

Appendix: Interventional Breast Procedures and High Yield Facts

MRI-GUIDED WIRE LOCALIZATION

INDICATION

BI-RADS 4 or 5 lesions detected only on MRI.

PROCEDURE STEPS

- Review prior MRI images.
- Obtain informed consent.
- Place the patient in the prone position in a dedicated breast coil within the magnet.
- Breast is placed in biopsy compression device (with a grid).
- Fiducial marker placed on skin at a slight distance from the expected lesion location (so fiducial marker does not obscure the lesion).
- Axial localizing sequence is obtained.
- Noncontrast sagittal T1-weighted sequence is obtained.
- Gadopentetate dimeglumine, 0.1 mmol/L/kg body weight, is injected intravenously as a rapid bolus.
- Immediately following contrast administration, sagittal fat suppressed T1-weighted sequence is obtained.
- Images are reviewed.
- A cursor is placed over the lesion and X (horizontal) and Y (vertical) coordinates determined based on the location of the fiducial marker and grid lines.
- Z (depth) coordinate is determined based on the depth from the skin surface.
- Depth in millimeters is calculated by multiplying the number of sagittal slices from the skin to the lesion and the slice thickness.
 - No. of slices \times slice thickness (in mm)
- Skin is cleansed and a local anesthetic is administered to the skin and deeper tissues.
- Skin incision is made with a scalpel.
- Needle guide is inserted into the grid.
- Needle is inserted to a depth of 5–10 mm deep to the lesion.
- Thickness of the needle guide is 20 mm.
- Therefore, the depth that the needle must be inserted is Z depth + needle guide thickness (20 mm) + depth of tip of wire beyond lesion (10 mm).
- Z depth + 20 mm + 10 mm
- Sagittal T1-weighted images are obtained to confirm needle location.
- Wire is inserted into the needle up to the mark. At this point, the wire tip is outside the needle.
- Needle is removed and wire is left in place.
- Wire position is confirmed with T1-weighted images.
- Postprocedure 2-view mammogram is obtained to show location of the wire.
- Specimen radiographs can be obtained, but usually the lesions are not visualized by mammography.

REFERENCE

Morris EA, Liberman L (eds) (2005) Breast MRI diagnosis and intervention, 1st edn. Springer, New York, pp 284–289

MRI-GUIDED VACUUM-ASSISTED BIOPSY

INDICATION

BI-RADS 4 or 5 lesions detected on MRI imaging.

PROCEDURE STEPS

- Review prior MRI images.
- Obtain informed consent.
- Place the patient in the prone position in a dedicated breast coil within the magnet.
- Breast is placed in biopsy compression device (with a grid).
- Fiducial marker placed on skin at a slight distance from the expected lesion location (so that fiducial marker does not obscure the lesion).
- Axial localizing sequence is obtained.
- Noncontrast sagittal T1-weighted sequence is obtained.
- Gadopentetate dimeglumine, 0.1 mmol/L/kg body weight, is injected intravenously as a rapid bolus.
- Immediately following contrast administration, sagittal fat suppressed T1-weighted sequence is obtained.
- Images are reviewed.
- A cursor is placed over the lesion and X (horizontal) and Y (vertical) coordinates determined based on the location of the fiducial marker and grid lines.
- Z (depth) coordinate is determined based on the depth from the skin surface.
- Depth in millimeters is calculated by multiplying the number of sagittal slices from the skin to the lesion and the slice thickness.
- No. of slices \times slice thickness (in mm)
- Skin is cleansed and a local anesthetic is administered to the skin and deeper tissues.
- Skin incision is made with a scalpel.
- Depth stop on the introducer is set at the determined depth.
- Stylet is put inside the introducer.
- Stylet and introducer are put in the needle guide, which is then placed in the grid.
- Stylet is advanced in the breast to the level of the depth stop.
- Stylet is removed and replaced with the obturator.
- MRI is obtained for confirmation of position, the obturator is removed and replaced with the biopsy device.
- Biopsy core samples are obtained.
- Biopsy device is removed and replaced with obturator.
- MRI for confirmation of lesion sampling.
- Titanium clip placed at biopsy site.
- Postprocedure 2-view mammogram obtained to document clip placement.

