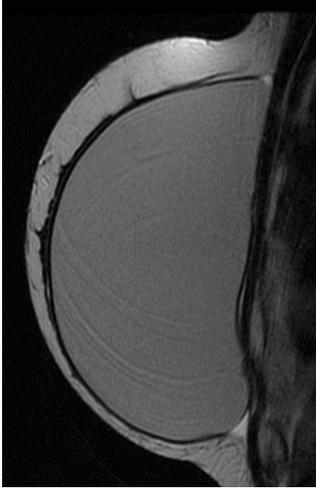
**Fig. 2:** Sagittal FSE T2-weighted image. Reverse double lumen implant.  
**References:** - Salamanca/ES

### **Location (Fig. 3)**

- Subglandular or retroglandular: located in front of the pectoralis major muscle. (Fig. 4).
- Subpectoral or retropectoral: behind the pectoralis major muscle, partial or completely. (Fig. 5).

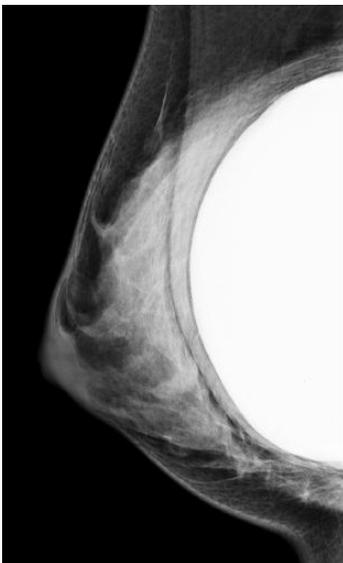


**Fig. 3:** Subglandular implant placement (left) and subpectoral implant placement (right).  
**References:** 2011, 2004 by Mosby, Inc., an affiliate of Elsevier Inc.



**Fig. 4:** Sagittal FSE T2-weighted image. Subglandular single lumen implant filled with silicone.

**References:** - Salamanca/ES



**Fig. 5:** Mediolateral oblique mammogram showing a retropectoral implant.

**References:** - Salamanca/ES

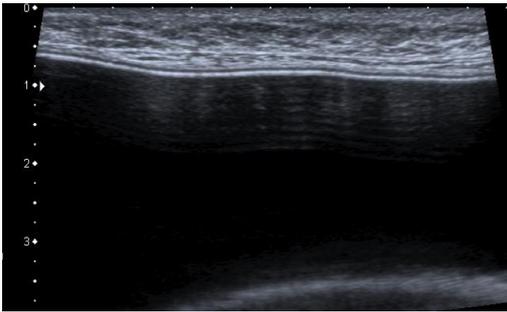
### **Imaging features**

The most common and most important sequences in silicone breast implant assessment are turbospin-echo (FSE) T2-weighted images (the silicone is moderately hyperintense in T2-weighted images but less than water), short-time inversion recovery silicone excited (silicone hyperintense, water suppressed), and silicone-saturated (water hyperintense, silicone suppressed).

In a normal implant we can see regularity of the implant contour and homogeneous lumen with anechoic content in ultrasound (Fig. 6). We can

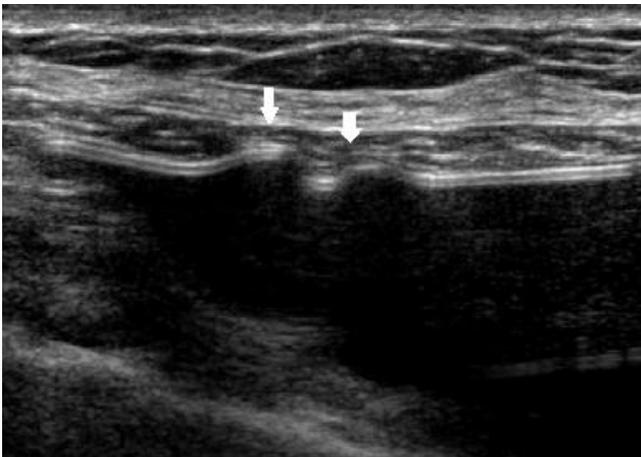
observe radial folds (Fig. 7) that shouldn't be confused with a rupture. They represent infoldings of the shell into the silicone gel and extend perpendicularly from the periphery to the interior of the implant, without presence of silicone between its layers. Similar findings can be seen in expanders. The expander is placed in the mastectomy site prior to a permanent implant. It is placed in the collapsed form and will be slowly inflated afterwards, so it may have folds in the surface if it is not completely filled and it should not be interpreted as a rupture.

