Imaging in breast implants: normal and pathological findings in mammography, ultrasound and MRI

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Learning objectives

- To evaluate the normal radiological, sonographic and MRI appearances of breast implants
- To identify major complications of breast implants
- To assess radiological and ultrasound findings of these complications
Background

Breast implants hinder a correct evaluation of the breast both mammography and ultrasound, leading to a delayed diagnosis of breast disease.

There is also pathology of the prosthesis itself, by retraction, intra or extracapsular rupture, capsular herniation, silicone migration, calcification...

A modern breast implant lasts about 20-25 years, with an estimated probability of complications at 5 years of 2% and at 10 years of 15-17% [1,2].

Symptoms of these complications include contour deformity, mass formation, pain and local inflammation, with a failure of the physical examination of nearly 50%.
NORMAL FINDINGS

There are different types of breast implants categorized by its external surface (smooth or textured) or its content (single lumen and double lumen).

Single lumen silicone implants are typically homogeneous and radiodense on mammography, with no visible distinction between the elastomer shell and the silicone gel.

Single lumen saline implants are less radiodense, with radiodense shell and usually a saline implant valve (CI to MRI sometimes). This kind of implants are usually called tissue expanders, used to stretch the skin before silicone implant insertion, especially in oncoplastic reconstruction.

Double lumen implants have an inner lumen usually with silicone and a small outer lumen with saline, and the different density or echogenicity between the two lumen can be seen.

Normal location of prostheses can be behind the breast tissue, ahead of the pectoralis muscle (retroglandular or subglabdular situation), or behind the pectoral muscle (retropectoral situation), in an attempt to reduce the frequency of fibrous capsule formation and improved visualization of mammary parenchyma, because it facilitates the movement of the prostheses and allows for a better breast compression [3].

Normal prosthesis is semiovoidea in mediolateral oblique (MLO) proyection mammogram, with smooth and well defined contours, sometimes with periprosthesisis calcium deposits, with an homogeneous content more or less dense depends if it is silicone or saline (Fig. 1 on page 8).

On sonography the intact implant is anechoic, with a echogenic membrane, formed usually by echogenic lines separated by an anechoic space. At the anterior third of the prosthesis is normal visualize echogenic bands and reverberation artifacts, wrinkles, creases and small membrane lobulations (Fig. 2 on page 8, Fig. 3 on page 9).

Linear hyperchoic images along the surface of the fibrous capsule (small calcifications) are also a normal finding, as well as small effusions of fluid between the membrane and the fibrous capsule, or within small folds (more common in textured membrane implants) (Fig. 4 on page 10).
MRI is the most accurate technique in the evaluation of implant integrity [4], and Turbo spin-echo T2-weighted images, short-time inversion recovery silicone excited and silicone-satured are the more common and most important secuences in silicone breast implant assessment [8].

On T2-weighted images silicone is moderately hyperintense (less than water), on STIR silicone-satured water is hyperintense and silicone suppressed, and on STIR silicone-excited, silicone is hyperintense and water suppressed.

Then, an intact silicone single lumen implant shows an homogeneous high signal on T2-weighted and STIR silicone-excited images and a homogeneous low signal on STIR silicone-satured images. An intact double lumen implant has an inner silicone lumen and a smaller outer lumen with saline, more hyperintense than silicone on T2 weighted images, hypointense on STIR silicone-excited images, and hyperintense on STIR silicone-suppressed images.

The normal MRI appearance of breast prostheses includes, of course, a normal situation, and a normal morphology, rarely oval or spherical with small contour deformations.

The shell and fibrous capsule are hipointense on all secuences, must be uninterupted, and can be thickened because the periprosthetic fibrosis, sometimes with small calcifications.

Small periprosthetic collections are also findings considered normal, as well as small lines originating from the surface of the implant inwards, with a radial disposition perpendicular to the membrane, which do not reach the opposite side of the prostheses in two planes (Fig. 5 on page 11).

**PATHOLOGICAL FINDINGS**

Early postoperative complications include hematoma and infection.

The most common and important late postoperative complications include capsular contracture, herniation and implant rupture.

- **CAPSULAR CONTRACTURE:**

Capsular contracture is a clinical diagnosis (distorted, painful and inflamed breast), represented on mammography, US and MRI by spherical irregular morphology of the prostheses (Fig. 6 on page 12), with abnormal capsular thickening, best shown on ultrasound, and sometimes periimplant calcifications.
- HERNIATION:

Prostheses herniation can occur because a fibrous capsule tear and protrusion of the membrane through the continuum. Sometimes is difficult to differentiate from prosthetic rupture.

On mammography we can see a lump, an unusual deformity in the contour (Fig. 7 on page 13).

On US or MRI the border of the implant is bulging more than usual, with a focal defect of the capsule.

- INTRACAPSULAR RUPTURE:

Most implant ruptures (77-89%) are intracapsular [6].

Silicone gel escapes through a crack or tear in the membrane, but is confined by the fibrous capsule.

US detect silicone implant rupture with a sensibility of 50-77% and a specificity of 55-84% [7].

The space between the capsule and the ruptured shell can be increased, sometimes we can see diffuse internal echoes within implant, or slightly echogenic fluid through the fibrous capsule and the shell of the implant, but these signs are not definitive and may be interpreted carefully (Fig. 8 on page 14, Fig. 9 on page 15).

The most reliable sign of intracapsular rupture on US is the "stepladder sign": folds of the membrane collapsed as thin echogenic lines parallel to each other, simulating steps of a ladder (Fig. 10 on page 16, Fig. 11 on page 17).

Anyway, as we have said before, MRI is the most accurate technique in the evaluation of implant integrity, with a sensibility for rupture between 80-90% and a specificity between 90-97% [4].