REFERENCE

Morris EA, Liberman L (eds) (2005) Breast MRI diagnosis and intervention, 1st edn. Springer, New York, pp 302–310

MAMMOGRAPHY-GUIDED WIRE LOCALIZATION

INDICATION

- Excision of previously diagnosed cancer or high risk lesion and localization of lesion not amenable to stereotactic or ultrasound guided biopsy.

PROCEDURE STEPS

- Obtain informed written consent.
- Determine approach by assessing shortest distance to the lesion on craniocaudal view (superior or inferior approach) or on lateral view (medial or lateral approach).
- Place breast in grid compression with opening of window placed over the skin of the determined approach (ex. If taking a superior approach the breast is placed in craniocaudal compression with the open grid window over the superior aspect of the breast).
- Imaging obtained to localize the lesion is within the window of the grid.
- X and Y coordinates of the lesion determined using the grid.
- Crosshairs are placed to form a target on the breast.
- Skin is cleansed and local anesthesia is used to anesthetize the skin and deeper tissue.

- The needle is advanced through the lesion, perpendicular to the skin at the determined target, allowing the crosshairs to be seen forming a cross over the hub of the needle.
- Image is obtained to assure the hub of the needle is seen over the lesion on the mammogram, thus assuring that the X and Y coordinate is accurate.
- The breast is taken out of compression and placed in orthogonal compression.
- An image is obtained in the orthogonal view to assess the depth of the needle, noting that the needle should traverse the lesion (the actual amount that the needle should traverse the lesion depends on the needle/wire system being used).
- The wire is placed through the hollow needle.
- Using the pinch-pull technique, the wire is held in place while the needle is removed from the breast.
- The hook of the wire is deployed within the breast once the needle is removed.
- Final image is obtained to document the wire is through the lesion.
- The specimen is sent for radiograph to assure that the lesion is within the specimen and that the wire has been removed from the breast intact.

REFERENCE

Kopans DB. Breast Imaging, 2nd ed. Philadelphia, PA: Lippincott Williams and Wilkins; 1998:637–692

ULTRASOUND-GUIDED CORE BIOPSY

INDICATION

Sonographically detected mass or axillary lymph node requiring a pathologic diagnosis.

PROCEDURE STEPS

- Obtain informed consent.
- Skin is cleansed and a local anesthetic is administered to the skin and deeper tissues.
- Insert a coaxial trocar corresponding to the biopsy device under ultrasound guidance with tip to the edge of the mass.

- Inner stylet of coaxial trocar removed. Biopsy device placed through coaxial trocar.
- Samples obtained of the mass.
- Stainless steel or titanium biopsy site marker placed in the mass through coaxial trocar.
- Postprocedure 2-view mammogram of the breast biopsied should be obtained to demonstrate clip placement.

REFERENCES

- Berg WB, Birdwell RB, Gombos EC et al (2006) Diagnostic imaging breast, 1st edn. Amirsys, Salt Lake City, Section V-2, pp 40–43
- Cardenosa G (2008) Breast imaging companion, 3rd edn. Lippincott Williams and Wilkins, Philadelphia, pp 523–532

ULTRASOUND-GUIDED CYST ASPIRATION

INDICATION

- Symptomatic cysts or atypical features on ultrasound.
- Patient anxiety or request.
- Uncertainty of whether a hypoechoic mass represents a complicated cyst vs. solid mass.

PROCEDURE STEPS

- Obtain informed consent.
- Skin is cleansed and a local anesthetic is administered to the skin and deeper tissues.
- A needle attached to a syringe is advanced into the cyst under ultrasound guidance.

- Cyst aspirated until no longer visualized.
 - Bloody, clear, or mucoid fluid is sent to cytology.
- If fluid is sent to cytology, a microclip should be placed in the area of the cyst.
- All other fluids are discarded.
- If lesion is solid or partially solid, convert to an ultrasound-guided core needle biopsy.
- If a clip is placed, a postprocedure 2-view mammogram of the breast should be obtained to document clip placement.

