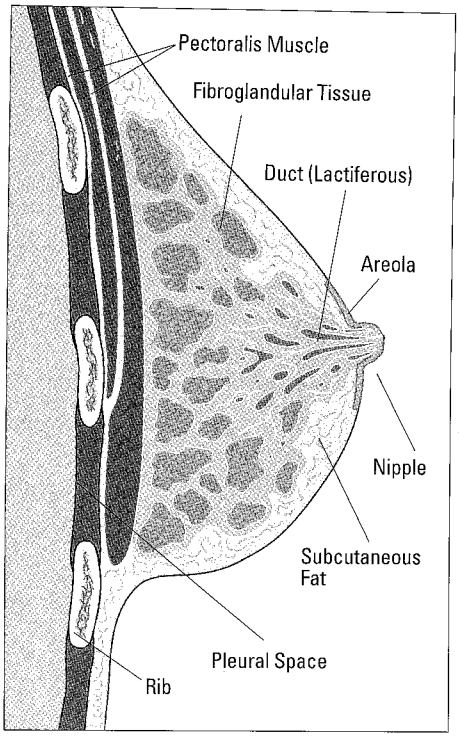
Sonography of the Breast



Ultrasound of the breast has been performed for well over a decade, with exam protocol continuously evolving based on current image quality of the equipment. Sonography provides a noninvasive, tomographic display of the breast without ionizing radiation.

Recent advances in digital technology bring added benefits to ultrasound as a useful complement to mammography and physical examination in the evaluation of breast disease. The adjunctive use of High Definition Imaging (HDI) ultrasound with mammography provides increased confidence in differentiating solid lesions to determine those that are benign, reducing the need to biopsy many lesions considered indeterminate on mammograms.*

Breast anatomy

Sonography of the breast requires that the sonologist or sonographer has a comprehensive knowledge of the anatomy of the breast. The sonographic presentation of the breast, which is composed of fat, fibrous tissue and glandular tissue, depends greatly on the hormonal status of the patient.

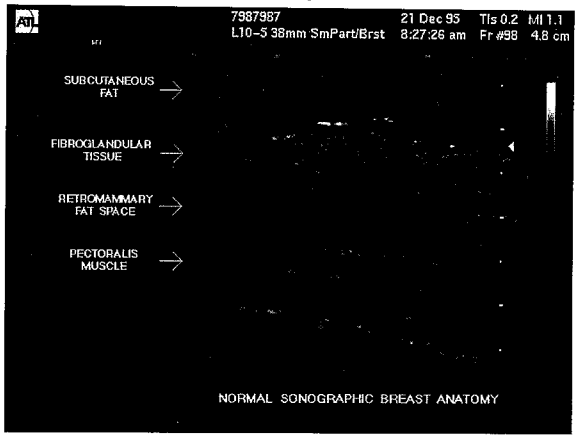
Sonographic anatomy of the breast

- Skin
- Subcutaneous fat
- Breast parenchyma
- Cooper's ligaments
- Retromammary fat
- Pectoralis muscle
- Ribs/pleura
- Nipple region
- Tail of Spence

The skin is seen as a highly reflective band along the surface of the breast. Normal thickness is 2 to 3 mm. Subcutaneous fat lies between the skin and the parenchymal (fibroglandular) tissue. The quantity of fat varies. Fibroglandular tissue is the echogenic layer of tissue beneath the nipple and subcutaneous fat. Once again the ratio of fat versus fibroglandular tissue varies among patients and may also depend on the age, parity and hormonal status of the patient.

Cooper's ligaments are suspensory ligaments, providing support to the glandular structures of the breast. They extend radially from the deep fascial planes to the skin.

Retromammary fat forms a layer between the deep fascial plane of the breast and the pectoral muscle, defining the posterior boundary of the glandular tissue. The pectoralis muscles can be clearly imaged sonographically in the direction of their fibers. They appear above the ribs and parallel to the skin. The clinician must have a clear understanding of normal appearance to evaluate the area for tumor extension.