As a normal finding, a small amount of periprosthetic fluid can be found.



**Fig. 6:** Breast ultrasound showing a normal contour of the implant, a thin and continuous echogenic line at the parenchymal tissue-implant interface.

**References:** - Salamanca/ES



**Fig. 7:** Normal folds (arrows) in an intact implant.

**References:** - Salamanca/ES

## 2. COMPLICATIONS OF BREAST IMPLANTS

Early postoperative complications of breast augmentation include hematoma and infection. Late postoperative complications include capsular contracture, implant herniation, silicone granuloma formation and implant rupture.

## 2.1 HEMATOMA

It usually appears in early stage after surgery or it could be posttraumatic (Fig. 8).

In mammograms we can see well defined hyperdense or heterogeneous densities. Both US and MRI can be used to determine hemorrhage staging.



**Fig. 8:** Chest CT with i.v. contrast administration in a polytraumatized patient shows a hyperdense collection consistent with a hematoma posterior to the implant (arrow) with increased bulk of the right breast.

**References:** - Salamanca/ES

## 2.2 INFECTION

It can occur in the early postoperative period, showing the classical clinical inflammatory symptoms. Radiological findings may not be significant.

The infection can evolve to an abscess and sometimes due to an infected seroma. It is visualized as an irregular, hypoechoic fluid collection with internal debris. Edema of the surrounding tissue can be seen. The abscess will typically show peripheral anular enhancement after endovenous contrast administration.

## 2.3 CAPSULE CONTRACTURE OR CAPSULITIS

This is the most common complication of breast prostheses, despite the fact that the incidence has decreased.

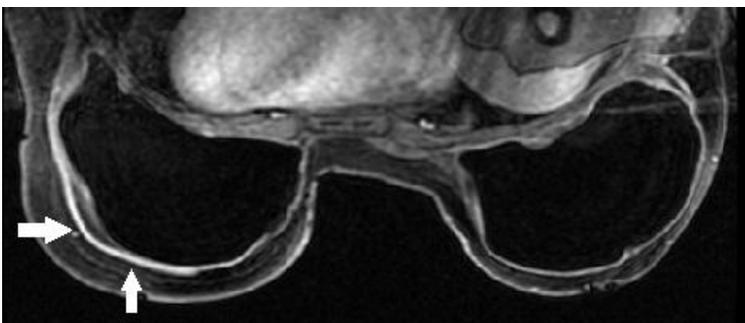
Capsule contracture is the abnormal constriction of the fibrous capsule that surrounds the implant as a physiologic response to a foreign body. The normal capsule should be elastic, mobile and non-palpable while in the contracture it becomes thickened, palpable and fixed.

It is mainly a clinical diagnosis (Fig. 9) with a distorted, tough and sometimes painful breast. The radiological findings may include implant asymmetry, irregular contour, increased antero-posterior diameter, periimplant calcifications, peripheral (capsular) enhancement after endovenous contrast administration (Fig. 10 and Fig. 11) and capsular adhesion to the pectoralis muscle in a more severe form of capsulitis.

Grade	Breast Firmness	Implant	Implant Visibility
I	Soft	Nonpalpable	Nonvisible
II	Minimal	Palpable	Nonvisible
III	Moderate	Easily palpable	Distortion visible
IV	Severe	Hard, tender, cold	Distortion may be marked

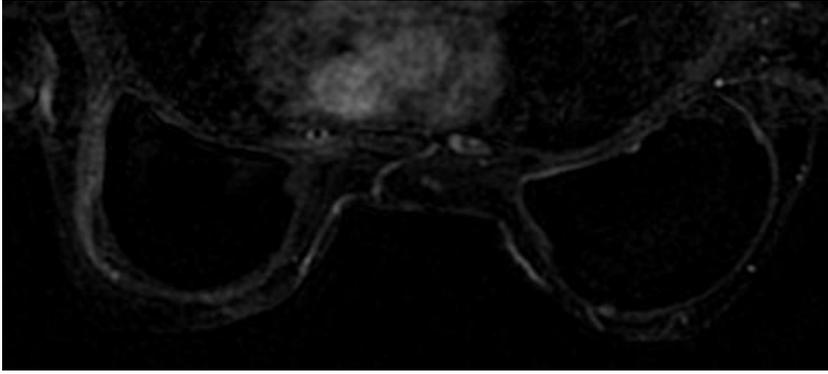
**Fig. 9:** Baker classification of capsule contracture.