REFERENCES

- Berg WA, Birdwell RL, Gombos EC et al (2006) Diagnostic imaging breast, 1st edn. Amirsys, Salt Lake City, Section V-2, pp 2–3
- Cardenosa G (2008) Breast imaging companion, 3rd edn. Lippincott Williams and Wilkins, Philadelphia, pp 499–501

ULTRASOUND-GUIDED WIRE LOCALIZATION

INDICATION

Excision of previously diagnosed cancer or high-risk lesion by prior core biopsy. Other indication is the localization of lesion that is best seen by ultrasound.

PROCEDURE STEPS

- Obtain informed written consent.
- Review prior ultrasound images.
- Skin is cleansed and local anesthesia is used to anesthetize the skin and deeper tissue.
- Choose the length of the needle by measuring the distance from the distal end of the lesion to the estimated skin entry +2 cm.
- A hollow needle is advanced through the lesion.
- Once the needle is placed through the lesion a wire is advanced through the hollow needle.

- The wire tip should be just beyond the lesion.
- Using the pinch-pull technique, the wire is held in place while the needle is removed from the breast.
- The hook of the wire is deployed within the breast once the needle is removed.
- Make an “X” mark on the overlying skin with a permanent marker directly over the lesion. Depth from the mark to the lesion should be provided to the surgeon.
- Orthogonal mammograms are not necessary if the appropriate wire placement is documented on ultrasound.
- Specimen imaging is required. If the lesion is not seen mammographically, ultrasound imaging can be performed in a saline bath to demonstrate the lesion within the specimen.

REFERENCES

- Berg WB, Birdwell RB, Gombos EC et al (2006) Diagnostic imaging breast, 1st edn. Amirsys, Salt Lake City, Utah, Section V 2, pp 20–21
- Kopans DB (1998) Breast imaging, 2nd edn. Lippincott Williams and Wilkins, Philadelphia, PA, pp 637–692

GALACTOGRAPHY

INDICATION

Single duct spontaneous bloody, serous, or clear nipple discharge.

PROCEDURE STEPS

- Obtain informed consent.
- Breast placed on the magnification stand (or the patient placed in the supine position) with gooseneck light positioned to illuminate the nipple.
- Nipple is cleansed.
- Duct opening is identified by squeezing the nipple to express a small drop of nipple discharge.
- The cannula is connected to the tubing and syringe containing 1–3 mL of Optiray contrast.
- A blunt (27 or 30 gauge), straight, or right-angled cannula, connected to tubing and a contrast filled syringe, is inserted into the duct opening.
- The cannula is taped in place to the patient's breast.

- Contrast is injected slowly into the duct until the patient feels fullness in her breast or there is reflux of contrast from the duct.
 - Special attention is paid not to inject air into the duct, as it can mimic a filling defect on the mammogram.
 - If resistance occurs while injecting, it may be the result of the cannula being placed against the wall of the duct or extravasation of contrast outside of the duct. Stop injection and reposition cannula.
- Once contrast has been injected, a magnification cranio-caudal and lateral view is obtained.
- Images are assessed for a filling defect within the duct or abrupt termination of the duct. Both findings will require biopsy.
- Galactography can assess for a mass within or compromising a duct, but cannot differentiate benign or malignant etiology.

REFERENCES

- Fajardo LL, Jackson VP, Hunter TB (1992) Interventional procedures in diseases of the breast: needle biopsy, pneumocystography and galactography. *AJR* 158:1231–1238
- Kopans DB (1998) *Breast imaging*, 2nd ed. Lippincott Williams and Wilkins, Philadelphia, pp 703–704

STEREOTACTIC GUIDED VACUUM-ASSISTED BIOPSY

INDICATION

Nonpalpable, mammographically detected BI-RADS 4 or 5 lesions that are not amenable to ultrasound-guided core needle biopsy.