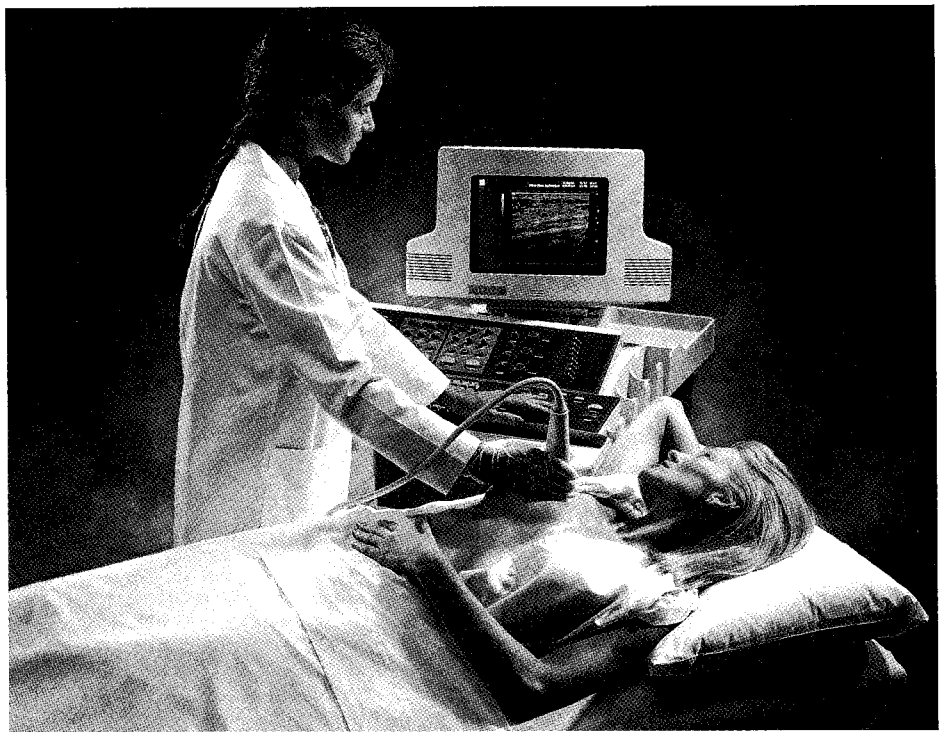


This image demonstrates most of the anatomical elements encountered by breast sonography.

The ribs are readily identified laterally because bone attenuates the sound beam, resulting in acoustic shadowing. Medially, the ribs appear as hypoechoic structures containing low level echoes.

The nipple region requires special attention, because it consists of both dense connective tissue (of the nipple) and partially connective tissue of the lactiferous ducts, which can cause posterior acoustic shadowing.

The tail of Spence (axillary tail) is the portion of the breast that extends into the axillary region.



Patient positioning

Technique

The examination of the breast with ultrasound requires a preview of the mammogram as well as a good physical examination and patient history.

The patient history should include:

- family history
- previous mammograms
- masses
- scars
- skin changes
- nipple discharge
- breast contour
- age
- parity
- gravida
- aborta
- medications (hormones)
- surgeries of the breast

Upon completing a thorough review of the patient's history, mammograms and physical examination, the breast exam can begin. The patient is scanned supine with the ipsilateral hand either above the head, or on the hip with the elbow pointed back. This causes the breast to flatten across the pectoralis muscle. Depending on the size of the breast, multiple scanning positions may be required. A cushion is placed behind the shoulder of the breast being examined. These techniques help stabilize the breast and provide reproducible positioning if open surgery is required.

The breast is then scanned with a high frequency (at least 7-10 MHz) scanhead. The breast may be scanned longitudinally or transversely. Stavros et al recently described scanning of the breast in the radial and antiradial presentation.[1] Regardless of which method is used, the breast needs to be examined in two or more orthogonal imaging planes when a mass is identified.

The breast also needs to be clearly labeled while scanning is being performed. While the "face of the clock" is the most common labeling method, others prefer to divide the breast into four quadrants. Regardless of the method used, consistency must be maintained to allow reproducibility in follow-up scans and quality control within imaging.

It is important to pay close attention to the nipple area when scanning, since a shadow can be caused by the erection of the nipple. In this case, either apply more pressure, use more gel or scan the nipple area obliquely. Scanning the nipple region obliquely is easily performed by placing a rolled up towel between the patient's breasts. By having her roll onto her side, the nipple of interest will be on top. The nipple can then be scanned from the side. This reduces the shadowing, avoids the need for a standoff pad, and provides adequate visualization of the anatomy posterior to the nipple.

Indications for breast ultrasound

Breast ultrasound is used as an adjunct to mammography and physical examination. The most common indications to perform an ultrasound exam are the presence of a palpable mass or discovery of a mass on mammogram. Ultrasound assists in identifying the mass as cystic or solid. High Definition Imaging (HDI) ultrasound assists in differentiating solid masses and identifying those lesions that are more likely benign and for whom a tissue diagnosis biopsy is more optional.* This information enables the physician and patient to make a decision as to how to manage the mass.