**References:** 2011, 2004 by Mosby, Inc., an affiliate of Elsevier Inc.



**Fig. 10:** Post-gadolinium fat-suppressed T1-weighted 3-D SPGR axial image, shows thickening and enhancement of the fibrous capsule consistent with capsulitis (arrows).

**References:** - Salamanca/ES



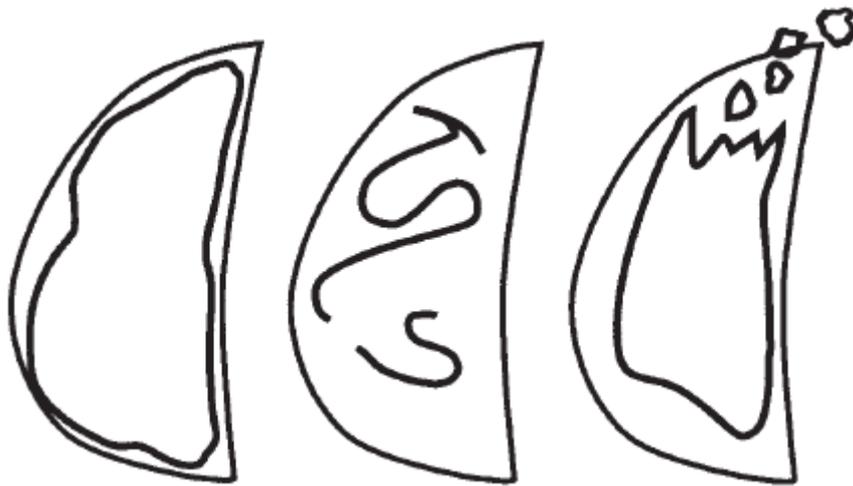
**Fig. 11:** T1-weighted 3-D SPGR before and dynamically following gadolinium and post-gadolinium fat-suppressed T1-weighted 3-D SPGR subtraction image shows fibrous capsule enhancement.

**References:** - Salamanca/ES

## 2.4 IMPLANT RUPTURE

Rupture is one of the key complications on breast implants, and its incidence has been correlated with implant generation. Most implant ruptures occur 10 to 15 years after implantation.

The rupture is classified in two categories depending on the location of the silicone with respect to the fibrous capsule (Fig. 12)



**Fig. 12:** Schematic of implant complications. Left: fibrous capsule normally surrounds the intact implant. Middle: Intracapsular rupture. The implant shell is ruptured, but the silicone is contained in the fibrous capsule. Right: Extracapsular rupture. The implant capsule and the fibrous capsule are damaged, and silicone is outside the fibrous capsule.

**References:** 2011, 2004 by Mosby, Inc., an affiliate of Elsevier Inc.

### 2.4.1 INTRACAPSULAR RUPTURE.

This is the most common type of rupture (80-90%).

The integrity of the implant is breached but the fibrous capsule is intact, so the silicone leakage does not extend beyond the capsule and is confined within the periprosthetic space.

- **Mammography** is not the best exam to assess an intracapsular rupture, a contour bulge could be detected, but it is a low specificity finding.

- **Ultrasound:** we can visualize the "stepladder" sign: multiple linear or curvilinear lines in the interior of the implant at various levels that correlates with the linguine sign. Normal radial folds can simulate this sign, but folds always extend to the implant periphery whereas stepladder lines do not.

We can also find low-level echoes within the implant (something that could be seen in a non-complicated implant) or isoechoic silicone between the fibrous capsule and the implant surface, as a sign of minimally collapsed implant rupture.

- **Magnetic resonance imaging** is the most accurate technique in the evaluation of implant integrity. Its sensitivity for rupture is 80%-90% and its specificity is between 90%-97%.

The most reliable criterion is the linguine sign, (Fig. 13) that reflects collapsed intracapsular rupture. It is due to the presence of layers of collapsed shell that appear as multiple curvilinear low-signal intensity lines floating in the high-signal intensity silicone gel.

In uncollapsed ruptures we could find small amount of silicone outside the shell but contained within the fibrous capsule. We can observe different signs:

"Subcapsular line" sign: a thin layer of silicone placed between the shell and the fibrous capsule.