PROCEDURE STEPS

- Obtain informed written consent.
- Breast should be suspended through the opening of the stereotactic table, with the breast positioned in compression against the image receptor plate.
- Stereotactic images should be obtained (+15° and -15°).
- Lesion should be targeted on stereotactic images.
- Skin is cleansed and the local anesthetic is administered to the skin and deeper tissues.
- A small incision is made in the skin with a scalpel.

- The probe/needle should be advanced to the prefire position with stereotactic images obtained to verify the position of the probe/needle.
- The probe/needle should be “fired” with stereotactic images obtained to verify the position of the probe/needle.
- Biopsy core samples should be obtained. The number of samples varies with the size of the probe/needle.
- Specimen radiograph should be obtained to verify calcifications in core samples. This is optional for noncalcified masses.
- Stainless steel or titanium clip should be placed at the biopsy site through the hollow probe.
- Postprocedure two-view mammogram of the biopsied breast should be obtained to demonstrate clip placement.

REFERENCE

Berg WA, Birdwell RL, Gombos EC et al (2006) Diagnostic imaging breast, 1st edn. Amirsys, Salt Lake City, Utah, Section IV 2, pp 28–29

HIGH-YIELD FACTS

BI-RADS (BREAST IMAGING AND REPORTING DATA SYSTEM) ASSESSMENT

CATEGORIES

- *Category 0*: Incomplete. Need additional imaging evaluation and/or prior mammograms for comparison.
- *Category 1*: Negative. No imaging findings to suggest malignancy. Routine follow-up.
- *Category 2*: Benign finding(s). Used when describing one or more specific benign findings in the report. Routine follow-up.
- *Category 3*: Probably benign finding. Initial short-interval follow-up suggested. The finding should have less than a 2% risk of malignancy. The finding is not expected to change over the follow-up interval.
- *Category 4*: Suspicious abnormality. Biopsy should be considered. Findings that do not have the classic appearance of malignancy but have a wide range of probability of malignancy that is greater than those in Category 3. Optional subdivision into:
 - Category 4A – low suspicion
 - Category 4B – intermediate suspicion
 - Category 4C – moderate suspicion
- *Category 5*: Highly suggestive of malignancy. Appropriate action should be taken. These lesions have a probability of $\geq 95\%$ of malignancy. Biopsy recommended.
- *Category 6*: Known biopsy – proven malignancy. Appropriate action should be taken. This category is for lesions identified on the imaging study that have been biopsied and proven malignant prior to definitive therapy.

BI-RADS Lexicon for mass shape	“ROLI”
	Round
	Oval
	Lobular
	Irregular
BI-RADS Lexicon for mass margins	“COMIS”
	Circumscribed
	Obscured
	Microlobulated
	Indistinct
	Spiculated

ACS RECOMMENDATIONS FOR BREAST MRI SCREENING AS AN ADJUNCT TO MAMMOGRAPHY

- Recommend annual MRI screening (based on evidence).
 - BRCA mutation.
 - First-degree relative of BRCA carrier, but untested.
 - Lifetime risk 20–25% or greater, as defined by BRCAPRO or other models that are largely dependent on family history.
- Recommend annual MRI screening (based on expert consensus opinion).
 - Radiation to chest between age 10 and 30 years.
 - Li–Fraumeni syndrome and first-degree relatives with breast cancer diagnosis.
 - Cowden and Bannayan–Riley–Ruvalcaba syndromes and first-degree relatives.
- Insufficient evidence to recommend for or against MRI screening.
 - Lifetime risk 15–20%, as defined by BRCAPRO or other models that are largely dependent on family history.
 - Lobular carcinoma in situ (LCIS) or atypical lobular hyperplasia (ALH).
 - Atypical ductal hyperplasia (ADH).
 - Heterogeneously or extremely dense breast on mammography.
 - Women with a personal history of breast cancer, including ductal carcinoma in situ (DCIS).
- Recommend against MRI screening (based on expert consensus opinion).
 - Women at <15% lifetime risk

BREAST LESION TRIANGULATION MNEMONIC

- **M**uffins (Medial) **R**ise and **L**ead (Lateral) **F**alls.
 - If a lesion is only seen on the CC view, obtain a lateral view.
 - If the lesion is located medially on the CC view, it will be more superior in the lateral view when compared with that in the MLO view.
 - If the lesion is located laterally on the CC view, it will be more inferior in the lateral view when compared with that in the MLO view.