Ultrasound guidance of aspiration, fine needle aspiration (FNA) and core biopsies is the most recent application for ultrasound of the breast. With recent advances in technology, ultrasound-guided needle biopsies offer both the patient and the sonologist a new, simple, effective choice in breast management.[2]

Indications

- After abnormal mammogram for differentiation between cysts and solid masses
- Differentiation of solid masses to determine more likely benign lesions
- Palpable mass not visible in a radiographically dense breast
- Young, pregnant or lactating patient with a palpable mass
- Suspected abscess in infected breast
- Mass that cannot be completely evaluated with mammography because of location
- Guidance for interventional procedures

Other potential circumstances for ultrasound examination include suspected leaks from silicone implants and oncology follow-up.

Sonography is advantageous because it provides a painless, noninvasive tomographic study of the breast. The strengths of sonography complement mammography, providing additional anatomical information and increasing diagnostic confidence.

The evaluation of masses in the breast has been traditionally one of investigating cystic versus solid. Now, using HDI ultrasound, even more information is obtainable and solid masses can be evaluated based on their ultrasound characteristics. The ability to differentiate benign masses from other suspicious tissue reduces the need for biopsy for many patients.*

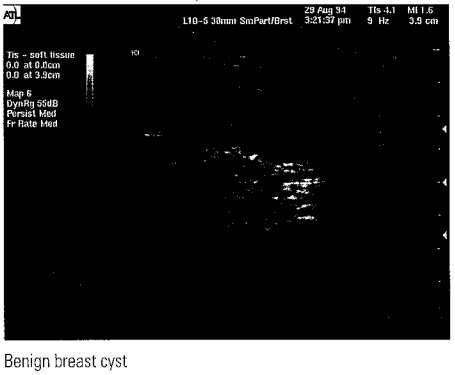
Ultrasound characteristics

- Margins
- Shape
- Echogenicity
- Echotexture
- Orientation
- Posterior acoustic attenuation pattern

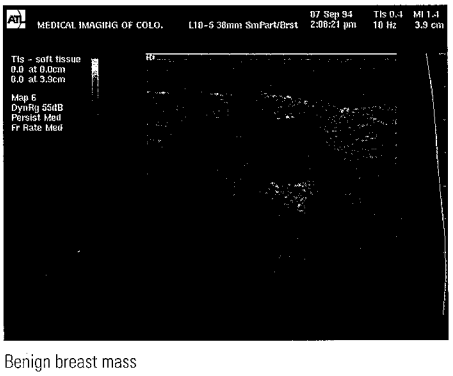
Overview of differentiating solid breast masses with HDI ultrasound*

Extensive use of ultrasound for adjunctive breast exams has shown that lesions have definite image characteristics that indicate benign appearance. When a solid breast mass is encountered, the following criteria should be evaluated:

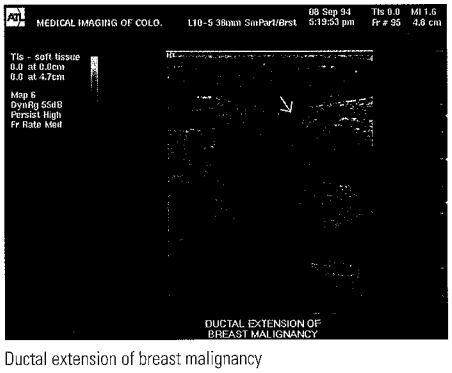
- Margins – degree of irregularity
  - Benign masses usually are indicated by smooth margins.
  - Malignant tumors appear aggressive and may have finger-like extensions or spiculations.
- Shape – ovoid, irregular, lobulated or spherical
  - Benign masses usually are spherical or ovoid – a smooth, round or egg shape. Stavros has found that lesions with three or less gentle lobulations are usually benign.
  - Malignant masses tend to be variable or irregular in shape.



Benign breast cyst



Benign breast mass



Ductal extension of breast malignancy

Simple cysts

- Completely anechoic
- Well-circumscribed
- Thinly-encapsulated
- Enhanced through transmission
- Thinly edged shadows