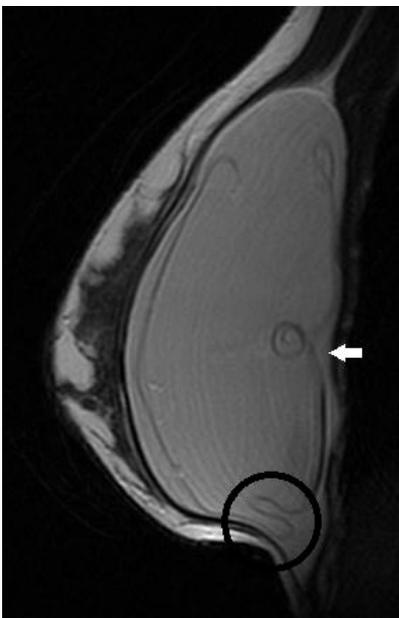
"Pull away" sign: a localized separation of the inner membrane of an implant with gel on both sides.

"Keyhole", "noose" or "inverted-loop" sign (Fig. 13): is a progression of the "pull-away" sign in which the separated layer of the inner membrane, creating a radial fold that looks like a keyhole. It signifies an incipient rupture and is the most common form of intracapsular rupture.

"Teardrop" sign (Fig. 14): it differs from the keyhole sign in that margins of the collapsing shell contact one another.

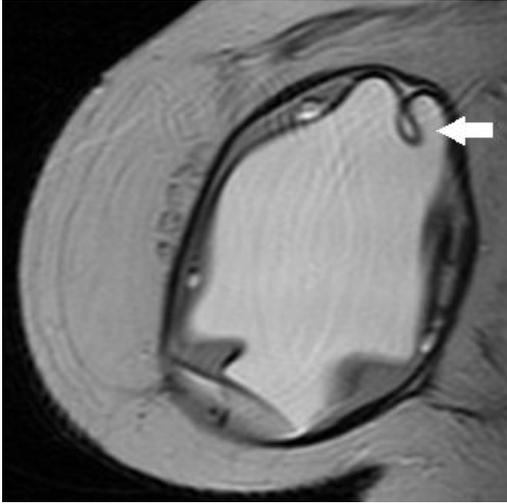
Whether if it is a collapsed or uncollapsed rupture we can find small hyperintense saline drops within the implant, termed the "salad-oil" or "droplet" sign (Fig. 15) It is nonspecific and not reliable without other evidence of implant rupture, but should prompt the search for subtle signs of rupture.

Other findings are deformity in the implant contour, termed the "rat-tail" sign when very pronounced; irregular margin showing a blurry border of the breast implant or changes in the signal intensity of the silicone gel due to a mixture of water-serum in the silicone gel through a defect in the membrane.



**Fig. 13:** Sagittal FSE T2-weighted image. Intracapsular rupture of a single lumen silicone-filled implant with intracapsular rupture. "Linguine" sign (arrow) and "keyhole" sign (circle).

**References:** - Salamanca/ES



**Fig. 14:** Sagittal FSE T2-weighted sequence. Intracapsular rupture in a reverse double-lumen implant. "Teardrop" sign (arrow).

**References:** - Salamanca/ES



**Fig. 15:** Sagittal FSE T2-weighted sequence. Intracapsular rupture in a reverse double-lumen implant. "Salad-oil" sign (arrow).

**References:** - Salamanca/ES

## 2.4.2 EXTRACAPSULAR RUPTURE

There is a rupture of both the implant shell and the fibrous capsule, with silicone leakage that extends into the surrounding tissues. The frequency of this rupture appears to be low in newer generation implants.

**Mammography:** we can find radiopaque silicone extending into the breast parenchyma, along the pectoralis muscle or within the axillary lymph nodes.

**Ultrasound:** the most reliable US sign is the presence of silicone in the parenchyma or the lymph nodes. When it is a conglomerate (Fig. 18) it appears as a hypoechoic or anechoic mass and can form siliconomas or silicone granulomas due to a foreign-body reaction, in which fibrous tissue reaction surrounds the silicone. More frequently we can see the "snowstorm" sign (Fig. 16), an echogenic nodule with dirty posterior shadowing.