MAMMOGRAPHY FINDINGS THAT CAN BE CATEGORIZED BY BI-RADS 3 (SHORT-TERM FOLLOW-UP)

- Findings must be seen on a baseline mammogram or a mammogram without comparison studies available.
- Cluster of calcifications on spot magnification views that are round or oval.

- Solid NON-palpable noncalcified mass with round or oval shape and circumscribed margins.
- NON-palpable focal asymmetry seen on two views with concave margins and interposed fat.
- Miscellaneous findings:
 - Single dilated duct
 - Architectural distortion at known biopsy site without dense central mass
 - Multiple similar lesions of intermediate suspicion

DIFFERENTIAL DIAGNOSIS OF BILATERAL AXILLARY LYMPHADENOPATHY

- Lymphoma
- Leukemia
- SLE
- Sarcoidosis
- Rheumatoid arthritis
- Mixed connective tissue
- HIV
- Granulomatous disease
- Drug reaction (dilatant)

DIFFERENTIAL DIAGNOSIS OF UNILATERAL AXILLARY LYMPHADENOPATHY

- Primary breast cancer with ipsilateral axillary lymphadenopathy spread
- Granulomatous disease
- Infection (mastitis)
- Extracapsular silicone leak

DIFFERENTIAL OF A FILLING DEFECT ON GALACTOGRAPHY

- Papilloma
- Intraductal papillary carcinoma
- Blood clot
- Inspissated material
- Air bubble

DIFFERENTIAL DIAGNOSIS OF A SPICULATED MASS ON MAMMOGRAPHY

- Cancer
- Radial scar
- Postbiopsy scar

- Fat necrosis
- Sclerosis adenosis
- Abscess
- Hematoma
- Granular cell tumor

DIFFERENTIAL DIAGNOSIS OF SKIN THICKENING (>2.5 MM)

- Inflammatory breast cancer
- Postsurgical
- Postradiation
- Cardiac failure
- Mastitis
- Renal failure
- Hypoalbuminemia
- Thrombophlebitis of the breast (Mondor's disease)
- Thrombosis in the subclavian vein or SVC (SVC syndrome)

DIFFERENTIAL DIAGNOSIS OF INCREASED BREAST DENSITY

- Estrogen replacement
- Weight loss
- Inflammatory breast cancer
- Mastitis
- Postradiation
- Trauma
- Lymphatic obstruction

CAUSES OF GYNecomastia

- Idiopathic (most common)
- Drugs
- Estrogen excess (exogenous administration, testicular tumor, or adrenal tumor)
- Male breast cancer

DRUGS THAT CAUSE GYNecomastia

- Marijuana
- Estrogen
- Tagamet and thiazides
- Phenothiazides
- Amphetamines
- Digitalis

US FEATURES OF A MALIGNANT LESION

- Spiculation
- Angular margins
- Hypoechoogenicity
- Acoustic shadowing
- Branch pattern
- Extension into a duct
- Microlobulation
- Taller than wide
- Calcifications

US FEATURES OF A BENIGN LESION

- Hyperechoic
- Wider than tall
- Macrolobulation
- Thin pseudocapsule
- Acoustic enhancement

DIFFERENTIAL DIAGNOSIS FOR A HYPERECHOIC MASS

- Acute hemorrhage
- Acute hematoma
- Focal fibrosis
- Hemangioma
- Angiolipoma
- Spindle cell lipoma
- Malignancy

TUMORS THAT COMMONLY METASTASIZE TO THE BREAST

- Contralateral breast cancer
- Melanoma
- Lung cancer
- Lymphoma
- Leukemia

ENHANCEMENT KINETIC CURVES ON BREAST MRI (FIG. 1)

- Type Ia: persistent; typically benign
- Type Ib: bowing; typically benign
- Type II: plateau; indeterminate
- Type III: washout; suspicious