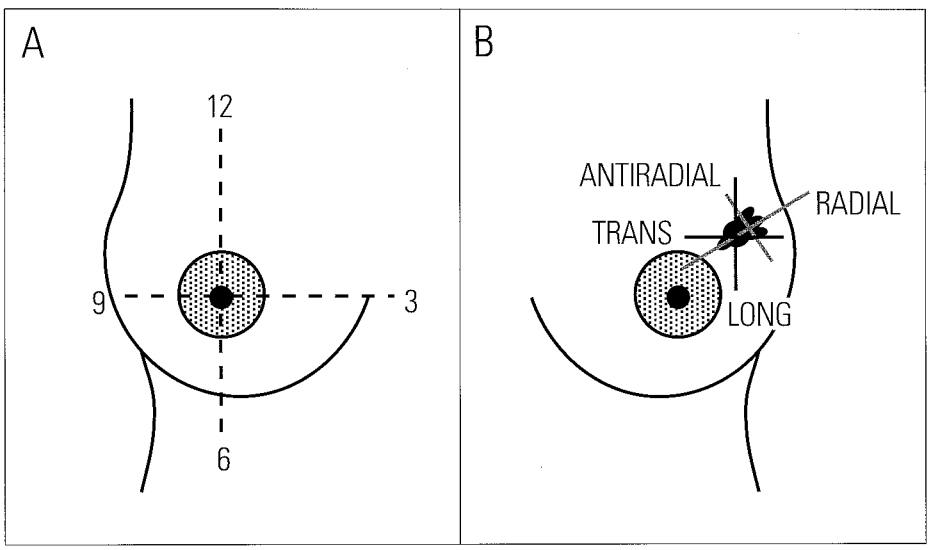
Solid masses: probably benign

- Oval shape
- Smooth defined borders
- Uniformly low or medium-level internal echoes
- Minimal attenuation, if any
- Wider than tall
- Two to three gentle lobulations

Malignant masses

- Variable shapes
- Irregular, ill-defined borders
- Low-level, non-uniform internal echoes
- Taller than wide
- Posterior attenuation

Sonography of the Breast



The breast can be scanned longitudinally or transversely whether the entire breast is scanned or just an area of interest (see figure A). If a mass is discovered, the radial/antiradial approach can help further identify borders and the possibility of ductal extension (see figure B).

Clinical Source:

Amy M. Lex, MS, RT(R), RDMS
Paula Gordon, MD

References:

[1]Stavros AT, Thickman D, Rapp C, Dennis M, Parker SH, Sisney GA. "Solid breast nodules: use of sonography to distinguish between benign and malignant lesions." *Radiology* 1995;196:123-134.

[2]Jackson VP. "The role of US in breast imaging." *Radiology* 1990;177:305-311.

Carr-Hoefer C: *Breast. In Diagnostic Medical Sonography: A guide to clinical practice, Kawamura D* (ed.), J.B. Lippencot: 1992: 541-578.

Fornage BD. "Ultrasound of the breast." *Ultrasound Quarterly* Vol. 11. No.1, 1993, pp. 1-39.

Leucht W. *Teaching Atlas of Breast Ultrasound.* Thieme Medical Publishing, Inc.: 1992.

Overview of differentiating solid breast masses *continued*

- Echogenicity and echotexture – characterization of echo pattern and texture
  - Benign masses usually are homogeneous, or of equal or lower echogenicity to the surrounding tissue, and have uniform internal echoes.
  - Malignancies are most often heterogeneous with a variety of echotextures, predominately hypoechoic.
- Orientation – position to tissue planes
  - Benign lesions usually grow parallel to tissue planes.
  - Malignant masses tend to invade surrounding tissue and cross tissue planes.
- Posterior acoustic attenuation pattern – degree of sound beam absorption
  - Benign solid masses have minimal through transmission and cystic lesions have high transmission of sound.
  - Malignant masses may absorb the sound beams and cause echoes posterior to their location to be very black and chaotic. Shadowing is also chaotic or random. (Colloid cancers may have through transmission.)

*Special training is provided for this indication. Refer to educational video program from ATL Learning Center.

We are ultrasound®

Worldwide Headquarters
Advanced Technology Laboratories
22100 Bothell Everett Highway
Bothell, Washington, USA 98021-8491
206-487-7000 or toll-free 800-982-2011
Fax: 206-485-6080

European Headquarters
Ohmstrasse 3
D-85716 Unterschleissheim
Munich, Germany
Tel: 49 (89) 32 17 50
Fax: 49 (89) 317 3955

ATL Subsidiary Offices
Argentina ☎ 54 1 642 2799; *Australia* ☎ 612 9971 1888; *Austria* ☎ 43 1 865 7337 0; *Belgium* ☎ 32 2 720 7140; *Canada* ☎ 905-475-7580; *France* ☎ 33 1 69 29 70 70; *Germany* ☎ 49 212 2840; *Hong Kong* ☎ 852 2312 0202; *India* ☎ 91 44 492 5108; *Italy* ☎ 39 2 57 51 22 03; *Netherlands* ☎ 31 3480 14848; *Singapore* ☎ 65 735 3320; *United Kingdom* ☎ 44 1462 679371

PAPER MADE FROM RECYCLED FIBER

R-0353 PRINTED IN USA 7-96