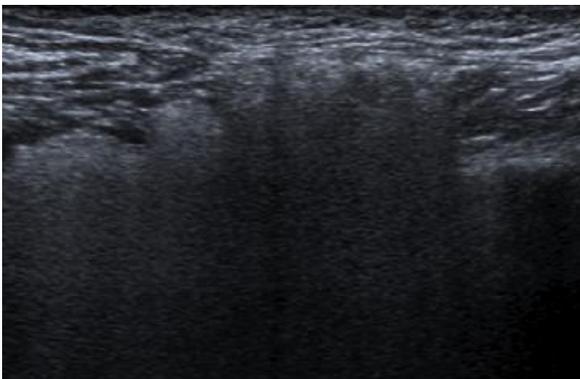
**MRI:** In this kind of rupture we can visualize free silicone as discrete foci or isointense to low signal intensity on water-suppressed T2-weighted images

In the short-term, the silicone signal in the breast will be as bright as the silicone within the implant (Fig. 17, Fig. 18, Fig. 19 and Fig. 20). With granulomatous formation, the signal of the extracapsular silicone will decrease to a variable extent.

It can be seen as free silicone or forming siliconomas. Silicone granulomas have similar enhancement to breast carcinomas and sometimes require biopsy. Also, silicone may have migrated to lymph nodes and they will show equal signal intensity to silicone in all the sequences.

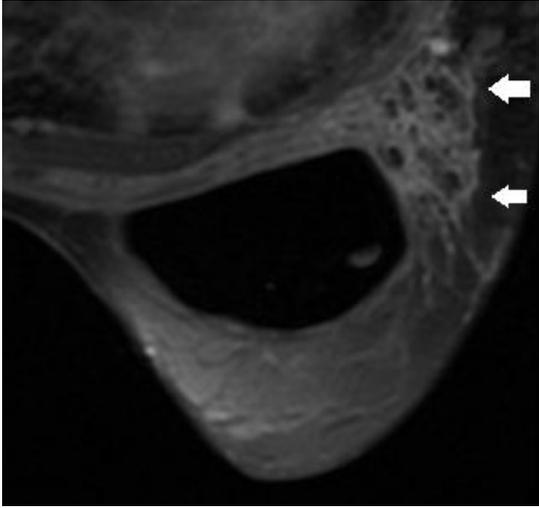
Signs of intracapsular rupture will always be present, the lingune sign is often seen as well as other previously described.

The presence of silicone outside of the fibrous capsule with no signs of intracapsular rupture could lead to a false positive diagnosis of rupture, but it should raise the possibility that the current implant is a replacement for a previously removed implant with uncompleted removal of intraparenchymal silicone.



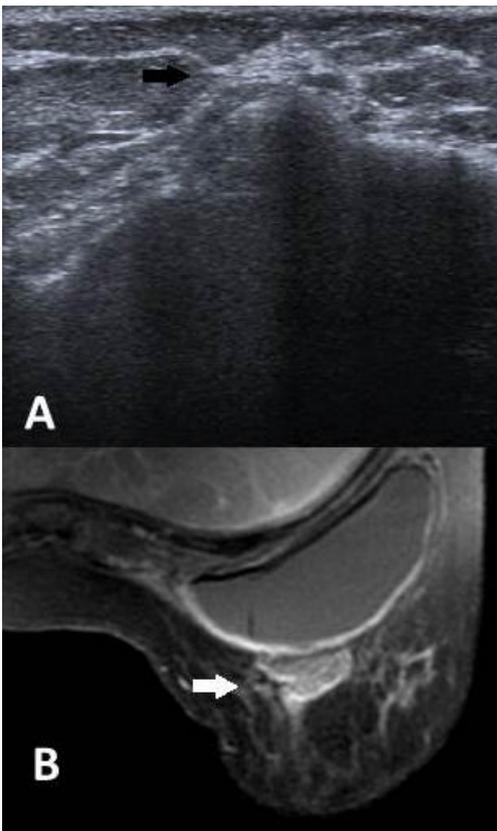
**Fig. 16:** Extracapsular implant rupture. Breast ultrasound showing an echogenic mass with dirty posterior shadowing, termed the "snowstorm" sign.