On initial phases, separation of the membrane respect to the fibrous capsule could be identified, with presence of silicone in between.

On subsequent phases appear changes in the signal intensity of the silicone, drops of serum floating inside the silicone gel (salad oil sign), small invaginations of the shell where the two membranes do not touch (noose sign or key hole sign) (Fig. 12 on page 18), and the most reliable sign of intracapsular rupture: the Linguini sign, multilinie low signal
curves corresponding to the collapsed membrane floating on the silicone gel, covered by
the fibrous capsule (sign analogous to the stepladder sign on US) (Fig. 13 on page 19).

- EXTRACAPSULAR RUPTURE-SILICONE MIGRATION

Extracapsular rupture is defined as rupture of the shell and the fibrous capsule, and
usually is easier to detect than intracapsular rupture.

Free silicone extending away from the fibrous capsule can be detected, radiopaque on
mammography, next to the prostheses, along the pectoralis muscle and sometimes into
the axillary lymph nodes (gel migration) (Fig. 14 on page 20).

On US and MRI the stepladder or linguini sing (or other signs of intracapsular rupture)
are observed, associated to free silicone (Fig. 15 on page 21).

Free silicone appears on echography as an echogenic nodule with an anterior well
defined margin and a dirty posterior shadowing ("snowstorm sign") (Fig. 16 on page
22), within either the breast parenchyma or even the axillary lymph nodes (Fig. 17 on
page 23), and sometimes as hypo or anechoic masses undistinguishable from other
masses (cyst, tumor...).

On MRI these nodules or masses usually have the same intensity as the silicone on all
sequences (Fig. 18 on page 24, Fig. 19 on page 25).

However, sometimes complex silicone granulomas or siliconomas are formed, appear as
heterogeneous nodules with irregular gadolinium enhancement, undistinguishable from
tumors and biopsy is still required.
Fig. 1: Digital mammography, left mediolateral oblique view (LMLO). Normal silicone prosthesis: semiovoidea with smooth and well defined contours, with an homogeneous dense content.

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Fig. 2: Ultrasonography of an intact implant: anechoic, with a echogenic membrane, formed usually by echogenic lines separated by an anechoic space. At the anterior third of the prosthesis is normal visualize echogenic bands and reverberation artifacts.

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**Fig. 3:** Ultrasonography of an intact implant: normal echogenic bands and reverberation artifacts at the anterior third of the prosthesis.

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Fig. 4: Ultrasonography of an intact implant: normal small effusion of fluid between the membrane and the fibrous capsule

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**Fig. 5:** Axial short time inversion recovery silicone MRI: normal findings in an intact silicone single lumen implant. The shell and fibrous capsule are hipointense and the silicone shows an homogeneous high signal. Small lines originating from the surface of the implant inwards, with a radial disposition perpendicular to the membrane, which do not reach the opposite side of the prostheses, are a normal finding.

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**Fig. 6:** Digital mammography, right mediolateral oblique view (RMLO). Capsular contracture: spherical irregular morphology of the prostheses.

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Fig. 7: Digital mammography, left mediolateral oblique view (LMLO). There is an unusual deformity in the upper contour (arrow). It could be an herniation, but difficult to differentiate from prosthetic rupture.

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**Fig. 8:** Ultrasonography of an intracapsular rupture: diffuse internal echoes within implant (not definitive finding)

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**Fig. 9:** Ultrasonography of an intracapsular rupture: slightly echogenic fluid through the fibrous capsule and the shell of the implant (not definitive finding)

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Fig. 10: Ultrasonography of an intracapsular rupture: folds of the membrane collapsed as thin echogenic lines parallel to each other, simulating steps of a ladder "stepladder sign" (DEFINITIVE FINDING)

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**Fig. 11:** Ultrasonography of an intracapsular rupture: thin echogenic curvilinear lines, somewhat parallel, traversing the interior of the implant "stepladder sign" (DEFINITIVE FINDING)

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Fig. 12: Axial STIR silicone excited MRI sequence of an early intracapsular rupture: small invaginations of the shell where the two membranes do not touch "noose sign or key hole sign" (arrows)

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Fig. 13: Axial STIR MRI sequence of an intracapsular rupture: multiline low signal curves corresponding to the collapsed membrane floating on the silicone gel, covered by the fibrous capsule: "Linguini sign" (sign analogous to the stepladder sign on US)

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Fig. 14: Digital RMLO mamography showing an area of increased density adjacent to the implant (arrow): free silicone

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**Fig. 15:** Sagital T2 silicone excited MRI sequence: extracapsular silicone implant rupture. Collapsed implant with silicone inside and outside the implant shell (black asterisks), and outside the fibrous capsule (arrow), and small amount of fluid surround the shell (white asterisk).

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Fig. 16: Ultrasonography of an extracapsular rupture: echogenic nodule with an anterior well defined margin and a dirty posterior shadowing ("snowstorm sign") adjacent to the inner edge of the implant

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**Fig. 17:** Axillary ultrasonography of an extracapsular rupture: echogenic nodules with an anterior well defined margin and a dirty acoustic posterior shadowing ("snowstorm sign"): silicone lymphadenopathy

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**Fig. 18**: Axial STIR MRI sequence: complex siliconoma (arrow) adjacent to the inner edge of the right implant (extracapsular rupture).

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**Fig. 19:** Axial STIR MRI sequence: axillary silicone lymphadenopathy secondary to an extracapsular rupture.

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Conclusion

Familiarity with the more common types of breast implants, the normal findings on mammography, echography and MRI and the possible complications of breast implants is very important for a dedicated breast radiologist.

Knowledge of those normal variants and complications is essential to recognize them, and in this exhibit we have done a review of the common findings in different imaging techniques.
References