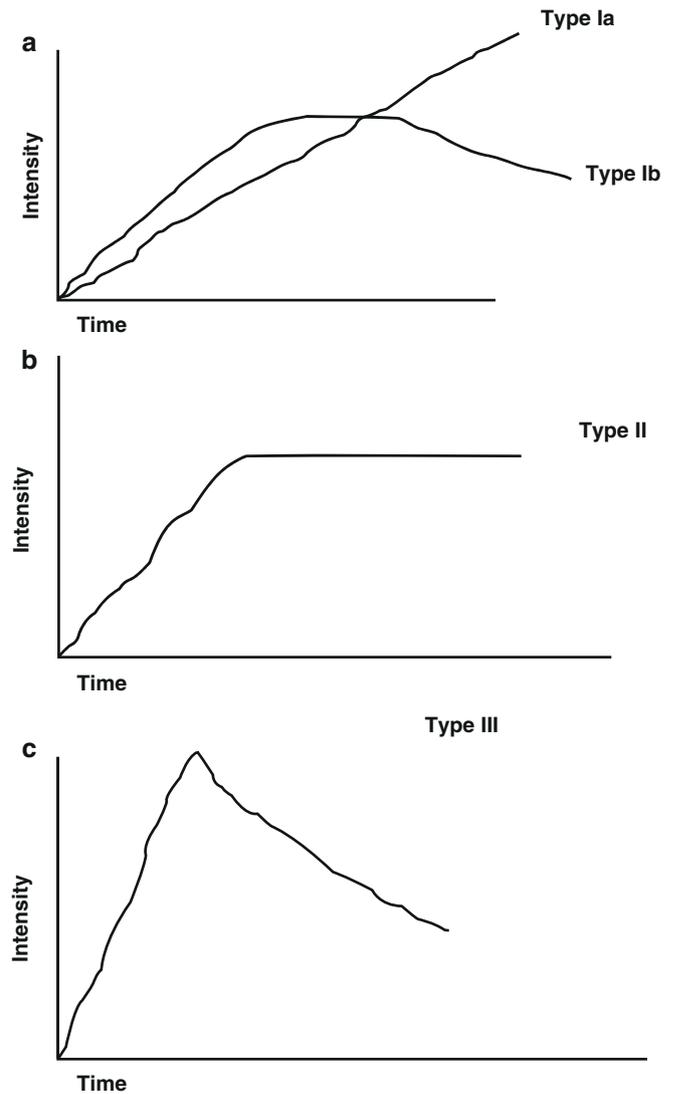


Figure 1

[AU1]

HIGH-RISK LESIONS AT CORE NEEDLE BIOPSY THAT REQUIRE EXCISION (*CONTROVERSIAL)

- ADH
- ALH*
- LCIS*
- Papilloma*
- Radial scar

DIAGNOSIS THAT INCREASE THE LIFETIME RISK OF DEVELOPING BREAST CANCER

- ADH
- LCIS
- ALH
- Radial scar

NORMAL DOUBLE LUMEN SILICONE BREAST IMPLANT (FIG. 2)

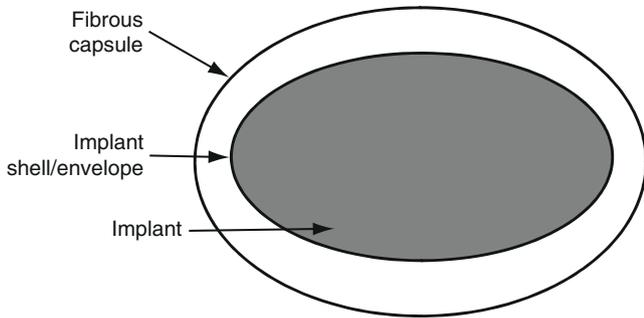


Figure 2

CAPSULAR CONTRACTURE OF A SILICONE IMPLANT (FIG. 3)

Capsular contracture results when normal scar tissue forms a capsule around the breast implant and tightens and/or squeezes the breast implant. This may occur over several months to years and can result in changes in breast shape, sensation of hardness of the breast, or breast pain due to contracture of the implant.