**References:** - Salamanca/ES



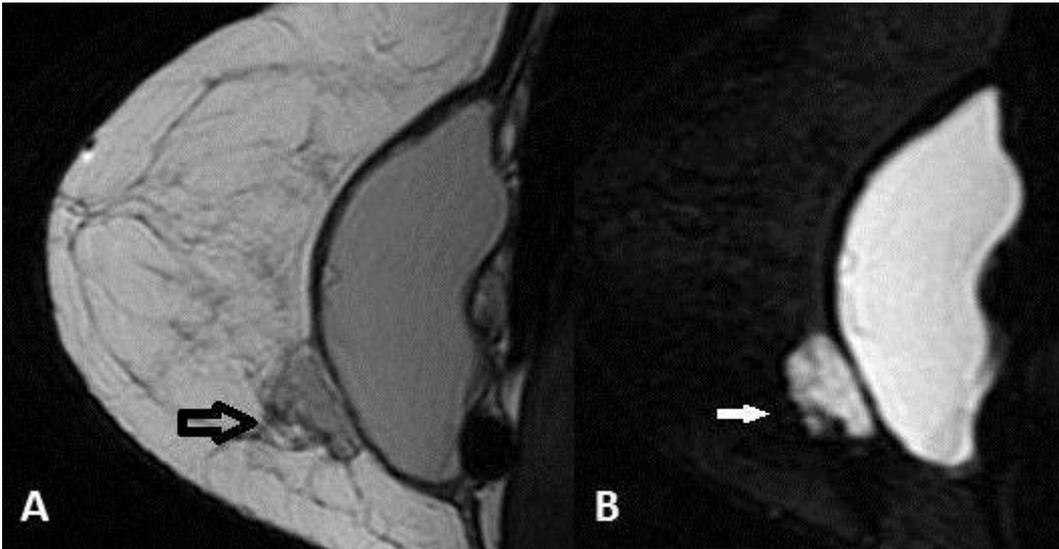
**Fig. 17:** Extracapsular implant rupture. Axial T1-weighted gadolinium- enhanced image shows extracapsular silicone in the lateral aspect of the right breast parenchyma, adjacent to the implant with peripheral inflammatory reaction and tissue enhancement (arrows).

**References:** - Salamanca/ES



**Fig. 18:** A)Ultrasound image shows a hypoechoic mass next to the anteroinferior and medial aspect of the implant (black arrow). B)Post-gadolinium fat-suppressed T1-weighted 3-D SPGR, axial image shows corresponding extracapsular mass consistent with extracapsular silicone rupture of right breast implant (white arrow).

**References:** - Salamanca/ES



**Fig. 19:** Sagittal FSE T2 weighted image (A) and silicone-excited sequence (B) show isointense extracapsular silicone (arrow) anteroinferior to the right breast implant, consistent with extracapsular silicone rupture.

**References:** - Salamanca/ES



**Fig. 20:** Extracapsular rupture. A) Sagittal T2 FSE image and silicone-selective image (B) show isointense extracapsular silicone (arrow) anterosuperior to the breast implant.

**References:** - Salamanca/ES

## 2.5 IMPLANT HERNIATION

This complication is due to a focal weakness of an intact capsule that results in a protrusion of the silicone through the implant shell and causes a lobulation in the contour of the implant. Sometimes it is difficult to differentiate it from implant rupture.

## **2.6 GEL BLEED**

It is defined as the normal transudation of microscopic amounts of silicone oils (and not gel) that can osmotically transgress the intact elastomer silicone shell. Increased accumulation of oils external to the elastomer shell, but within the fibrous capsule, has incorrectly been referred to as gel bleed.

Silicone oils can migrate, so the presence of this material in regional lymph nodes may not always be indicative of implant rupture.

On ultrasound we can see the "snowstorm" sign or echodense noise.

Gell bleed is difficult to identify on MRI unless it is extensive. In this case MRI findings may be similar to an intracapsular rupture such as "teardrop" or "subcapsular line" signs, because these oils maintain a silicone signal.

## **2.7 PERIPROSTHETIC FLUID COLLECTION**

Postoperative seromas are expected following implantation. The development of a large fluid collection beyond the immediate postoperative period, raises the possibility of infection.

Generally, it has an inflammatory origin, sometimes these collections follow viral syndromes and aspiration demonstrates no causative organism.

They are visualized as periprosthetic fluid between the shell and the fibrous capsule that can be differentiated from an intracapsular rupture with MRI sequences that suppress or emphasize silicone signal intensity.

Recently, a relationship between breast silicone implants and anaplastic large cell lymphoma has been described. Although the usual manifestation of this disease is an ill-defined mass, one of the unexpected imaging manifestations mimics a seroma or postviral syndrome fluid collection.

### 3. CONCURRENT BREAST ABNORMALITIES.

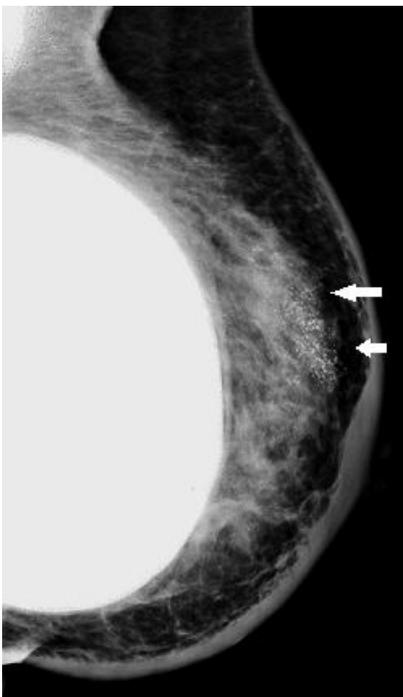
Benign or malignant breast disease can occur in women with breast implants and radiological assessment could be conditioned by the presence of prostheses. We should be able to distinguish these findings from implants' complications. Mammography and ultrasound present more limitations for the evaluation of breast abnormalities while MRI with administration of endovenous contrast has more sensitivity and specificity.

#### - Breast cancer

The prevalence of breast cancer and the distribution by stage is similar to the general population and there is no significant difference in survival rates.

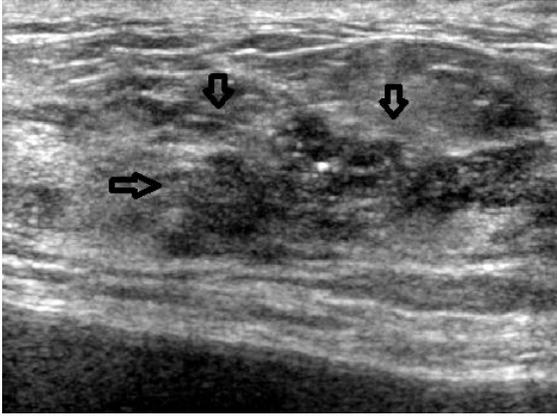
Implants can condition the detection of breast cancer. Sensitivity of mammography and US may be reduced for cancer detection although MRI sensitivity is not decreased.

In this patients, any abnormality should be assessed with US and/or MRI with contrast, and if necessary, a fine-needle aspiration or core needle biopsy should be performed. (Fig. 21, Fig. 22, Fig. 23 and Fig. 24).

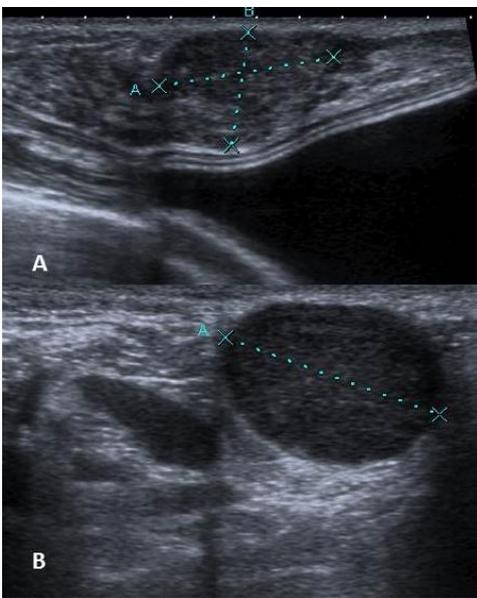


**Fig. 21:** Left Mediolateral oblique mammogram. A cluster of suspicious microcalcifications are identified in the breast gland (arrows) with associated skin thickening. Imaging guided biopsy confirmed the diagnosis of infiltrating ductal carcinoma.

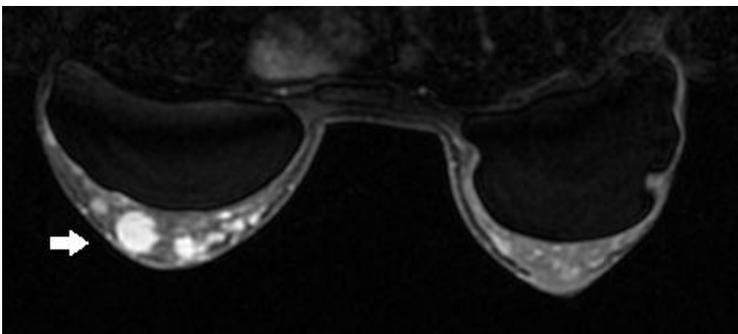
**References:** - Salamanca/ES



**Fig. 22:** Breast ultrasound image showing an irregular lobulated hypoechoic mass. Imaging guided biopsy confirmed the diagnosis of infiltrating ductal carcinoma.  
**References:** - Salamanca/ES