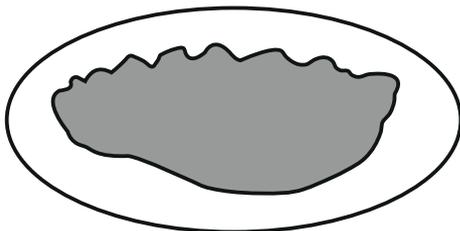


Figure 3

RADIAL FOLDS OF A SILICONE IMPLANT (FIG. 4)

Infolding of the implant shell, termed radial folds, can be a normal finding seen in silicone implants. This should not be confused with implant rupture.

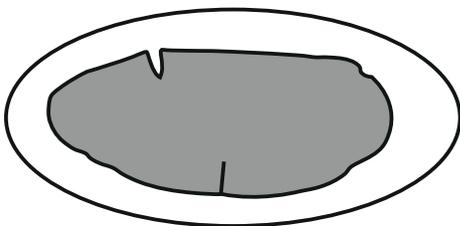


Figure 4

INTRACAPSULAR RUPTURE OF SILICONE IMPLANT (FIG. 5A, B)

Rupture of the implant shell walls result in lines within the implant that have a “stepladder” appearance on ultrasound and “linguine” sign on MRI.

or

A small intracapsular leak with silicone gel on the surface of the shell creates a “subcapsular line” sign.

“Inverted teardrop” or “keyhole” sign of a silicone implant (Fig. 6)

“Inverted tear drop” sign or “keyhole” sign is when silicone is within a radial fold.

It is a nonspecific finding that may be seen with a focal intracapsular rupture or extensive gel bleed.

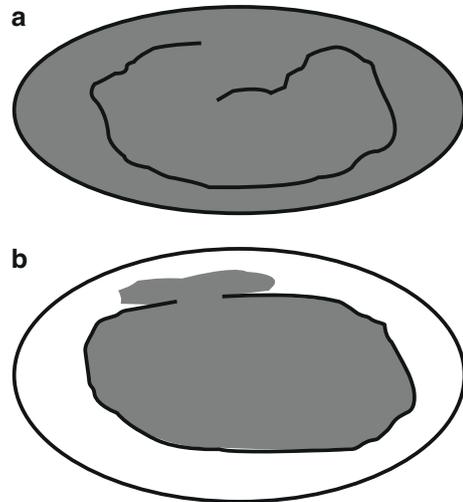


Figure 5

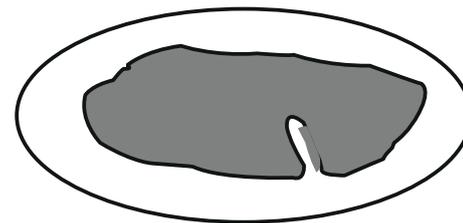


Figure 6

FINDINGS SEEN IN IMPLANT RUPTURE

- Saline implant – implant collapse
- Silicone implant:
 - Intracapsular rupture: US shows a “stepladder” appearance. MRI shows a “linguine sign.” No mammographic findings seen.

- Extracapsular – high density seen in mammography if silicone gel within the tissues. Silicone may be seen in lymph nodes.
- Ultrasound shows a “snowstorm” appearance (extreme echogenicity with extensive shadowing).

Saslow D, Boetes C, Burke W et al (2007) American Cancer Society Guidelines for breast screening with MRI as an adjunct to mammography. *J Clin* 57:75–89

Sickles EA (1991) Periodic mammographic follow-up of probably benign lesions: results in 3,184 consecutive cases. *Radiology* 179:463–468

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D’Orsi CJ, Basset LW, Berg WA, Feig SA et al (2003) *Breast imaging reporting and data system (BI-RADS) atlas*, 4th edn. American College of Radiology, Reston, pp 193–197

Gay SP, Woodcock RJ Jr (2008) *Radiology recall*, 2nd edn. Lippincott William & Wilkins, Philadelphia, pp 537–575

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