**Fig. 23:** A) Ultrasound image of a hypoechoic mass with lobulated margins in the upper left breast, biopsy-proven invasive lobular carcinoma. B) Left axillar region with rounded, enlarged and hypoechoic lymph nodes consistent with metastasis.  
**References:** - Salamanca/ES



**Fig. 24:** Post-gadolinium fat-suppressed T1-weighted 3-D SPGR shows multiple enhanced nodules biopsy-proven invasive lobular carcinoma (arrow).  
**References:** - Salamanca/ES

## - Cysts

This is a very common finding in the breast parenchyma, with or without prostheses. In extracapsular ruptures, we can sometimes find large conglomerates of free silicone that appear as hypoechoic or anechoic masses and can mimic cysts.

## - Fibroadenoma

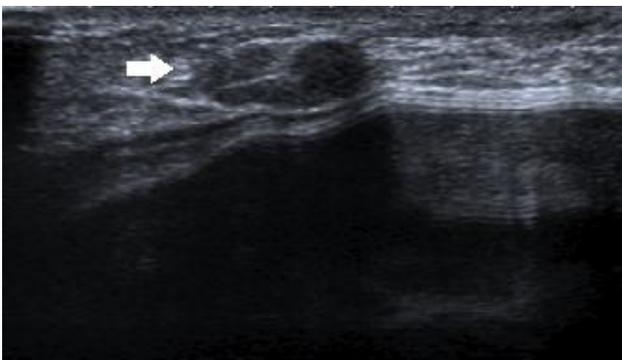
Fibroadenomas have the same features as in women without implants.

On mammograms, the classic fibroadenoma is an oval or lobular equal-density mass with smooth margins.

On ultrasound (Fig. 25) fibroadenomas are oval, well-circumscribed homogeneous masses, usually wider than tall. They are hypoechoic but may occasionally contain cystic spaces.

Fibroadenomas occasionally display irregular borders or heterogeneous internal characteristics, so biopsy is necessary to distinguish them from cancer.

On MRI, fibroadenomas have the classic appearance of an enhancing oval or lobulated mass with well circumscribed margins. On T1 weighted images, these are typically hypointense or isointense compared with adjacent breast tissue, on T2 weighted images these can be hypo or hyperintense depending on the cellularity. After contrast administration, enhancement pattern is variable but the vast majority will show type I enhancement curve or less common type II. Non enhancing internal septations may be seen.



**Fig. 25:** Breast ultrasound. Biopsy-proven fibroadenoma at the 10 o'clock position of the left breast.

**References:** - Salamanca/ES

## **- Microcalcifications**

It can sometimes be difficult to distinguish intraparenchymal calcifications from dystrophic sheetlike calcifications of fibrous capsule. Implant-displaced and spot magnification views can be helpful to differentiate them.

We can find dystrophic calcifications in a curvilinear pattern after an implant rupture if the calcified fibrous capsule wasn't completely removed during surgery, and should be distinguished from cancer.

If polyurethane-covered implants calcify, a meshlike calcification can occur and it may resemble the appearance of carcinoma in situ.

## **FINDINGS OR PROCEDURE DETAILS**

We have made a bibliographical research and analysed our cases at Hospital Universitario de Salamanca.

A 1.5 Tesla MRI was used to perform the exams.

Our protocol includes the following planes and sequences: sagittal FSE T2-weighted, sagittal and axial silicone excited sequence, T1-weighted 3D SPGR before and dynamically following gadolinium and postgadolinium fat-suppressed T1-weighted 3D SPGR, and axial contrast-enhanced fat suppressed T1-weighted.

Ultrasound were performed with a multi-frequency high resolution linear transducer.

## **CONCLUSION**

Familiarity with the most common types of breast implants, their imaging features, radiological findings of their complications and concurrent breast abnormalities that we must distinguish from implant's complications, will allow the radiologist to provide an accurate diagnosis of this pathology.

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## KEYWORDS

Area of Interest: Breast

Imaging Technique: MR Ultrasound

Procedure: Complications

Special Focus: Prostheses